8th BACSA INTERNATIONAL CONFERENCE

"Climate changes and chemicals – the new sericulture challenges"

"CLISERI" 2017

Sheki, Azerbaijan

April 2nd – 7th 2017

PROCEEDINGS

Black, Caspian Seas and Central Asia Silk Association (BACSA)

Regional Scientific Center of Sheki of National Academy of Sciences of Azerbaijan

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PROGRAMME

Organizing committee:

President: Prof. Dr P. Tzenov, President of BACSA and Director of Academy of Agricultural Sciences, Sericulture and Agriculture Experiment Station, Vratsa, Bulgaria

Vice-president: Assoc. Prof. Dr. YUSIF SHUKURLU, Director, Regional Scientific Center of Sheki, Sheki, Azerbaijan

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Prof. Dr. Elgudja Shapakidze, Georgian Academy of Agricultural Sciences, Tbilisi, Georgia
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Scientific committee
Prof. Dr. E. Shapakidze
Dr. S. Cappellozza
Prof. Dr. S. Madyarov
Prof. Dr. P. Tzenov

Venue and Dates:

Hotel Marxal, Sheki, Azerbaijan

Programme:

1st and 2nd April, Saturday and Sunday

Arrival of the participants at Baku international airport, meeting and transfer them to Sheki by the local hosting institution, check in at Sheki Palace hotel and registration.

3rd April, Monday

9:00 – 9:30 registration.
9:30 – 10:00 opening ceremony.
10:00 – 12:00 Climate change and chemicals influence on sericulture Session 1
12:00 – 12:30 visit the sericulture exhibition.
12:30 – 13:30 Lunch
13:30 – 14:30 Climate change and chemicals influence on sericulture Session 2
14:30 – 16:00 Country reports on sericulture session 1 – background, present status, problems, issues and development strategies
16:00 – 18:00 scientific – technical reports session 1
20:00 Welcoming Dinner

4th April, Tuesday

Technical and study tour visit to Gakh town, Zakatali and Belokane: silkworm egg production factories in Gakh, and Zakatali, ethnographical museum and some other amazing places. Lunch during the tour, dinner at Zakatali.

5th April, Wednesday

9:00 – 12:30 scientific – technical reports session 2
12:30 – 13:30 Lunch
13:30 – 14:30 Posters session
14:30 – 15:30 BACSA Executive committee meeting
20:00 Dinner

6th April, Thursday

City tour in Sheki: visit the king's palace, "Karvansaray", temple from 1st century AD in Kish village, Ethnographical and Archeological museum in Fazil village, silk reeling and weaving factory in Sheki, private enterprise for production of Azeri national silk handcraft Kelagai. Lunch during the tour, farewell dinner.

7th April, Friday

Closing the conference
Departure

LIST OF PARTICIPANTS

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OPENING AND WELCOMING SPEECH

Ladies and gentlemen, Sericulturists and Distinguished delegates,

It is a privilege and a honor to meet all of you here and I am very pleased to be in the company of fellow sericulturists in this important gathering for the purpose of sharing information and experiences in world sericulture development.

I would also like to express my gratitude to the Regional Scientific Center of Sheki of National Academy of Sciences of Azerbaijan and to Dr Yusif Shukurlu personally for their tremendous efforts in organizing the present conference.

You will recall that in the early 1990s, some companies from China and some other East Asian countries damaged the image of silk with the mass production of low quality silk fabrics and wide circulation of the low quality products in the world markets. By the same time the manufacture of super fine synthetic fibers and the improved quality of other natural fibers increased their competitiveness at the market. This "strike" on the World sericultural industries led to a long period of too low silk prices, which reflected in destroy of parts or even whole sericultural value chains in many countries.

The fluctuation of silk price and unstable supply of high quality silk have impacted negatively on silk industry promotion particularly in Europe which led many silk-fabrics and silk garments manufacturing private companies to shift their major products from silk to other synthetic fibers or close.

In the recent years however the raw silk price went up, reaching over US$ 55/kg which gave optimistic expectations for cocoon production revival in many countries whose sericulture activities had been declining dramatically during the previous two decades.

The Black, Caspian Seas and Central Asia Silk Association now associates 21 countries from Europe, Caucasus and Central Asia. In most of them the sericulture has been very negatively affected during the past 30 years, in some countries any detectable sericultural activity has even stopped. Fortunately enough the research potential, even reduced and the germplasm resources have been saved in most of the member countries.

At present the trend for World silk prices increase, the availability of European and national subsidies, long tradition and farmer's experience, the need of silk industry of raw materials etc. give some new opportunities for the regional sericulture revival.

In this respect the changes of the climate and the not well controlled use of agriculture and industry chemicals are among the most critical factors for sericulture development.

In fact through changes in temperature, water regimes and carbon dioxide levels, global climate change may directly affect mulberry, soil, pests, and the silkworm.

The specific climatic conditions in the BACSA region countries require mulberry to have high cold and drought tolerance and the silkworm strains to possess a good tolerance to adverse rearing conditions like high temperature, daily temperature fluctuations and coarse mulberry leaves feeding.

On the other hand the not well controlled use of insecticides can easily harm the silkworm rearings and even to destroy completely the whole sericulture value chains in some regions or countries.

Believing that the work of the present international meeting will be successful and useful for the regional and world sericulture industry development I open the International conference **"Climate changes and chemicals – the new sericulture challenges", "CLISERI" 2017**

Thank you very much for your kind attention!

Prof. Dr. P. Tzenov, President of BACSA

LEAD PAPER!

CLIMATE CHANGES EFFECT ON SERICULTURE IN EUROPE, CAUCASUS AND CENTRAL ASIA

By

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(oral presentation)

THE GLOBAL WARMING AND CLIMATE CHANGES

The main official conceptions about the Global warming are that:

- Global temperatures are rising at a rapid, unprecedented rate.
- The "hockey stick" graph proves that the earth has experienced a steady, very gradual temperature decrease for 1000 years, then recently began a sudden increase.
- Human produced carbon dioxide has increased over the last 100 years, adding to the Greenhouse effect, thus causing most of the earth's warming of the last 100 years.
- CO2 is the most common greenhouse gas.
- Computer models verify that CO2 increases will cause significant global warming.
- The United Nations' Intergovernmental Panel on Climate Change has proven that man–made CO2 causes global warming.
- CO2 is a pollutant.
- Global warming will cause more storms and other weather extremes.
- Receding glaciers and the calving of ice shelves are proof of man-made global warming.
- The earth's poles are warming and the polar ice caps are breaking up and melting.

At the same time others consider that all these Global warming conceptions are just myths.

For example the Climate Research Unit of the University of East Anglia, shows warming to 1878, cooling to 1911, warming to 1941, cooling to 1964, warming to 1998 and cooling through 2011. The warming rate from 1964 to 1998 was the same as the previous warming from 1911 to 1941. Satellites, weather balloons and ground stations all show cooling since 2001. The mild warming of 0.6 to 0.8 ^{o} C over the 20th century is well within the natural variations recorded in the last millennium.

Significant changes in climate have continually occurred throughout geologic time. For instance, the Medieval Warm Period, from around 1000 to1200 AD (when the Vikings farmed on Greenland) was followed by a period known as the Little Ice Age. Since the end of the 17th Century the "average global temperature" has been rising at the low steady rate mentioned above; although from 1940 – 1970 temperatures actually dropped, leading to a Global Cooling scare.

There is no proof that CO_2 is the main driver of global warming. As measured in ice cores dated over many thousands of years, CO_2 levels move up and down AFTER the temperature has done so, and thus are the RESULT OF, NOT THE CAUSE of warming. Geological field work in recent sediments confirms this causal relationship. There is solid evidence that, as temperatures move up and down naturally and cyclically through solar

radiation, orbital and galactic influences, the warming surface layers of the earth's oceans expel more CO_2 as a result.

To the present day there is still no scientific proof that man-made CO2 causes significant global warming. Besides Carbon dioxide is no more a pollutant than nitrogen is. CO2 is essential to life on earth. It is necessary for plant growth since increased CO2 intake as a result of increased atmospheric concentration causes many trees and other plants to grow more vigorously.

Nevertheless whether there really is a "Global warming" or these are just cyclic climatic changes it is obvious that there are some climate changes which may badly influence the sericulture development.

CLIMATE CHANGES AND SERICULTURE

Through changes in temperature, water regimes and carbondioxide levels, global climate change will directly affect mulberry, soil, pests, and the silkworm.

The effect of climate change is not uniform on all types of crops in all regions and also during all seasons. The increase in temperature may affect crop productivity in tropics. At the same time it may help the temperate regions for higher production or product diversification.

On the contrary, the drought which is also the part of climate change, will definitely affect the productivity.

Besides there are some specificities of the climate in European and Central Asian sericulture countries. Even though these countries are located in the temperate and sub-tropical belt like Japan, Korea and parts of China, the climatic conditions are quite different. Most of European and Central Asian sericulture countries with temperate climate have comparatively cold winter and hot, but dry summer. The peak of rains during mulberry vegetation period is in May and June, but July and August are the driest months. On contrary in Japan and Korea July and August are the most rainy months during the mulberry vegetation period due to monsoons. Even though June is considered as a late spring, usually the weather is very hot during the 5^{th} larval instar. Due to very hot weather in June the mulberry leaves get coarse quickly. There is also a big temperature fluctuation during the spring rearing season in May and June, namely the night temperature could be half of the day temperature. In early spring (March and April) hot weather with high temperatures like 25 – 30 ^{o} C is quickly changed with abnorbally cold weather, even temperatures below zero which may very badly affect the already sprouted mulberry trees.

All these specific climatic conditions require mulberry to have high cold and drought tolerance and the silkworm breeds and hybrids to possess a good tolerance to adverse rearing conditions like high temperature, daily temperature fluctuations and coarse mulberry leaves feeding. It is not occasional that the bush type of mulberry plantations are not popular in any European and Central Asian sericulture country, mainly because their roots are situated too shallow in the soil, compared with low/medium/high stem mulberry trees. In some region countries like Uzbekistan for example the summer is so dry that there is almost impossible to grow mulberry without irrigation. In Japan and Korea after the spring bottom pruning of mulberry in early June starts the monsoon rainy season which is very beneficial for the trees recovery, sprouting and vigorous growth in June and August, providing long enough shoots for the summer - autumn silkworm top mulberry pruning. In our region countries however the situation is completely different because after the mulberry bottom pruning in early June starts the summer dry and hot season and mulberry suffers because of lack of sufficient water, so without irrigation the new sprouts are too short for top pruning in early September. It is not occasional also that the share of summer-autumn silkworm rearing in our region countries has always been less than 5 – 10 % of the total annual silkworm rearing.

The climatic changes are towards more periods of sudden change of temperature within one season, extremely hot weather in June, July, August and September and less rain, therefore the regional mulberry and silkworm genetic material and rearing technologies should be adapted to such climatic changes.

Unlike in the past when the temperate countries use to be the major silk producers, there is a Paradigm shift of silk production towards tropical and sub-tropical countries namely South China, India, Vietnam, Thailand in Asia who are the major silk producers in nowadays.

However what will be the situation in the medium and long term future? During the second half of 20th century and beginning of 21st century the sericulture was supported by the different international organizations and national governments mostly as an agro based industry, having a high social impact – "let develop the sericulture to alleviate poverty and create job opportunity and income resources for the poorest parts of rural society". This concept is one of the reasons for the "moving" of sericulture from the industrialized to developing regions and countries: the examples with Italian, Japanese and South Korean sericulture. The subsidies for sericulture, even very generous in some countries succeeded to save the sericulture from complete disappearing, but only maintained the production at a low level and did not succeed to revive it to the previous high production volumes.

The silk produced was comparatively cheap, providing income resources to many poor farmers from the developing countries. In nowadays there are two main cocoon producers – China and India, providing more than 97 % of the Global cocoon production. In both two countries the local silk market plays a very important role, especially in India, thus presently China exports more than 98 % of the raw silk in the world market. Therefore the fresh cocoon purchasing prices in all the other countries are considered with the Chinese raw silk price. The fresh cocoon purchasing prices in China and India have increased almost triple during the last 10 years, reaching around 7 – 10 US$/kg now. In fact, judging from the previous experience, there is no any chance these prices to go down back, on the contrary they increase year by year so far. Here I am not going to discuss the reasons of raw silk prices increase, but this situation will lead in a medium – term future to higher cocoon and raw silk prices and as a main result in the long-term future – big increase of the silk fabrics and garment and other sericultural products prices. I believe that it will no more be possible to produce cheap silk like in 90's of 20th century and early 2000's.

Then the question is whether the more expensive silk and other sericulture products may be sold at the similar quantities like now?

It seems that at too high final products prices there will not be possible anymore to produce so comparatively big amount of cocoons and raw silk as now, so my vision about the sericulture long-term future is that it will gradually become a boutique-like industry, producing very high value product in restricted amount. This is valid also for the sericulture products use for non-textile purposes.

In the long-term future may be there will be a much smaller than now sericulture products market, but of high value products.

That means the sericulture may change from an industry for the poorest farmers, to an agribusiness, requiring more investments and productional costs, but having high revenues by high market price of the products.

If this scenario will come true some of the climate changes problems, especially the drought and high temperature during the silkworm rearing will be solved by more investments in mulberry irrigation and suitable rearing houses with good insulation and air conditioned.

Sericulture is an agroactivity comprising of host plant cultivation, silkworm egg production and silkworm rearing. Climate change affects the industry both in positive as well as negative way.

The climate changes have differential effect in different parts and seasons both on host plant cultivation and silkworm rearing.

CLIMATE CHANGE AND MULBERRY CULTIVATION

Mulberry, a perennial species is physiologically classified as C 3 plant. Plants that survive solely on C_3 fixation (C_3 plants) tend to thrive in areas where sunlight intensity is moderate, temperatures are moderate, carbon dioxide concentrations are around 200 ppm or higher, and groundwater is plentiful.

Therefore the increase in quantum of Carbon Dioxide is reported to be beneficial to mulberry which is C_3 plant. The increase in temperature may accelerate the faster growth of mulberry. Hence enabling more leaf harvests and a good biomass. However, this is possible only when there is enough moisture available in the soil.

To take the advantages of climate change, one has to have multidirectional approach of genetically improved mulberry with desired characters, better cultivation practices and better pest management system.

How to adjust the mulberry varieties and agrotechnics to cold winters, sudden temperature changes, higher temperatures and drought?

The most important way of course is the mulberry varieties improvement.

An ideal genotype of mulberry for cold and drought resistance should have following features:

- High cold tolerance, one of its most important component is the capability of variety to ripe well the shoots in order not to be damaged by the low temperatures during the winter.
- The variety to have medium term sprouting in the spring because the early sprouting varieties may be damaged by early spring frosts.
- Deep root system (for water mining from deep layers).
- High branch number.
- Can produce more biomass in stress.
- Continues to grow during stress period.
- High leaf thickness (high moisture retention, more photosynthetic efficiency).
- Capable of responding to rains immediately whereas varieties with ceased growth response takes more time.
- High cell membrane stability (can withstand high temperatures), high epicuticular wax (more water use efficiency).
- Less post-harvest water losses and increase the reflection of light).

The other important factor is a suitable mulberry agrotechnics. We could recommend the following type of plantations:

A planting inter-row distance of 1.8 – 3 meter and 0.6 – 1 m between the trees in the row. In this planting scheme the number of trees per 1 ha is 9250 – 3330. The stem height is 0.50 – 0.60 m (low – cut). The advantages of low stem trees rather than bush type plantation are deeper rooting system, thus more tolerant to drought conditions, more “fists” (3 – 6), each one producing shoots, thus giving higher leaf yield and easier to operate (harvest) because the level of pruning is higher and more convenient for the worker, thus labor saving. Besides the low – stem mulberry shoots ripe better than in the bush type, thus the trees perform better cold tolerance.

The medium and high stem mulberry trees have the same advantages, but they are more difficult for harvesting and require longer period to become full harvesting.

CLIMATE CHANGE AND SILKWORM REARING

Majority of the insects like the silkworm are cold blooded organisms, whose body temperature is approximately similar to that of environment, hence, the change in temperature influence insect behavior, distribution, development, survival, growth, and reproduction.

For the uni-bivoltine highly productive silkworm races high temperature (over 26 ^{o} C), high humidity (over 75 %) during the 5th larval instar and cocoon spinning, high rearing density, malnutrition caused by low mulberry leaf quality, high density or too low feeding amounts provided, not sufficient ventilation during the 4th and 5th instars and cocoon spinning may be considered as adverse rearing conditions.

The high air temperature during the 4th and 5th larval instars is the most harmful climatic factor that may influence badly the silkworm and cocoon crop.

In fact the problems caused by all these adverse conditions can be solved easily by keeping strictly the optimal silkworm rearing technology recommended, stressing on the following technical methods:

Adverse rearing factor	**Method to solve the problem**
High temperature and humidity during the grown larval instars and cocoon spinning	- rearing house with good insulation - air conditioned rearing house - good ventilation - cleaning the bed after each molt, in the middle of 5th instar and before the cocoon spinning - Dusting of slaked lime on rearing bed and floor to remove excess moisture especially during moulting.
High larval density	Providing sufficient rearing space
Low mulberry leaves quality	-irrigated mulberry plantation -covering the larvae by polyethylene sheet during the young, but if necessary in the grown larval instars as well.
Lack of sufficient ventilation	Equipping the rearing house with electrical fans

The problem however is that the above methods, listed require more labor and capital investments which most of the sericulture farmers do not want or are not able to make due mainly to the too low economical interest.

Therefore presently, when the sericulture farmers are still one of the poorest people from the society and the cocoon purchasing prices can not allow them to make big capital investments the only solution to solve partly the problem of adverse silkworm rearing conditions is breeding of silkworm races and F_1 hybrids, having higher tolerance to such a conditions.

The main methods in the silkworm hardy varieties breeding are:

- Selection of silkworm breeds under adverse rearing conditions.
- Crosses between bivoltine and polyvoltine races for use as breeding material.
- F1 hybrids between polyvoltine and bivoltine parents.
- F1 hybrids between hardy and highly productive silkworm breeds.

The main problem in this type of silkworm breeding is the negative correlation between the larval sturdiness and the cocoon weight, silk shell weight and the shell ratio.

Nevertheless in some countries like for example India, Japan, China, Bulgaria etc. some hardy silkworm breeds and F1 hybrids have been created during the last 20 years.

The breeding target is to create races and hybrids having high tolerance to adverse rearing conditions and medium productivity so that when providing optimal rearing conditions the farmer to obtain a normal fresh cocoon yield per box of eggs with sufficiently high silk shell ratio and reelability.

SUGGESTIONS TO MITIGATE THE EFFECTS OF CLIMATE CHANGE

- Develop new cold and drought tolerant mulberry varieties.
- Develop silkworm races to adopt for increased temperature coupled with high moisture situations.
- Develop effective management system for silkworm disease prevention/control as high temperature and moisture promote faster growth of pathogens.
- Develop suitable methods to manage high humidity and CO2 both during rearing and cocoon spinning.
- Creating economical conditions the farmers to be interested and able to make more capital investments in improving the mulberry cultivation and silkworm rearing facilities.

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P A P E R S

Some papers were presented only as PowerPoint presentations.

SOCIO- ECONOMIC PROBLEMS IN THE DEVELOPMENT OF SERICULTURE IN THE NORTH-WEST PART OF AZERBAIJAN

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Abstract: Sericulture is one of the important potential agro- based rural industries in the world. It is an important means for generating employment, income enhancement crop enterprises, and is a most appropriate household activity. So, the development of sericulture is a particular importance in our Republic. This article analyzed that socio- economic development through sericulture sector in the world and in Azerbaijan. Azerbaijan silk has repeatedly won several awards and gold medals at exhibitions. For centuries silk has brought considerable income to the country, but for the past several years, the production went into decline. Sericulture industry is facing many problems like high cost of production, limited production of local of yarn and depending on the imported yarn to produce silk fabrics etc. Today, there are great opportunities for the development of sericulture in Azerbaijan. However, it is not fully used from existing opportunities and potentials to increase its efficiency and the growth and development of silkworm breeding by intensive ways. Thus, by the way of the extensive use of existing scientific and technical achievements requires special preparation of the intensification of cocoon production. In this regard, the article investigated the development history of silkworm in the region and production indicators were analyzed, future development directions were investigated. This paper is mainly concerned with socio economic development, employment generation and sericulture sector activities in the region.

Key words: Sheki, raw silk, sericulture, silkworm breeding, natural fiber

Introduction

According to its irreplaceable uniqueness and characteristics, silk is used not only in our daily lives or in a textile industry but also used in the manufacture of following articles: radio engineering, electro technology, insulation coil for electric and telephone wire, cinematography, aviation and aerospace, medical surgery, tyres of racing cars, artillery gunpowder and including surgical sutures. It is one of the best textile materials for its hygienic, leniency, elegancy and beauty features. All of these steadily increase a demand for natural silk and cocoon which they are valuable raw materials in the global market. Standards of living, modern economic growth, the quality of life of the population, capron, perlon and several other synthetic fiber productions do not restrict the production of natural silk; as well it requires its increasing once again. Therefore, special care should be given to the development of sericulture. The major changes taking place in modern life has opened up new horizons in the development of sericulture as in other sectors of the economy. Now, enterprises involved with production make a directly connection with companies of foreign countries and have the opportunity to access the world market. This in turn, it creates favorable trading conditions of selling the product a higher price and the growth of foreign currency income which is very important for our country. Without doubt, getting of such an opportunity will provide impetus to the growth of both the mulberry and non-mulberry sectors and in generally the development of sericulture especially the acquisition of political and economic independence of republic.

The *History* of *Sericulture* in *Azerbaijan*

Since ancient times in Azerbaijan, sericulture was one of the main activities of population and was known as the largest silk producing country of the East. According to the hypothesis and study, the history of sericulture in Azerbaijan dates back to one and a half

thousand years ago. As a raw material silkworm primarily was brought to Central Asia in the form of seed, and from there to Iran and then to Azerbaijan. For many years, favorable natural and geographical conditions of Azerbaijan turned the country into the major centers of silk industry all over the world. In V-VI century sericulture has already taken an important place in the economy of Azerbaijan. The development of sericulture in the country continued XIII-XV centuries. From XIV-XV centuries to the beginning of the XIX century, Shamakhi was considered a major center of trade in silk and raw silk. Thus, sericulture became a profitable industry in the employment of population and for the quality of life and well-being. Since then, Nakhchivan, Baku, Shirvan, Sheki turned into the cocoon and silk thread producing regions, Shamakhi, Ganja and Tabriz known as silk fabric woven centers. From the second half of the XVI century Julfa and Ordubad also known as the great silk trade center. Excellent quality silk fabrics which produced in Azerbaijan have attracted the attention of traders and travelers visiting the country. Even *merchants* from *Genoa* and Venice *come here to buy silk*. A large portion of the raw material was sold to Iran, Italy, France, Russia and Turkey. Till the XIX century, sericulture and silk supplies were one of the main places in the economy of Azerbaijan. Here about 80 percent of supplied raw silk was sold to foreign countries. Raw silk of Azerbaijan was of great importance for Russia manufactory industry. Since the beginning of the XIX century the development of the textile industry in Russia, gave an impetus to the expansion of Azerbaijan silkworm. In Azerbaijan, the main factor for the development of sericulture was mulberry orchards, its cultivation and totally expanding of this industry. At the beginning of twentieth century silk productivity was very low. So that, acquisition of 18-24 kg cocoons seed from each box was considered a high product. Since 1921, Azerbaijan has started the construction of seed producing factories (Sheki, Zagatala, Agdash, Nakhchivan). In 40s years of XX century 29 thousand poods (464 tons) of 34 million pounds (544 tons) produced silk in the South Caucasus accounted for Azerbaijan.In addition, silk production had even made great progress in the regions of Basgal, Ganja and Nakchivan. During this period Sheki and Shirvan were the largest centers for the cultivation of silkworms and production of silk goods. Thousands of hectares of new mulberry orchards were gardened to expand the raw-material base in 15 regions of the country. The growth of silk production required more raw materials and mulberry trees were planted not only in Shirvan, Ganja and Sheki, but also in Zagatala, Balakan, Aghdash, Gakh and Gabala regions. Sericulture being a part of history and culture of the country had positive impacts on maintaining historical traditions by bringing direct economic benefit as an industry area. Very elegant, decorated, embroidered silk veils and scarfs were being manufactured for women in these regions. Sericulture provided job opportunities for men and women. The role of women's labor has been an essential and decisive in the process of silkworm feeding. Women were playing a major role in silk production as they constitute about 60-70% of the labor force in sericulture and silk industry, without having any role in decision making. This activity had the most significant effect on the employment or family labor. Thus, farm laborers were able to find employment all-round the year by combining work in mulberry cultivation with silk worm rearing. There were silkworm seed production/preservation centers, mulberry sapling and silkworm egg production centers, silkworms rearing houses, cocoon drying equipment/machines, cocoon storage houses and other institutions.

In the Soviet period, the volume of production of raw cocoons in Azerbaijan exceeded 20 thousand tons per year, and the silk thread was supplied to 80 weaving factories of the Union. It is worth mentioning that despite ranking the second after Uzbekistan in terms of production volumes, but was considered first in fiber quality. Azerbaijan was the leader in quality silk fibers and fabrics exported to Japan, Switzerland, Italy and many other nations of the world. The country annually produced 7,800 tons of raw cocoons in 1960-1970, while the overall production dropped to 10 tons in 2014.

Historical and current status of the sericulture and silk industry in the North-West Part of Azerbaijan

Economic-geographical region of Sheki-Zagatala counted as one of rich regions of the Azerbaijan Republic covers the administrative regions of Balakan, Gakh, Gabala, Oghuz, Zagatala and Sheki city. This economic region is the third largest in the country on its industrial importance. Over two percent of the nationwide industrial products accounts for it. The industrial structure of the economic region consists of light and food industries that operate on the basis of local agricultural raw materials and natural resources. Agriculture is the basis of the region's economy, for this reason industrial enterprises mainly processed agricultural products. Sericulture is also one of the traditionally profitable employment areas in the economy of North-West part of Azerbaijan. As we know, sericulture industry is the combination of agriculture, animal husbandry, cottage industry and pure textile activities. It is a labor-intensive industry in all its phases, namely, cultivation of silkworm food plants, silkworm rearing, silk reeling, and other post-cocoon processes such as twisting, dyeing, weaving, printing and finishing. It provides employment to approximately thousands of people, most of them being small and marginal farmers, or tiny and household industry mainly in the hand reeling and hand weaving sections.

When it comes to silk in Azerbaijan, the first place that comes to mind is ancient city of Sheki, which once considered the largest center for the production of silk and silk farming in the middle ages. The basis of the Sheki light industry is sericulture. As Sheki is located on the old Silk Road, silkworm breeding has been the main industry here for centuries. The development of sericulture put this ancient Azerbaijani city in the center of great caravan routes, and that encouraged constructing new caravanserais, bustleof city life, as well as had a significant impact on the development of trade and crafts in the region. In 1975 all the silk production enterprises were combined into V.I.Lenin Silk Productive Association. If in 1975 total volume of output was equal to 117048 thousand roubles, in 1980 this figure reached 124201 thousand roubles.In 1980 this figure reached over 8 million roubles. Six thousand workers worked in the workshops of the V.I.Lenin silk Productive Association. The Sheki kelagais (silk kerchiefs) were highly esteemed outside the Republic, in particular, in Middle Asia, North Caucasus, Daghestan. The Sheki kelagais were on display at All-Union and international exhibitions and fairs in the USSR, Iran, Syria and Rumania. The demand for kelagais is growing from year to year; resulting is broadening of its production. The silk, produced in Sheki, is being imported to some foreign countries, i.e. Japan, Sweden, Italy, etc. The silk fabrics “Shekinka”, ”Lirika”, ”Zimniy Den”, etc. Woven at the V.I.Lenin silk weaving works, is a saleable commodity in all parts of this country. In republic annually produced 5-6 thousand ton of fresh cocoons, 350-400 ton of raw silk, developed tens millions square meters of silk fabrics of various assortment.With the silkworm rearing and manufacture of cocoons were engaged more than 150 thousand country families (approximately 750-800 thousand person). In the silk industry worked more than 14 thousand person, including in Sheki silk factory more than 7 thousand person.Sericulture complex has achieved to create a network of sericulture in 60 regions of the republic and as a result, fresh cocoons production has reached 6 thousand tons in 1991.

For centuries silk has brought considerable income to the country, but for the past several years, the production went into decline and Sheki factory have been periodically stopped.In subsequent periods the demand for cocooning has sharply reduced after the suspension of activity of Ordubad silk reeling factory, Karabakh silk factory in the city of Khankendi was occupied by Armenian and the other difficulties in the activity of Sheki silk factory. 5-7 tons of leaf yields from each per hectare, with a total area of 23476 hectares, the mulberry gardens gradually fell into serious disrepair. Fresh cocoon production began to decline since 1992 (5200 tons), in 2010 only 5 tons and in 2012, 7 tons of fresh cocoons were produced. ***Until 2010, the silkworm cocoons that produced in the country over the years did not meet the demand of "Sheki Ipek" JSC (an open joint-stock company on primary cocoon processing) so, in order to provide continuous operation of this factory at full strength was imported from Uzbekistan and Iran cocoon. One of the main problems of the industry in the country is the poor***

development of silkworm and silk market. So that, the cocoon has only one buyer in the domestic market and the price is not formed on the basis of rivalry which one of the basic factors mainly influence the reduction of interest of the silkworm producers.

According to research we can say that fresh cocoons in Sheki there have been grown 4.7 million tons in 1978, 4.8 million tons in 1979, 5 thousand tons in 1980, 5.3 million tons in1982, but a total of 0.1 million tons of cocoons per year were produced for the years 2000-2007.In 2010, Shaki manufactures raw silk in the amount of 51.8 tons, including commodity - 12.2 tons. Silk cloth was produced in the amount of 735,800 square meters, including commodity - 164,500 square meters. The cotton fabric production hit 6,900 square meters and carpets - 127 square meters. Some 24 industrial enterprises with manufactured products worth 13.9 million manats were recorded here in 2010.Only 232 kg of silkworm cocoons were produced in Sheki in 2015. However, as a result of measures taken in 2016, the production increased to 70.7 tons of raw cocoons in 25 districts in less than two months, which is 300 times more than in 2015. The most important incentive for farmers was an almost threefold increase in the purchase price: if the kilogram of silkworm cocoon was purchased for 3 manats before, today it is purchased for 8 manats. The realities of post-oil economy of Azerbaijan call for the revival of a full-cycle sericulture industry. This will be followed by the export of competitive products such as silk, fabrics, pret-a-porter garments to international markets.

Strategic goals and objectives in the development of sericulture

Today, the development of silk industry becomes even more urgent with the increasing of demand for organic products. Another advantage of sericulture is that it is non-waste production. At each stage of the manufacturing process both obtain basic product and as well as the additional product are used in the production process again. The necessity of sericulture development associate with both economic factors and cultural and historical factors. As a part of history and culture of the country, sericulture has positive impacts on maintaining historical traditions by bringing direct economic benefit being an industry area.

There are a number of strategic objectives to achieve the goal. The main goal consists of to achieve sustainable development of sericulture industry, as well as the modernization of the economic infrastructure, application of intensive methods and improving the quality and volume of production by increasing the knowledge and skills of entrepreneurs. The following goals were reflected in the plans: attracting investments for the sericulture and silk industry, forming maximum favorable business environment and an effective mechanism for economic support for farms that engaged in rearing of silkworms and harvesting of cocoon for profit, creation of entrepreneurs and small business owners in sericulture industry, strengthening competitive power in the field of sericulture and implementation of antimonopoly measures, increasing the productivity of mulberry trees by carrying out restoration and reconstruction of existing gardens, increasing the productivity of cocoon production in manufacturers farms by using of intensive methods in sericulture, bringing it up to modern standards of technical and technological level of sericulture, provision of the population with jobs and support for industrialization and socio-economic development of rural areas.

The following additional issues arealso included here: providing manufacturers farms entities with the necessary knowledge and information, the development of relations between scientific research and business activities in the field of sericulture, creating technology parks in sericulture, increasing the role of silk products in diversifying exports, support for the strengthening of Azerbaijan's position as a country that produce organic products, the creation of new production companies in order to increase employment in the regions and implementation of relevant measures on the restoration of inactive companies.

Other important issues are: researching of investment opportunities in order to attract investors to the regions for the creation of new workplaces, implementation of relevant measures which will be offered to investors for the preparation of concrete investment opportunities, implementation of relevant measures of cocoon production in the region for the establishment of

cooperatives, the development of seedling and silkworm breeding farms, implementation of relevant measures for strengthening their material-technical base, the establishment of technical and vocational education in order to ensure low-skilled specialists in this area.

The silk factory has been going since 1931 in this region. Nowadays the silk industry is still alive in the region, but through smaller private workshops. There is chronic employment in the region. The present rate of unemployment is alarming. Reduction of poverty and socioeconomic development is possible through the creation of productive employment opportunity. Basgal, Ganja and Nakchivan, Sheki are famous for their silk industry and our aim to follow our traditions and to maintain those traditional methods and respect our history.

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EMPHASIS ON AN EXPERIMENTAL MODEL IN PLANTS TRANSFER OF PB IN MORUS SP.

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Long-term application of manure, sludge, pesticides and commercial waste tailings containing heavy metals, led to contamination of agricultural soil surface over the allowable limits, or small areas or on large surfaces. The techniques currently available are physicochemical methods of ex-situ extraction, usually costly. Moreover, they destroy the soil structure and leaves it biologically inactive.

The extraction of heavy metals by accumulation in plants (phytoextraction) was suggested as an in-situ remediation strategy, mild surface soils. Hiperacumulatoare plants are able to accumulate high concentrations of metals in exceptionally biomass without showing symptoms of phytotoxicity

However hiperacumulatoare such plants typically have slow-growing and producing only small amounts of biomass, which results in the need for a period of years for the decontamination of polluted sites.

As an alternative, the trees were proposed due to extensive root system, high rates of sweating, rapid growth and high biomass production. It is known that some species of the genus Salix and Populus can accumulate high concentrations of heavy metals, especially Cd and Zn in biomass.

Once inside the ground lead is very difficult to remove. Metal resist layer 0-15 cm from the surface, which is strongly related processes adsorption, ion exchange, precipitation and complexation with organic matter absorbed.

Lead found in soil can be classified into six general categories: lead ion dissolved in water in the soil, exchangeable, carbonate, oxide hydroxide, organic Pb, precipitated insoluble fraction. All these categories combined make up the total content of lead in soil. Lead soluble in water and are interchangeable only the fractions which are ready for consumption by the plants. Other forms of lead are very strongly linked to the ground.

All interactions that occur in the soil matrix dependent on pH. Soil pH has a significant effect on the mobility of lead and other metals in the soil. soil pH generally ranges from 4.0 to 8.5. In acidic conditions (pH <5.5), metal cations are more mobile, while anions tend to absorb the mineral surfaces.

In these conditions, the metals are more available for plant roots; However, due to an increase in solubility aluminum plant growth may be inhibited because of its toxicity. The opposite occurs when the soil matrix are basic conditions. Anions and cations are mobile are adsorbed onto mineral surfaces or precipitate, decreasing the bioavailability of consumption by the plant. Soil's capacity to adsorb lead increases with pH, cation exchange capacity (CEC), organic carbon content, redox potential soil / water and phosphate levels.

A major limiting factor for phytoextraction potential is decreased bioavailability of lead metal consumption by the plant. To overcome this limitation, it may be necessary to add synthetic chemical binders to contaminated soil to increase the amount of bioavailable lead to plants. Using synthetic sequestrants in phytoremediation process is not only to increase

consumption of heavy metals by plants by increasing the bioavailability of the metal, but also to increase the availability of micronutrients, which decreases the possibility of the plant nutrient deficiencies.

Fitoextractiei commercial purpose is to remove or reduce the level of toxic metals in contaminated soil so that it can meet the standards allowed in a period of 1 to 3 years. Standards Agency allowed under European soils contaminated with lead are approximately 500 ppm. It was observed that the application of soil amendments and chemical chelates, this target can be reached. It has been demonstrated based on scientific studies that only 1% of the total amount of lead contaminated soil is in solution and bioavailable plant in order bioremediation. By adding the synthetic chelators total amount of lead in solution can be increased close to 100%.

Increased mobility and bioavailability of lead in soil using certain chelators such as organic acids or other chemical compounds, allows hiperacumularea metals in certain plants. For lead were tested a number of different chelators: EDTA, CDTA (trans-1,2-cyclohexylene-dinitrilo-tetraacetic acid), DTPA (dietilentrinitrilo-pentaacetic acid), EGTA (etilbis [oxzetilentrinitrilo] tetraacetic acid), HEDTA (hydroxyethyl-ethylene-dinitrilo-triacetic acid), citric acid and malic acid.

Adding chelates resulted in elevated levels of lead in the plant. EDTA was found to be the best and least expensive. In soils with pH 5 and corrected EDTA, plants have accumulated nearly 2000mg / kg more lead in plants compared to other treatments applied to soils at pH 7.5. EDTA, CDTA, and DTPA all led at concentrations of lead in the plant more than 10 000 mg / kg.

To be possible a substantial lead accumulation in plant (>5000mg / kg), the concentration of synthetic chelates (EDTA, DTPA, CDTA) must exceed 1 mmol / kg. It has also been observed that plants grown in soil with chelating varied concentrations of lead consumption.

For example, the concentration of lead in peas (Pisum sativum L.cv Sparkle) was

11 000 mg / kg compared to corn that has accumulated 3500 mg / kg in soils that received equivalent quantities of EDTA. Although there are advantages associated with the use of synthetic chelates, their impact on contaminated sites have researched in terms of environmental protection.

Using chelates to increase the bioavailability of toxic metals and thus higher performance fitoremedierii at risk in their migration from the deep water or in the surface.

To study the soil Pb fitoextractiei with Morus alba, it was conceived as an experimental model consisted of the introduction of lead in soil with irrigation water, Pb phytoextraction and translocation of the roots to the leaves.

To study the influence of the concentration of lead in soil and soil pH on the amount of Pb in leaf was varied both Pb concentration of the irrigation water (40-320 mg / L) and its pH (1-5).

Experiments were carried out with mulberry trees level pots. 7 days after transplantation, it was started watering with solutions containing Pb. The soil and leaf samples were taken after 21, 42 and 63 days from the start of the experiment.

Samples of soil and leaves were dried and crushed by grinding. (<2 mm). After digestion with microwave under pressure (1 g ml sample + 9 HNO 3), the Pb content was determined by atomic adsorption (acetylene flame).

As can be seen from Figure 1 and 2, the content of Pb in the soil increased duration of treatment and the concentration of Pb in the water used for watering.

The concentration of Pb in the leaf was influenced by both the concentration of Pb in the soil, the duration of treatment and the soil pH. In the experimental conditions used, the highest concentrations of Pb in leaf were obtained at pH 5 (Figure 4-9).

From measurements performed can be seen as Morus alba is a plant hiperacumulatoare for lead (Pb in leaf maximum concentration of 38.2 mg / kg << 1000 mg / kg).

Through data analysis was evidenced influence Pb concentration in soil, the duration of

treatment and the concentration of the soil pH + Pb leaf.

Through data analysis was evidenced influence Pb concentration in soil, the duration of treatment and the concentration of the soil pH + Pb leaf.

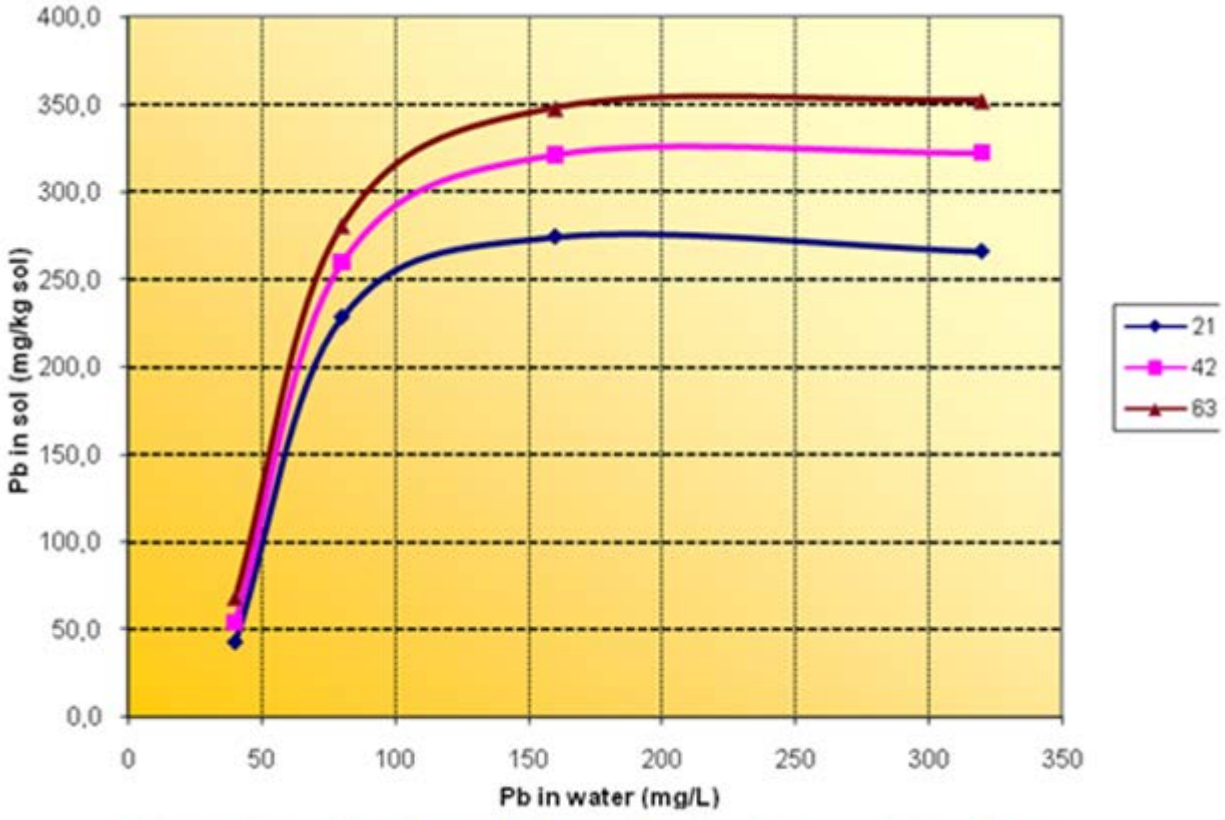

Fig.1 Influence of Pb concentration in water on the Pb concentration in soil

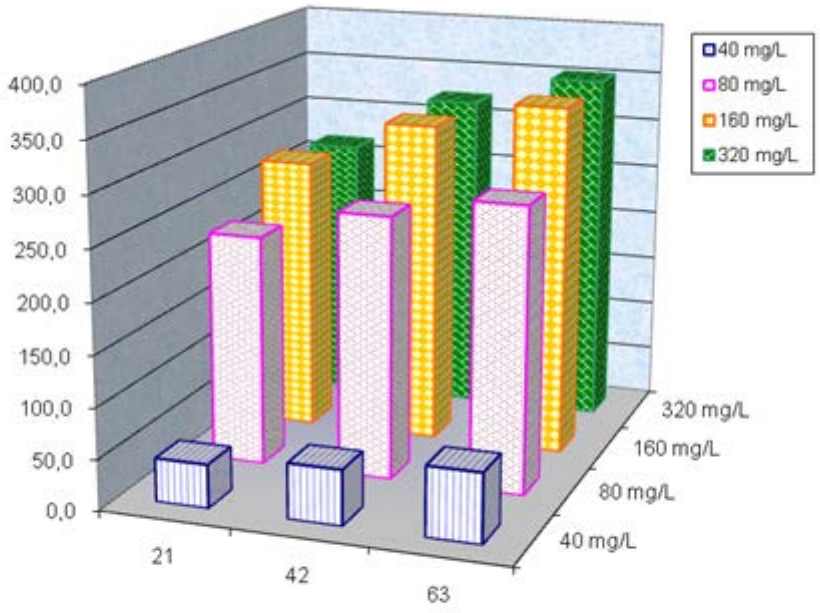

Fig.2 The influence of treatment duration on the Pb concentration in soil

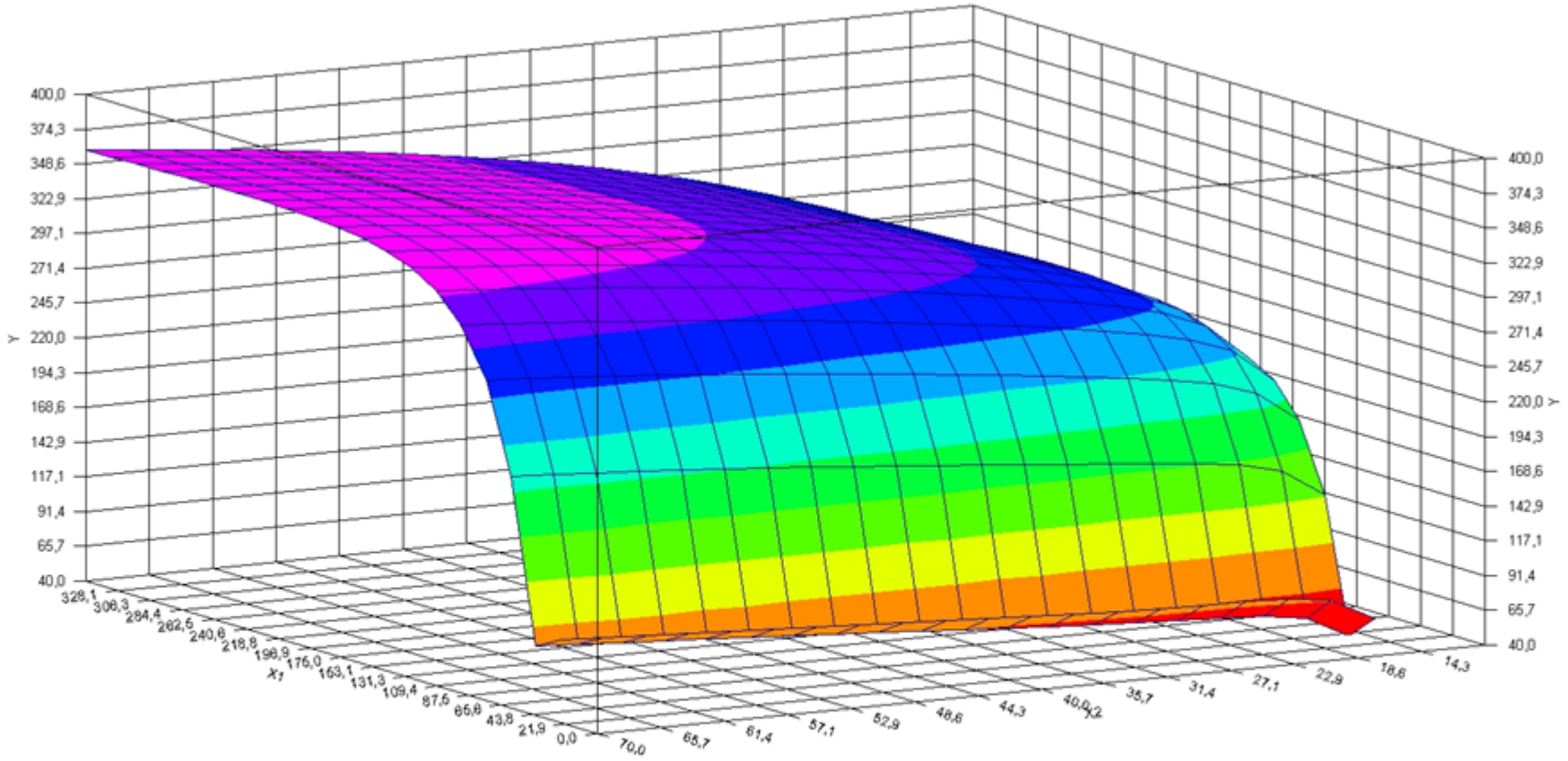

Fig.3 Modeling the influence of the concentration of lead in the water and the duration of treatment the concentration of lead in soil

Regression equation used to model the influence of soil pH and duration of treatment on the Pb concentration of leaf: $Y = a+b*x1+c/x2+d*x1^2+e/x2^2+f*x1/x2+g*x1^3+h/x2^3+i*x1/x2^2+j*x1^2/x2$

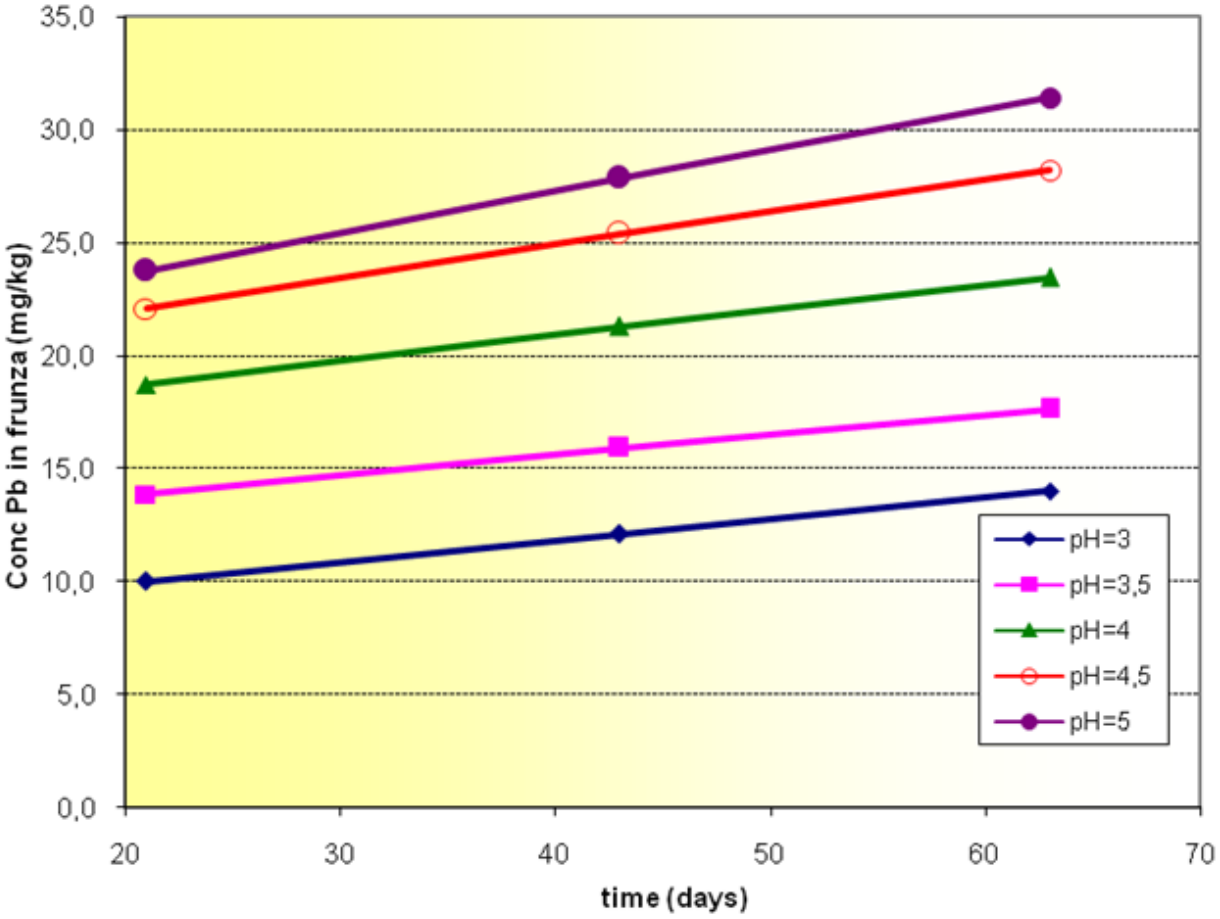

Fig.4 The influence of treatment duration on the concentration of Pb in leaf

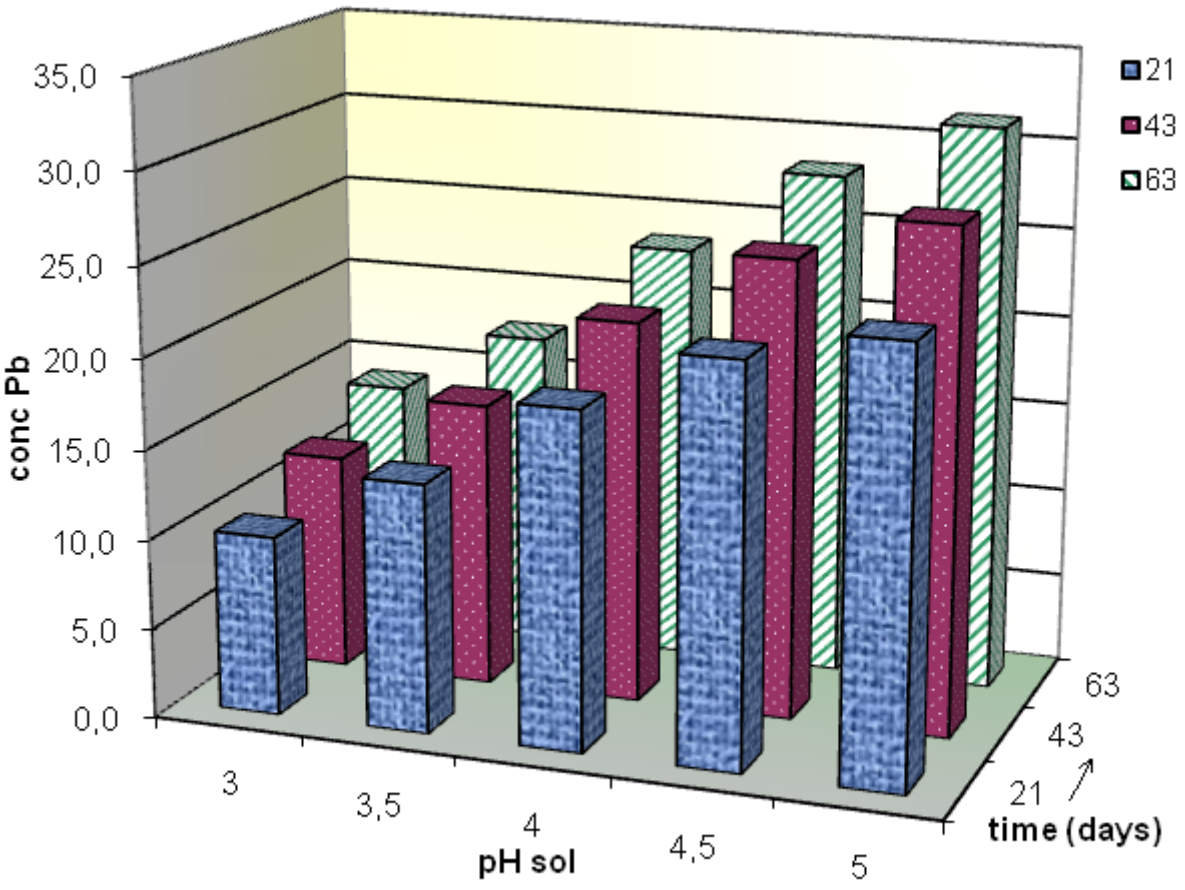

Fig.5 Influence of soil pH on Pb concentration of leaf

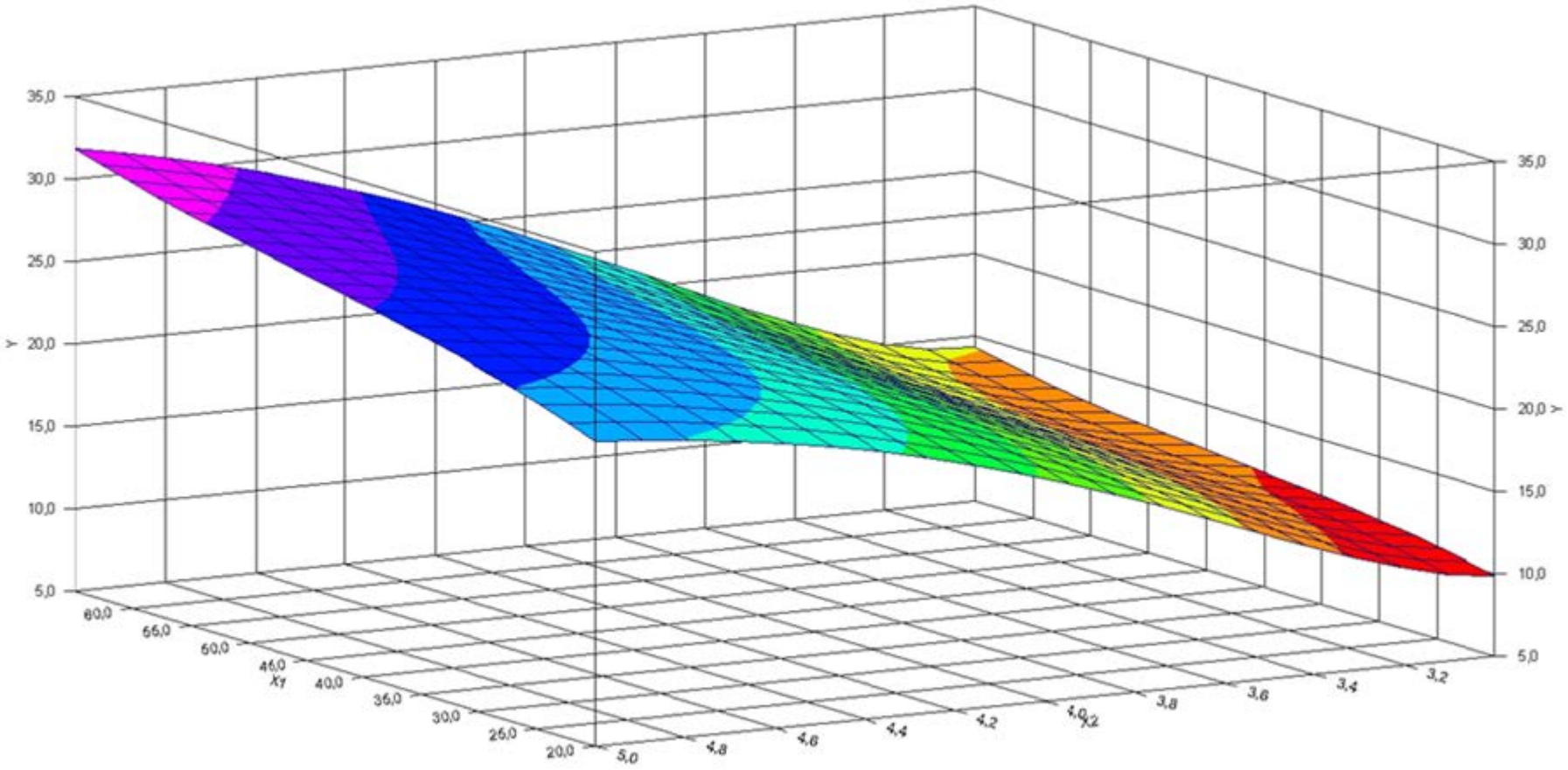

Fig.6 Modeling the influence of soil pH and duration of treatment on the Pb concentration of leaf

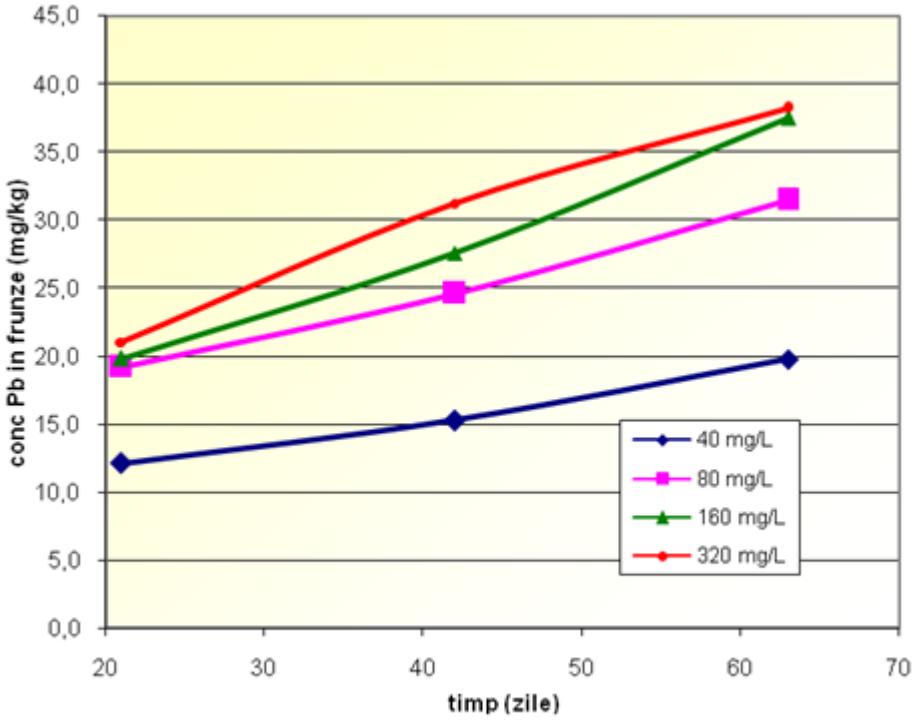

Fig.7 The influence of treatment duration on the concentration of Pb in leaf

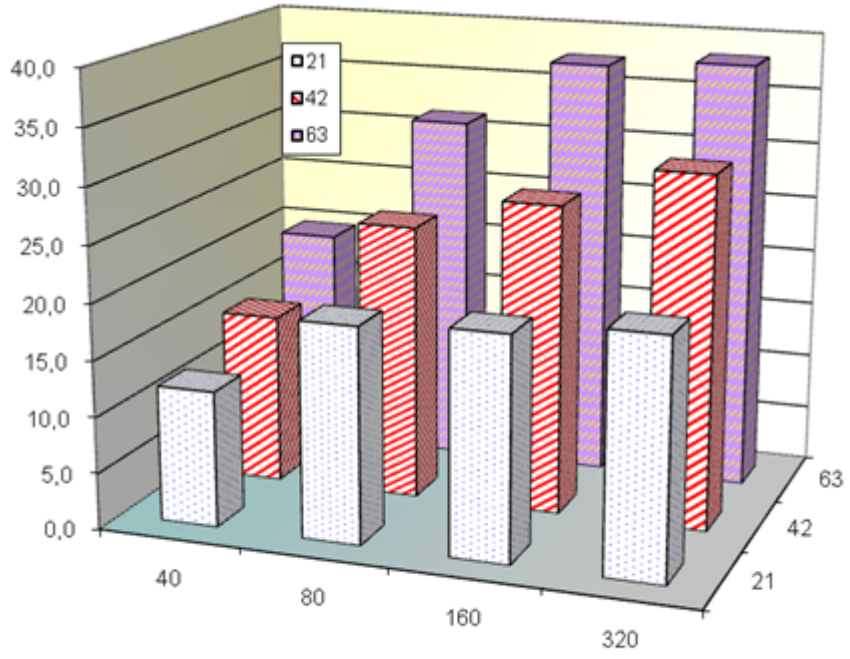

Fig.8 The influence of treatment duration and concentration of lead in the soil Pb concentration of leaf

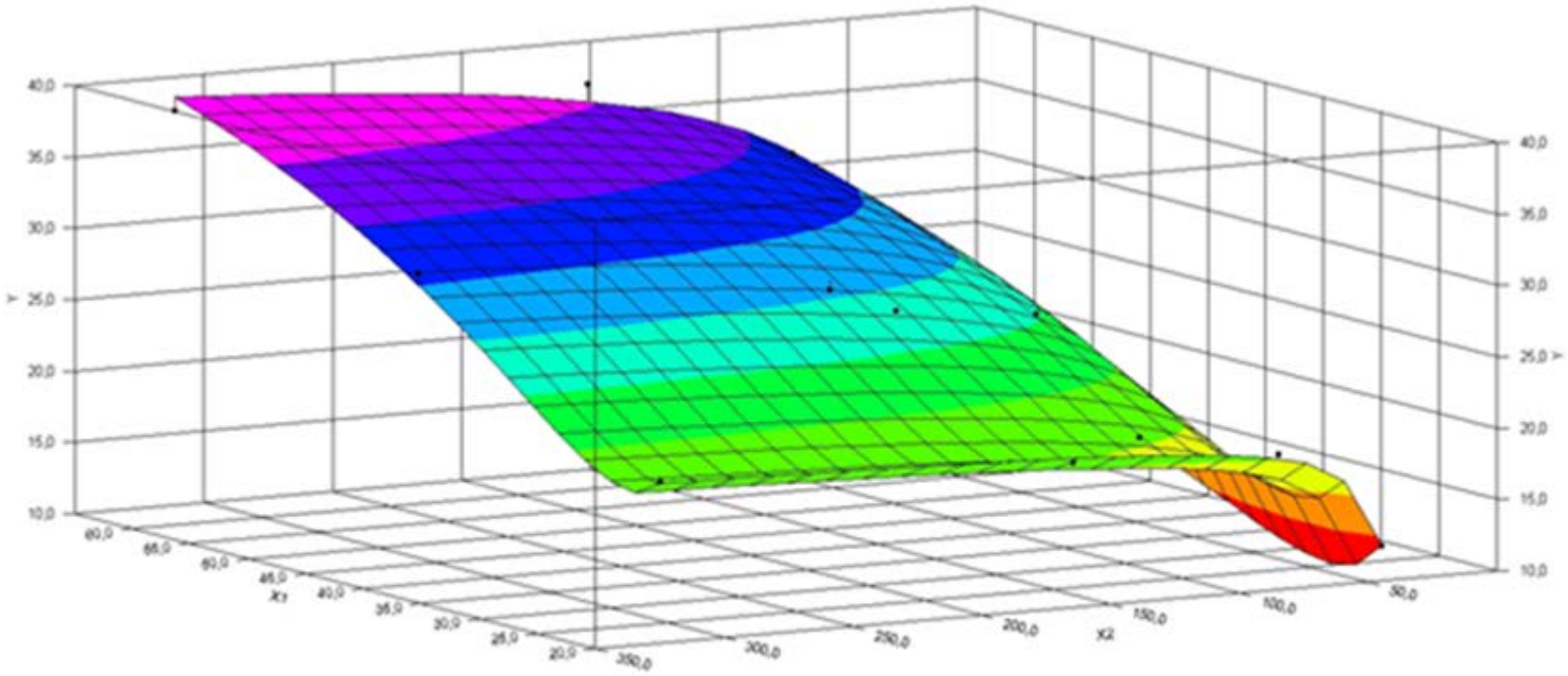

Fig.9 Modeling the influence of soil Pb concentration and duration of treatment on the Pb content in the leaf

Regression equation used to model the influence of the concentration of lead in the water and the duration of treatment on the Pb concentration of leaf:

$$Y = a+b/x1+c/x2+d/x1^2+e/x2^2+f/(x1*x2)+g/x1^3+h/x2^3+i/(x1*x2^2)+j/(x1^2*x2)$$

The values of model parameters are listed below:

Tabel 1

Variable)	Value	Standard Error	t Value	Prob (t)
a	391,9312	1075509	0,000364	0,99974
b	9634,108	25,96442	371,0503	0,00001
c	-3265,24	1,36E+08	-2,41E-05	0,99998
d	-1627403	2092,729	-777,646	0
e	-61134,1	5,22E+09	-1,17E-05	0,99999
f	160788,2	758,3735	212,0171	0,00002
g	30284394	51214,42	591,3255	0
h	1220190	5,98E+10	2,04E-05	0,99999
i	-235241	10376,85	-22,6698	0,00194
j	-2068893	11493,38	-180,007	0,00003

The residual value and relative error for data calculated in comparison with experimental data:

Tabel 2

X1	X2	Yexp	Ycalc	Residual value	Error%
40	21	43	42,997	0,003	0,006
40	42	54,5	54,506	-0,006	-0,011
40	63	68,3	68,297	0,003	0,005
80	21	228,5	228,513	-0,013	-0,006
80	42	259,8	259,784	0,016	0,006
80	63	280,9	280,903	-0,003	-0,001
160	21	274,3	274,281	0,019	0,007
160	42	321,2	321,206	-0,006	-0,002
160	63	347,9	347,913	-0,013	-0,004
320	21	266	266,009	-0,009	-0,003
320	42	322,2	322,204	-0,004	-0,001
320	63	352,2	352,187	0,013	0,004

The results of regression analysis of the experimental data are listed below:

Tabel 3

Variabla	Value	Standard Error	t value	Prob(t)
a	-7059,488	120378,724	-0,059	0,956
b	607,574	10509,254	0,058	0,956
c	1631,677	36,821	44,313	0,000
d	-15,756	272,968	-0,058	0,956
e	-6498,276	138,360	-46,967	0,000
f	-5,601	0,189	-29,593	0,000
g	0,125	2,166	0,058	0,956
h	8030,291	172,261	46,617	0,000

i	8,754	0,315	27,784	0,000
j	0,003	0,001	3,296	0,022

The following table is very good observe a correlation between the model predictions and experimental data.

Tabel 4

x1	x2	Y	Ycalc	Rezidual value	Error%
21	3	10	10,014	-0,014	-0,137
42	3	12,1	12,092	0,008	0,067
63	3	14	13,992	0,008	0,054
21	3,5	13,9	13,862	0,038	0,272
42	3,5	15,9	15,911	-0,011	-0,066
63	3,5	17,6	17,640	-0,040	-0,228
21	4	18,7	18,726	-0,026	-0,137
42	4	21,3	21,299	0,001	0,007
63	4	23,5	23,447	0,053	0,225
21	4,5	22,1	22,106	-0,006	-0,028
42	4,5	25,4	25,411	-0,011	-0,045
63	4,5	28,2	28,210	-0,010	-0,035
21	5	23,8	23,792	0,008	0,032
42	5	27,9	27,888	0,012	0,044
63	5	31,4	31,411	-0,011	-0,034

The results of regression analysis of the experimental data are listed below:

Tabel 5

Variabla	Value	Standard error	t value	(t)Prob
a	62,46	2618131,3	0,00	1,00
b	-1156,95	329884544,2	0,00	1,00
c	-1747,34	1391,5	-1,26	0,34
d	-13425,74	12700554961,8	0,00	1,00
e	39023,59	112108,0	0,35	0,76
f	42979,79	40674,2	1,06	0,40
g	416944,57	145479084184,5	0,00	1,00
h	-988241,26	2743666,9	-0,36	0,75
i	-285341,54	615647,1	-0,46	0,69
j	-312181,98	557119,1	-0,56	0,63

The following table is very good observe a correlation between the model predictions and experimental data:

Tabel 6

x1	x2	Y	Ycalc	Residual	Error%

				value	
21,0	40	12,1	12,19	-0,087	-0,719
42,0	40	15,3	15,11	0,191	1,251
63,0	40	19,8	19,90	-0,104	-0,527
21,0	80	19,2	18,88	0,318	1,655
42,0	80	24,6	24,77	-0,174	-0,708
63,0	80	31,4	31,54	-0,143	-0,457
21,0	160	19,8	20,14	-0,344	-1,737
42,0	160	27,5	28,32	-0,817	-2,972
63,0	160	37,5	36,34	1,161	3,097
21,0	320	21	20,89	0,113	0,539
42,0	320	31,2	30,40	0,800	2,565
63,0	320	38,2	39,11	-0,913	-2,391

Conclusion

- To study the soil Pb fitoextractiei with Morus alba, it was conceived as an experimental model consisted of the introduction of lead in soil with irrigation water, Pb phytoextraction and translocation of the roots to the leaves.
- To study the influence of the concentration of lead in soil and soil pH on the amount of Pb in leaf was varied both Pb concentration of the irrigation water (40-320 mg / L) and its pH (1-5).Experimentele s-au realizat cu **puieti** de dud la nivel de ghivece.
- 7 days after transplantation, it was started watering with solutions containing Pb. The soil and leaf samples were taken after 21, 42 and 63 days from the start of the experiment.
- The concentration of Pb in the leaf was influenced by both the concentration of Pb in the soil, the duration of treatment and the soil pH. In the experimental conditions used, the highest concentrations of Pb in leaf were obtained at pH= 5.

INFLUENCE OF CLIMATE ON THE DEVELOPMENT AND PRODUCTIVITY OF SOME BULGARIAN MULBERRY VARIETIES. 1. INFLUENCE OF SOME CLIMATIC FACTORS ON ECONOMIC CHARACTERS OF MULBERRY BRANCHES

By

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Abstract: The influence of basic parameters which characterized the climate conditions on economical important branch characters of some Bulgarian varieties of mulberry has been investigated. The study was conducted at Moriculture Experimental Field of SAES - Vratsa during 2010-2012. It was found that the values and the variability of climatic factors over the years affected sustainability in the development of the tested varieties. Generally, climate affects significantly the length of branches and total branch length of a tree. Correlation's coefficients between the main branch characters of mulberry and climate parameters have been ranged from negative to positive and from very low to medium by power. Length of the branches correlates weakly and negatively with the amount of rainfall during the growing period of mulberry and the amount of rainfall during the period from September to May and slightly positive by the sum of effective temperatures for the growing season. Internodal distance itself negatively correlated with the amount of precipitation for the period from September to May and the sum of effective temperatures for vegetation period and positively with the amount of rainfall during the growing period of mulberry. The influence of air temperature on the main branch characters is proved, and the sum of effective temperatures for vegetation period of mulberry correlates positively with most economical characters of tested Bulgarian varieties at Vratsa's, ecological conditions.

Keywords: mulberry varieties, climate, Vratsa, branch parameters, correlations

Morus, a genus of flowering plants in the family *Moraceae,* comprises 10-16 species of deciduous trees commonly known as mulberries, growing wild and under cultivation in many world regions. Mulberry is a shrub or tree, traditionally used in sericulture in various countries. There aremore than 100 varieties of the genus *Morus,*whichare preserved at SAES - Vratsa

Plant species with a wide range of environmental adaptations; like mulberry, have been found to exhibit numerous morphological and physiological characteristics (Cordell et al., 1998). Morphological variability in mulberry is said to have contributed to its growth and survival under various disruptive environmental conditions (Gray, 1990). Phenotypic plasticity - the ability to develop different phenotypes in response to environmental conditionsis heritable and plays an important role in species evolutionary strategy (Agrawal, 2001). Morphological characterization of mulberry has been used as a tool to examine possible genetic relationships, and this information used in its improvement (Tikader, 1997; Adolkar et al., 2007).

Orhan and Ercisli (2010) conducted a survey on mulberries aimed to select and characterize promising genotypes naturally grown in Erzurum province. In the study, a total of 26 superior mulberry accessions were selected and pomological characteristics were done. All these results showed that mulberries are well adapted to the different climatic and soil conditions, but they differ in numerous morphological traits and productivity and fruit quality.

Ten accessions selected for characteristics from the Morus germplasm maintained at the CSGRC (Hosur), were evaluated (Jalikop et al., 2011). Significant differences among the accessions were noted for trunk circumference, twig length, number of internodes and leaf size.

From all ecological factors affecting the growth and development of mulberry plantationstemperature and air relative humidity are critical.

Correlations are important in understanding the relationships between morphological/agronomic traits of accessions. This helps breeders to formulate appropriate breeding strategies for selection of desired traits (Herbert et al., 1994). In some cases, differences in relationship of growth and yield parameters associated to yield are often noticed (Vijayan et al., 1997; Tikader & Dandin, 2005, 2008).

The aim of the present study was to analyse the influence of climate conditions on economical important branch characters of some Bulgarian mulberry varieties.

Material and Methods

For the analysis of the climatic conditions all necessary meteorological data were obtained from the Meteorological Observatory in the city of Vratsa. The values of air temperature, humidity, precipitation (rainfall), wind speed and direction, etc. have been analysed.

Testing of mulberry varieties has been done on main morphological and economic characters of branches, which are strongly influenced by climatic conditions. The survey was conducted with 10 Bulgarian varieties from the genetic resources of mulberry in SEAS - Vratsa.Morphological measurements were made on 5 randomly selected and tagged plants per accession. Some of the main parameters were measured and data used for analysis. The quantitative traits were branch length (cm), branchthickness/diameter (cm), total branch length (cm), internodes distance (cm) and conversion rate of mulberry buds into shoots (sprouting rate).

Branch length was measured from the branchbase to the branch tip; branch thickness was measured at the basal point of the branch. These parameters were recorded in spring time during the fifth silkworm instar by taking measurements from the fully grown branches. Counts of the number of branches were done while growth height was measured on the longest shoot. Internodes distances were measured between the 8th-9th nodes. These measurements have been adopted by Petkov (2000a).

Some correlations and regressions between factors of agro-ecological development and some quantitative yield related characters of mulberry have been explored, according to Petkov (2000b). Correlations and regressions between amount of rainfall during the period of September - May, the amount of precipitation during the growing season of mulberry (May - October) and the sum of active temperatures (over5.0^{o}C) during the growing season of mulberry with followed mulberry characters percentage of branch ‘topfrosting; length of the branch; leafiness of the branch; leaf yields per one branch were analysed.

All necessary calculations and statistical analysis were made with IBM SPSS 23 Statistic program.

Results and Discussion

Data on environmental conditions during our study are presented in figures 1-3. Thermal regime in the region of SAES-Vratsa in the winter of 2009-2012 was characterized by normal air temperatures: November 3.1^{o}C, December 4,2^{o}C, January 0,2^{o}C, February - 5.0^{o}C and March 8.6^{o}C. Relatively high temperatures weredominated at the beginning of the year, followed by strong frosts in February when the lowest temperature -21.6^{o}C was reported. The weather was cold during the first and second decade of February and the third decade of January. Rainfall during 2011-2012 winter was relatively good in quantity and the following amounts of rainfall were measured, October -68.4 mm, November- 6.3 mm, December - 41.0 mm, January 2012-122.5 mm, February 2012-41.5 mm and March 2012 - 18.6 mm, as a minor part of them were from snow. Vegetation of mulberry in Vratsa’sregion started in the beginning of April.

The reported air temperatures during the period March-June were relatively lower than usual, and then at the end of the period, returns to average monthly temperatures ranged between 8 and 15.7^{o}C. The summer of 2011 year was very hot. Mean monthly temperatures exceeded the

average for the region: June - 23.1^{o}C, July - 26.5^{o}C, August -25.0^{o}C and September -20.5^{o}C. Precipitation was relatively low and unevenly distributed over the period, and three high extended drought periods have been described. The relative humidity was also low and ranged between 48% and 60%.

Mulberry (*Morus* spp.) is grown under varied climatic conditions ranging from temperate to tropical (Siddiquiet al., 2008). Mean separation of the morphological traits according to analysis showed that the three years were significantly differentinbranch length and internodes distance. This could have been attributed to differences in environmental conditions. Similar results were reported by Karst and Lechowics (2007) where they found differences in plasticity within varieties in relation to environmental factors. Phenotypic plasticity in response to temperature and photoperiod changes has been noted on European tree species (Kramer, 1995). The wide natural distribution of mulberry supports the idea that plasticity operates in these species. It is therefore true that inherent phenotypic differences allow a plant to survive in a wide range of environmental conditions by altering its morphology

Table 1 presents data on branch length of the mulberry varieties. The average branch length during the three years of investigation wastherefore 158.52, cm 161.51 cm and 171.39 cm. In 2010 the shortestbranches were recorded in P 17 variety-129.19 cm, and longest ones in Vratsa 18 variety - 175.80 cm. In 2011 the branches were shortest again in P 17 variety - 132.08 cm, and the longestin Veslets variety – 177.42 cm. In 2012 the branches were the longest in Vratsa 18 variety - 217.22 cm. This character is characterized by low coefficient of variation - 0.10 in 2010 and 2011 and 0.15 in 2012. The length of branches in tested mulberry varieties is affected by climatic conditions during the year, but in the majority ofvarieties the coefficient of variation was under 0.10.

From the ANOVA analysis the substantial influence of both factors - mulberry variety and year (the factor which includes itself a complex influence of climatic factors) on the branch length character was found. The interaction of the two factors on the branch length was also significant.

Data oftotal branch length per tree in tested Bulgarian varieties in the three years of our study are presented in table 2. This attribute is the product of the average length of a branch and the number of branches per tree. The highest growth was recorded in 2010 - 42.54 m, which ranges from 32.52 m to 49.81 m in Vratsa 1 variety. In 2011 the average overall growth for all tested varieties was 36.36 m, and in 2012 - 47.06 m, which ranges from 39.08 m in P 17 variety to 54.32 m in Veslets variety. Low values of the coefficient of variation for of this character- 0.08, 0.16 and 0.11 were determined for separate years of investigation. In the majority of tested varieties the coefficient of variation of this character was under 0.10, indicating that he is relatively unaffected by environmental conditions.

From the ANOVA analysis we found the significant influence of both factors- mulberry variety and climatic factors on total branch length per tree. The interaction of the two tested factors on signs was not essential.

Data for branch thickness variabilityin tested mulberry varieties are presented in table 3. The branches were thin in 2011 - 8.92 mm in average, ranging from 8.49 mm to 11.24 mm in Vratsa 1 variety. Branches in 2012 had the highest diameter -10.53 mm in average.Relatively low values of the coefficient of variation - 0.11, 0.12 and 0.17, respectively were recordedduring the different years of our study. Most of Bulgarian mulberry varieties are characterized with coefficient of variation under 0.10, indicating that branch diameter very slightlyaffected by environmental conditions. This is proved by ANOVA analysis. It can be seen that branch thickness character is significantly influenced only by mulberry variety. The influenceof climatic factors during different years and the interaction between two factors on branch diameter is irrelevant.

In table 4 wepresent data for variability of internodes distance character in tested Bulgarian mulberry varieties. It was found that this character was affected significantly by both environmental conditions and variety of mulberry and also by their interaction

The rate of conversion of buds in new shoots in the spring is an important economical character in mulberry, because to some extent it determined the productivity of mulberry (table 5). In our study we established that on average 76.12% of buds sprout and form new shoots in 2010, 76.63% in 2011 and 74.86% in 2012. This character is characterized by low values of the coefficient of variation (under 0.10)- which proved that it is an essential mulberry character,which do not influenced significantly by climate conditions. This is proved by the ANOVA analysis applied.

Due to the physiology of mulberry and the nature of its production - leaves, the influence of climatic factors on its development and productivity is difficult to determine. In mulberry the exploitation is done by full pruning of vegetativemass in the months of May and June. New shootssproutsfrom dormant and spare buds, which by the end of the growing season growing to a certain length and ripens to become branches. In the spring of next year from branch's lateral buds tosprout, and their leaves define mulberry productivity. That's why climate and agricultural conditions, from the current and previous yearinfluenced in great extent the productivity of mulberry.

For this reason we have investigated the impact of following environmental factors, which can be measured easily - amount of rainfall during the months of September - May, the amount of rainfall during the mulberry growing season (May-October) and the sum of active temperatures (over5^{o}C) during the growing season of the mulberry tree.

We have estimated the correlations and regressions between these environmental factors and some of the main characters of mulberry. Data for inter relations between characters mentioned above are presented in table 6.

The data shows that, in almost all couples of characters the correlation coefficient is non-significant. The exceptions are correlations between total growth of tree (total branch length) and rainfall for the period September - May and of rainfall for the vegetation period of mulberry and between the frost part of branches and of rainfall and sum of effective temperatures for growing season of mulberry.

The most of correlations were negative. It is interesting to note that in all cases the calculated regressions were not statistically proven. This may be due to the fact that we use data only fromfew years, or that weather conditions affect the mulberry is complex way and it is difficult to identify which one indicator of climate impacts to the fullest extent the development and productivity of mulberry.

Conclusions

The main morphological characters of 10 Bulgarian mulberry varieties were studied. It was found that climate affects significantly the length of branches and total branch length per tree. Correlation's coefficients between the main branch characters of mulberry and climate parameters have been ranged from negative to positive and from very low to medium by power. Length of the branches correlates weakly and negatively with the amount of rainfall during the growing period of mulberry and the amount of rainfall during the period from September to May, and slightly positive by the sum of effective temperatures for the growing season. Internodal distance itself negatively correlated with the amount of precipitation for the period from September to May and the sum of effective temperatures for vegetation period and positively with the amount of rainfall during the growing period of mulberry. The influence of air temperature on the main branch characters is proved, and the sum of effective temperatures for vegetation period of mulberry correlates positively with most economical characters of tested Bulgarian varieties at Vratsa's, ecological conditions.

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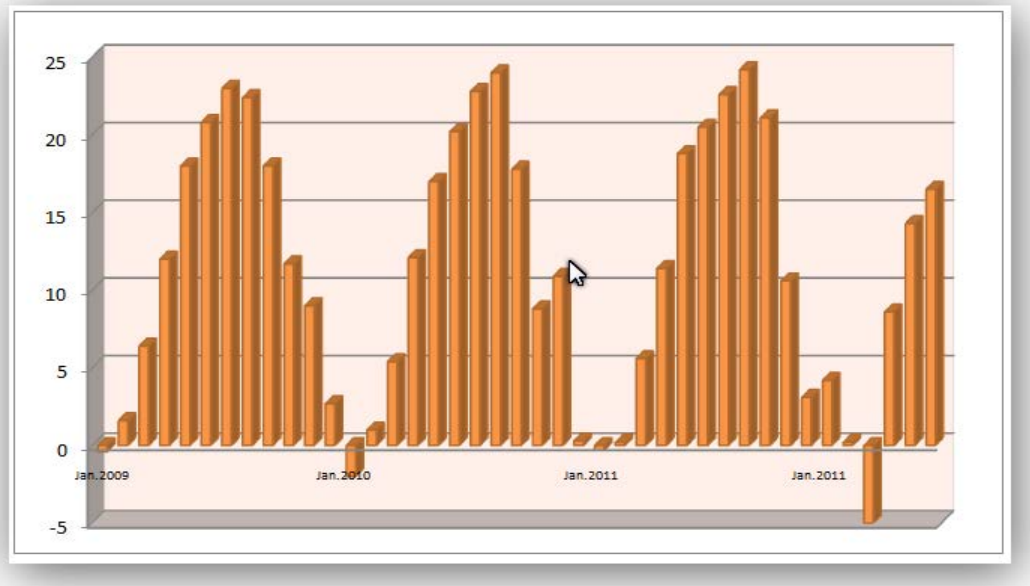

Fig. 1. Average monthly air temperature in Vratsa

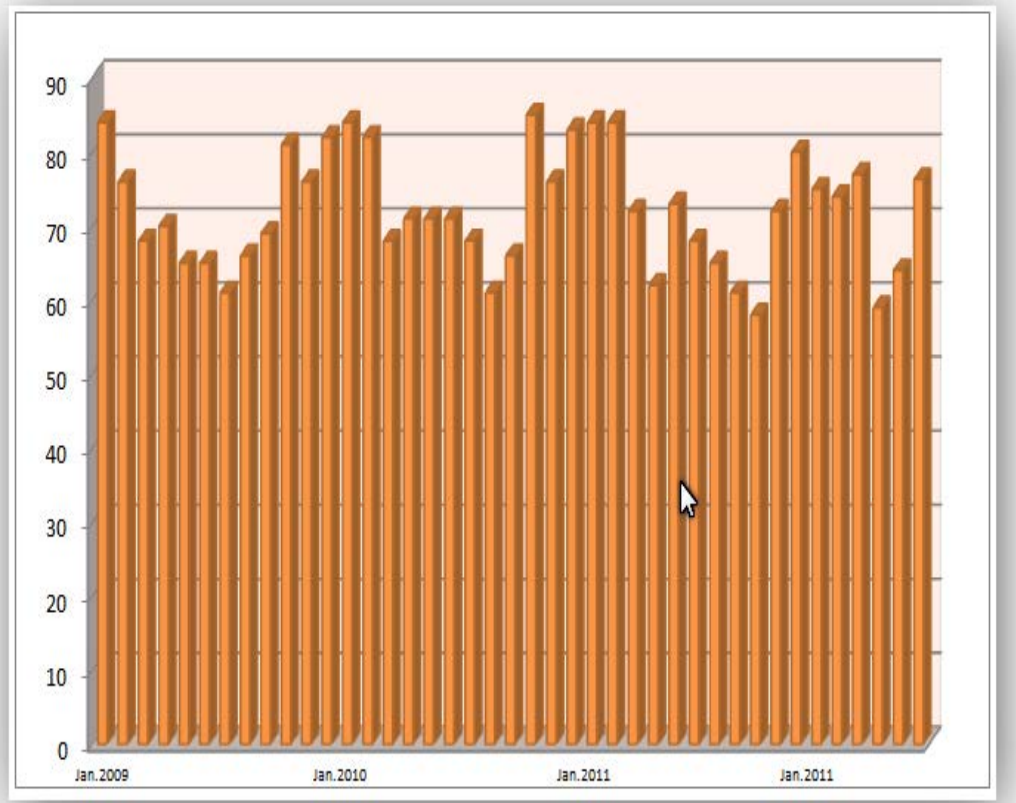

Fig. 2. Average relative air humidity of in Vratsa

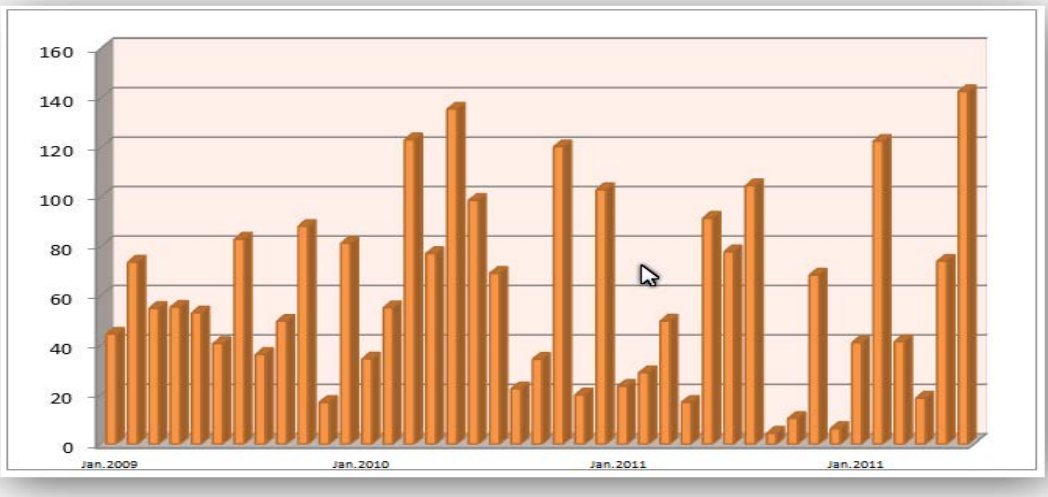

Fig.3. Monthly rainfall in Vratsa

Table 1.Length of mulberry branches, variability and ANOVA

Variety	Year			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				
No 3	162.48	166.42	154.77	167.89	3.62	6.28	0.04
No 24	151.46	154.28	186.68	155.39	2.65	4.58	0.03
P 7	158.79	160.42	189.30	174.92	8.85	15.33	0.09
P 9	164.76	167.29	143.87	175.31	9.31	16.13	0.09
P 17	129.19	132.08	121.51	127.59	3.15	5.46	0.04
P 19	143.12	146.17	124.24	147.84	3.32	5.75	0.04
Vratsa 1	169.34	173.52	191.28	178.05	6.73	11.65	0.07
Vratsa 18	175.80	178.05	217.22	190.36	13.45	23.29	0.12
Veslets	173.36	177.42	196.93	182.57	7.28	12.60	0.07
No 106	156.90	159.48	188.19	168.19	10.03	17.37	0.10
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	2460.39	2	1230.195	6.257	** (P<=0.01)		3.118
V (Varieties)	16960.1	9	1884.462	9.584	*** (P<=0.001)		1.663
Y x V	6180.86	18	343.381	1.746	* (P<0.05)		1.524
YV	25602.4						
R(YV) (Error)	23988.3	122	196.626				
YVR (Total)	49590.7	149					

Table 2.Total branch length (mulberry growth), variability and ANOVA

Variety	Year			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				

No 3	37.74	32.73	39.73	36.73	2.08	3.61	0.10
No 24	41.23	34.32	43.32	39.62	2.72	4.71	0.12
P 7	40.17	31.29	42.29	37.92	3.37	5.84	0.15
P 9	32.52	25.25	34.25	30.67	2.76	4.78	0.16
P 17	38.61	30.08	39.08	35.92	2.92	5.07	0.14
P 19	39.42	33.05	40.05	37.51	2.24	3.87	0.10
Vratsa 1	48.66	44.84	50.84	48.11	1.75	3.04	0.06
Vratsa 18	47.83	44.65	49.65	47.38	1.46	2.53	0.05
Veslets	49.81	46.32	54.32	50.15	2.32	4.01	0.08
No 106	49.65	41.06	47.06	45.92	2.54	4.41	0.10
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	1080.78	2	540.39	3.416	* (P<=0.05)		3.119
V (Varieties)	6668.27	9	740.919	4.683	** (P<=0.01)		1.663
Y x V	132.49	18	7.361	0.047	N.S. (P>0.05)		1.525
YV	7881.54						
R(YV) (Error)	19301.8	122	158.212				
YVR (Total)	27183.3	149					

Table 3 Branch thickness, variability and ANOVA

Variety	Year			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				
No 3	8.49	7.11	8.97	8.19	0.56	0.97	0.12
No 24	9.71	8.34	11.62	9.89	0.95	1.65	0.16
P 7	8.65	7.7	9.27	8.54	0.46	0.79	0.09
P 9	9.58	8.53	11.17	9.76	0.77	1.33	0.14
P 17	9.81	8.79	10.04	9.55	0.38	0.67	0.07
P 19	9.43	8.64	8.16	8.74	0.37	0.64	0.07
Vratsa 1	11.24	11.12	12.87	11.74	0.56	0.98	0.08
Vratsa 18	9.61	8.75	10.83	9.73	0.60	1.05	0.11
Veslets	9.35	9.52	10.55	9.81	0.37	0.65	0.07
No 106	9.96	10.71	11.82	10.83	0.54	0.94	0.09
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	1.81	2	0.905	1.166	N.S. (P>0.05)		3.119
V (Varieties)	45.10	9	5.011	6.454	*** (P<=0.001)		1.663
Y x V	14.83	18	0.824	1.061	N.S. (P>0.05)		1.525
YV (Interaction)	61.74						
R(YV) (Error)	94.72	122	0.776				
YVR (Total)	156.46	149					

Table 4.Internodes distance, variability and ANOVA

Variety	Year			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				
No 3	4.84	4.7	4.97	4.84	0.08	0.14	0.03
No 24	5.12	5.02	5.45	5.20	0.13	0.23	0.04
P 7	4.46	4.35	4.81	4.54	0.14	0.24	0.05
P 9	5.36	5.11	5.83	5.43	0.21	0.37	0.07
P 17	4.68	4.37	4.92	4.66	0.16	0.28	0.06
P 19	4.89	4.81	4.94	4.88	0.04	0.07	0.01
Vratsa 1	5.61	5.21	5.96	5.59	0.22	0.38	0.07
Vratsa 18	5.42	5.21	5.84	5.49	0.19	0.32	0.06
Veslets	5.48	53.5	5.72	5.52	0.11	0.19	0.03
No 106	5.73	55.7	6.03	5.78	0.13	0.23	0.04
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	481.13	2	240.565	3.197		* (P<=0.05)	3.119
V (Varieties)	3821.23	9	424.581	5.642		*** (P<=0.001)	1.663
Y x V	2076.65	18	115.369	1.533		* (P<=0.05)	1.525
YV (Interaction)	6379.01						
R(YV) (Error)	9180.72	122	75.252				
YVR (Total)	15559.73	149					

Table 5.Conversion of mulberry buds into shoots (sprouting rate), variability and ANOVA

Variety	Year			Mean	S.D.	Range	Coef. Var.
	2010	2011	2012				
No 3	76.20	77.70	68.88	74.26	3.937	7.32	0.09
No 24	78.90	76.80	75.09	76.93	5.885	3.81	0.03
P 7	71.40	70.90	72.68	71.66	1.583	1.78	0.02
P 9	71.40	72.70	67.49	70.53	2.313	5.21	0.05
P 17	75.60	76.20	70.50	74.10	0.685	2.10	0.10
P 19	66.20	68.41	70.62	68.41	2.575	4.42	0.03
Vratsa 1	80.30	79.80	81.58	80.56	1.124	1.78	0.12
Vratsa 18	82.40	81.70	83.91	82.67	3.138	2.21	0.13
Veslets	83.60	82.50	78.61	81.57	3.159	4.99	0.05
No 106	75.21	79.62	79.26	78.03	2.220	4.41	0.05
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	11.13	2	5.565	0.056		N.S. (P>0.05)	3.119
V (Varieties)	4221.23	9	469.026	4.698		*** (P<=0.001)	1.663
Y x V	266.65	18	14.814	0.148		N.S. (P>0.05)	1.525
YV	4499.01						
R(YV) (Error)	12180.72	122	99.842				
YVR (Total)	16679.73	149					

Table. 6. Correlations and regressions

Mulberry character	Ecological traits	Coefficient of correlation	Regression equation
Length of branches	Rainfall from September to May	- 0.113	y = - 0.034*x + 182.573
	Rainfall for all mulberry vegetation period	- 0.029	y = - 0.004*x + 165.871
	Sum of effective temperatures for	0.056	y = - 0.014*x + 124.283
Total branch length per tree	Rainfall from September to May	- 0.030	y = - 0.022*x + 58.783
	Rainfall for all mulberry vegetation period	- 0.164	y = - 0.062*x + 79.497
	Sum of effective temperatures for	0.183	y = - 0.110*x - 262.659
Branch thickness	Rainfall from September to May	- 0.061	y = - 0.001*x + 10.783
	Rainfall for all mulberry vegetation period	- 0.020	y = - 0.001*x + 10.194
	Sum of effective temperatures for	0.035	y = 0.001*x + 8.379
Internodal distance	Rainfall from September to May	- 0.079	y = 0.001*x + 5.498
	Rainfall for all mulberry vegetation period	- 0.007	y = 0.001*x + 5.152
	Sum of effective temperatures for	0.010	y = 0.001*x + 4.991
Sprouting rate	Rainfall from September to May	0.021	y = 0.021*x + 72.869
	Rainfall for all mulberry vegetation period	0.020	y = 0.001*x + 73.409
	Sum of effective temperatures for	- 0.028	y = - 0.021*x + 80.799

Influence of climate on the development and productivity of some Bulgarian mulberry varieties. 2. Influence of some climatic factors on economic characters of mulberry leaf and productivity in mulberry

By

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Abstract: The influence of basic parameters which characterized the climate conditions on economical important characters of leaves and productivity of some Bulgarian mulberry varieties has been investigated. The study was conducted at Moriculture Experimental Field of SAES-Vratsa during 2010-2012. It was found that climatic conditions over the years affected sustainability in the development and productivity of the tested varieties. Generally, climate affects significantly the size and weight of leaves. Mulberry productivity, expressed in leaf yield per branch also has influenced significantly by ecological conditions. Correlation's coefficients between the main leaf characters, together with leaf yield of mulberry and climate parameters have been ranged from negative to positive and from very low to medium by power. Most of tested characters, as leafiness percentage of tree, leaf weight and leaf yield per one branch correlates negatively with the amount of rainfall during the growing period of mulberry and the amount of rainfall during the period from September to May, and slightly positive by the sum of effective temperatures for the growing season. The sum of effective temperatures for vegetation period of mulberry correlates positively with most economical characters of tested Bulgarian varieties at Vratsa's ecological conditions.

Keywords: mulberry varieties, climate, leaf characters, productivity, correlations

Mulberry (*Morus* spp.), the host plant of silkworm (*Bombyx mori*) is perennial in nature. The plant is widely distributed all over the world and easily adapted to different ecological conditions(Heide, 1985) because of its wide diversity and plasticity.Moreover, genetic diversity within the population is the backbone of conservation of mulberry genetic resources (Fotedar and Dandin, 1998).

Many plant species occupy a variety of contrasting habitats and therefore plants must deal with environmental conditions. Mechanisms by which a species may occupy a wide habitat range include reversible modifications to environmental conditions, where plants attain a high degree of phenotypic plasticity (Fukui et al., 2000; Vijayan, 2009). Phenotypic plasticity is an important means by which individual plants respond to environmental heterogeneity (Guo et al., 2007). Plant species with a wide range of environmental adaptations like mulberry have been found to exhibit numerous morphological and physiological characteristics (Cordell et al., 1998).

Morphometric characterization can be used as a tool to analyze the genetic relationship among different genotypes of mulberry and the information is utilized in mulberry selection (Tikader, 1997, Masilamani and Camble, 1998, Tikader and Roy, 1999, Masilamani et al., 2000).

Genetic divergence of five mulberry accessions grown in Kenya was examined using twelve phenotypic traits (Wangari et al., 2014). The traits that were significantly different across accessions included lamina width and petiole length ($P \leq 0.01$), petiole width and growth height ($P \leq 0.05$), internodes distance and number of branches ($P \leq 0.001$). Analysis of variance of lamina length, lamina width, lamina weight, petiole weight and leaf petiole ratio by weight, petiole length, leaf petiole ratio by length and leaf yield per plant showed significant variation (Wani et al., 2014).

From all environmental factors that influenced the growth and development of perennials, air temperature and relative humidity are critical. Mulberry (*Morus* spp.) is grown under varied climatic conditions, ranging from temperate to tropical.

Siddiqui et al. (2003) studied 7 mulberry genotypes to determine the genetic variation in foliar traits. Among the seven foliar traits studied high heritability associated with high genetic advance recorded in leaf index and leaf area due to additive gene effects.

Correlations are important in understanding the relationshipsbetween morphological/agronomic/ecological traits of accessions. This helps breeders to formulate appropriate strategies for selection of desired traits (Herbert et al., 1994). In some cases, differences in relationship of growth and yield parameters associated to yield are often noticed (Vijayan et al., 1997; Tikader and Dandin, 2005, 2008).

The aim of the present study was to analyse the influence of climate conditions on economical important leaf characters and productivity in some Bulgarian mulberry varieties.

Material and Methods

For the analysis of the climatic conditions all necessary meteorological data were obtained from the Meteorological Observatory in the city of Vratsa. The values of air temperature, humidity, precipitation (rainfall), wind speed and direction, etc. have been analysed.

Testing of mulberry varieties has been done on main morphological and economic characters of leaves, which are strongly influenced by climatic conditions. The survey was conducted with 10 Bulgarian varieties from the genetic resources of mulberry in SEAS - Vratsa. Morphological measurements were made on 5 randomly selected plants per accession. The quantitative traits were leaf length (cm), leaf weight (g), frozenness of branches (%) and leafiness (%). Mulberry productivity, measured with leaf yield per one branch was analyzed also.

Leaf length was measured from the leaf base at the juncture of the petiole attachment to the leaf tip leaving the extended portion of the tip; leaf weight was measured at the same time. These parameters were recorded in spring during the fifth silkworm instar by taking measurements from the fully grown leaves from the 7th to 9th positioned leaves in the longest shoot. Frozenness of branches was determined at the bud sprouting time. Tree productivity was recorded at full growth stage of the plant. These measurements have been adopted by Petkov (2000a).

Correlations and regressions between factors of agro-ecological development and some quantitative yield related characters of mulberry have been explored, according to Petkov (2000b). Correlations and regressions between amount of rainfall during the period of September - May, the amount of precipitation during the growing season of mulberry (May - October) and the sum of active temperatures (over 5.0^{o}C) during the growing season of mulberry with tested parameters were analysed.

All necessary calculations and statistical analysis were made with IBM SPSS 23 Statistic program.

Results and Discussion

The wide distribution of mulberry suggests that this plant has big plasticity. Lamina length, lamina width, petiole length and width as well as leaf weight varied across the environments. Gray (1990) observed plasticity in leaf and fruit characteristics of mulberry. On the other hand, Kitajima et al. (1997) reported for seasonal variation and leaf polymorphism is a result of great phenotypic plasticity. It is therefore true that inherent phenotypic differences allow a plant to survive in a wide range of environmental conditions.Gray (1990) suggested phenotypic plasticity as the contributory factor to mulberry's growth and survival under disruptive environmental conditions.

Table 1 presents data on leaf length of tested mulberry varieties. The average leaf length during the three years of investigation was 16.16, cm 16.00 cm and 18.27 cm, respectively. In 2010 the smallestleaves were recorded in No 106 variety - 12.16 cm, and longest ones in Vratsa 1 variety -18.31 cm. In 2011 the leaves were the smallestin P 7 variety - 12.42cm, and the longest again in Vratsa 1 variety -18.01 cm. In 2012 the leaves were the longest in Vratsa 18

variety -20.89 cm. This character is characterized by low coefficient of variation - 0.08 in 2010, 0.07 in 2011 and 0.10 in 2012. The length of leaves in tested mulberry varieties is affected by climatic conditions during the years, but in the majority of varieties this coefficient was under 0.10.

From the ANOVA analysis the substantial influence of both factors - mulberry variety and year (the factor which includes itself a complex influence of climatic factors) on leaf size was found. The interaction of the two factors on the leaf length was also essential ($P \leq 0.05$).

Data for leaf weight in tested Bulgarian varieties in three years of our study is presented in table 2. This is an economical important character which affects the productivity in mulberry. The heaviestleaves were recorded in 2012-2.21g, which ranges from 1.57g to 2.78g in Vratsa 1 variety. In 2011 the average leaf weight for all tested varieties was 1.77g, and in 2010-1.89g, which ranges from 1.39g in P 19 variety to 2.29g in Veslets variety. Low values of coefficient of variation for this character - 0.08, 0.16 and 0.14 were determined for separate years of investigation.

In the majority of tested varieties the coefficient of variation of this character was under 0.10, indicating that he is relatively unaffected by environmental conditions.

From the ANOVA analysis we found the significant influence of both factors - mulberry variety ($P \leq 0.01$) and climatic factors ($P \leq 0.05$) on leaf weight. The interaction of these factors on tested character was not significant.

Data for tree leafiness percentage variability in tested mulberry varieties are presented in table 3. This percentage was the lowest in 2011 –51.19% in average, ranging from 46.14 % to 65.75 % in P 19 variety. Mulberry trees in 2012 had the highest percentage of leaves in their vegetative mass production -55.74 % in average. Relatively low values of the coefficient of variation – 0.06, 0.07 and 0.06, respectively were recorded during the three years of our study. Most of Bulgarian mulberry varieties are characterized with coefficient of variation under 0.10, indicating that leafiness of trees is very slightly affected by environmental conditions. This is proved by ANOVA analysis. It can be seen that leafiness is significantly influenced only by mulberry variety ($P \leq 0.001$). The influence of climatic factors during different years and the interaction between two factors is irrelevant.

This kind of performance was reported by Ogunbodede and Ajibade, (2001) to be a function of environmental adaptation as well as genetic component.

In table 4 we present data for variability of leaf productivity in tested Bulgarian mulberry varieties, represented by leaf yield per one branch character. It was found that this character was affected significantly by both climate and variety of mulberry ($P \leq 0.001$ and $P \leq 0.01$, respectively),but not by their interaction

The leaf yield per one branch is an important economical character in mulberry, because to some extent it determinesits productivity. In our study we established on average 233.36 gleaves per branch in 2010, 227.14 g in 2011 and 266.33 g in 2012.

Similar results were reported by Tikader and Kamble, (2008) with highly significant differences of growth and yield traits of mulberryaffected by ecological conditions. Phenotypic variability of mulberry germplasm has been detected also (Thangavelu et al., 2000; Tikader and Roy, 2002).

Due to the physiology of mulberry and the nature of its production - leaves, the influence of climatic factors on its development and productivity is difficult to determine. In mulberry the exploitation is done by full pruning of vegetative mass in the months of May and June. That's why climate and agricultural conditions, from the current and previous year influenced in great extent the productivity of mulberry.

Because of this we have studied the impact of following environmental factors, which can be measured easily - amount of rainfall during the months of September - May, the amount of rainfall during the mulberry growing season (May - October) and the sum of active temperatures (over $5^{o}C$) during the growing season of the mulberry tree.

We have estimated the correlations and regressions between these environmental factors and some of the characters of mulberry and its productivity. Data for inter relations between characters mentioned above are presented in table 5.

The data shows that, in almost all couples of characters the correlation coefficient is non-significant. The exceptions are correlations between the frost part of branches and of rainfall and sum of effective temperatures for growing season of mulberry.

The most of correlations were negative. It is interesting to note that in all cases the calculated regressions were not statistically proven. This may be due to the fact that they we use data only from few years, or that weather conditions affect the mulberry is complex way and it is difficult to identify which one indicator of climate impacts to the fullest extent on the development and productivity of mulberry.

Conclusions

It was found that climatic conditions over the years affected sustainability in the development and productivity of the tested Bulgarian varieties. Generally, climate affects significantly the size and weight of leaves. Mulberry productivity, expressed in leaf yield per branch also has influenced significantly by ecological conditions. Correlation's coefficients between the main leaf characters, together with leaf yield of mulberry and climate parameters have been ranged from negative to positive and from very low to medium by power. Most of tested characters, as leafiness percentage of tree, leaf weight and leaf yield per one branch correlates negatively with the amount of rainfall during the growing period of mulberry and the amount of rainfall during the period from September to May, and slightly positive by the sum of effective temperatures for the growing season. The sum of effective temperatures for vegetation period of mulberry correlates positively with most economical characters of tested Bulgarian varieties at Vratsa's ecological conditions.

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Table 1.Leaf length, variability and ANOVA

Variety	Years			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				
No 3	16.85	16.38	18.23	17.15	0.56	0.96	0.06
No 24	16.68	16.27	18.68	17.21	0.74	1.29	0.07
P 7	12.73	12.42	14.66	13.27	0.70	1.21	0.09
P 9	16.54	16.27	18.99	17.27	0.87	1.50	0.09
P 17	16.61	16.52	17.22	16.78	0.22	0.38	0.02
P 19	15.69	15.49	18.17	16.45	0.86	1.49	0.09
Vratsa 1	18.31	18.01	20.89	19.07	0.91	1.58	0.08
Vratsa 18	18.11	17.91	20.85	18.96	0.95	1.64	0.09

Veslets	17.46	17.86	19.82	18.38	0.73	1.26	0.07
No 106	12.66	12.85	15.16	13.56	0.80	1.39	0.10
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	27.38	2	13.690	3.552	* (P<=0.05)		3.119
V (Varieties)	211.83	9	13.537	3.512	* (P<=0.05)		1.663
Y x V	117.40	18	6.522	1.692	* (P<=0.05)		1.525
YV	356.61						
R(YV) (Error)	470.24	123	3.854				
YVR (Total)	826.85	149					

Table 2.Leaf weight, variability and ANOVA

Variety	Years			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				
No 3	1.93	1.77	2.23	1.98	0.13	0.23	0.12
No 24	1.74	1.56	2.13	1.81	0.17	0.29	0.16
P 7	1.57	1.34	1.88	1.60	0.16	0.27	0.17
P 9	1.86	1.49	2.12	1.82	0.18	0.32	0.17
P 17	1.44	1.47	1.65	1.52	0.07	0.11	0.07
P 19	1.39	1.42	1.57	1.46	0.06	0.10	0.07
Vratsa 1	2.27	2.31	2.78	2.45	0.16	0.28	0.12
Vratsa 18	2.29	2.03	2.64	2.32	0.18	0.31	0.13
Veslets	2.15	2.18	2.52	2.28	0.12	0.21	0.09
No 106	2.21	2.14	2.53	2.29	0.12	0.21	0.09
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	9.06	2	4.530	3.782	* (P<=0.05)		3.119
V (Varieties)	43.17	9	4.798	4.005	** (P<=0.01)		1.663
Y x V	1.38	18	0.077	0.064	N.S. (P>0.05)		1.525
YV	53.61						
R(YV) (Error)	146.15	122	1.198				
YVR (Total)	199.76	149					

Table 3.Tree leafiness, variability and ANOVA

Variety	Years			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				
No 3	46.58	44.85	49.54	46.99	1.37	2.37	0.05
No 24	48.54	48.05	53.14	49.91	1.62	2.81	0.06
P 7	56.71	54.13	60.41	57.08	1.82	3.16	0.06

P 9	56.43	53.83	58.87	56.38	1.46	2.52	0.04
P 17	44.23	43.72	46.14	44.70	0.74	1.28	0.03
P 19	63.95	62.42	65.75	64.04	0.96	1.67	0.03
Vratsa 1	59.57	58.72	63.28	60.52	1.40	2.42	0.04
Vratsa 18	48.78	46.08	52.88	49.25	1.98	3.42	0.07
Veslets	58.15	55.46	57.89	57.17	0.86	1.48	0.03
No 106	47.83	44.66	49.24	47.24	1.35	2.35	0.05
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	98.99	2	49.500	2.166	N.S. (P>0.05)		3.119
V (Varieties)	1911.38	9	212.375	9.292	*** (P<=0.001)		1.663
Y x V	645.44	18	35.858	1.569	N.S. (P>0.05)		1.525
YV	2655.81						
R(YV) (Error)	2788.37	122	22.856				
YVR (Total)	5444.18	149					

Table 4.Leaf yield per branch, variability and ANOVA

Variety	Years			Mean	S.E.M.	S.D.	Coef. Var.
	2010	2011	2012				
No 3	212.12	206.77	242.3	220.40	11.06	19.16	0.09
No 24	217.04	220.72	267.07	234.94	16.10	27.88	0.12
P 7	235.11	217.31	280.03	244.15	18.66	32.32	0.13
P 9	240.61	223.72	269.62	244.65	13.40	23.22	0.09
P 17	187.74	171.07	195.78	184.86	7.28	12.60	0.07
P 19	221.25	216.95	232.91	223.70	4.77	8.26	0.04
Vratsa 1	277.77	262.04	317.17	285.66	16.40	28.40	0.10
Vratsa 18	232.58	236.98	289.12	252.89	18.16	31.45	0.12
Veslets	273.29	276.47	306.88	285.55	10.71	18.54	0.06
No 106	236.11	239.33	262.41	245.95	8.28	14.35	0.06
Factor	SS	Df	Ms	F(cal)			F(0.05)
Y (Years)	12517.13	2	6258.57	7.756	*** (P<=0.001)		3.119
V (Varieties)	28364.89	9	3151.65	3.906	** (P<=0.01)		1.663
Y x V	20012.81	18	1111.82	1.378	N.S. (P>0.05)		1.525
YV	60894.83						
R(YV) (Error)	98449.38	123	806.96				
YVR (Total)	159344.21	149					

Table. 5. Correlations and regressions

Mulberry character	Ecological traits	Coefficient of correlation	Regression equation
Length of	Rainfall from September to May	- 0.061	y = 0.001*x + 10.783

leaves	Rainfall for all mulberry vegetation period	- 0.020	y = -0.001*x + 10.194
	Sum of effective temperatures for	0.035	y = 0.011*x + 8.379
Leaf weight	Rainfall from September to May	- 0.058	y = -0.001*x + 2.285
	Rainfall for all mulberry vegetation period	- 0.019	y = -0.001*x + 2.084
	Sum of effective temperatures for	0.033	y = 0.011*x + 1.489
Tree leafiness	Rainfall from September to May	- 0.021	y = -0.001*x + 53.630
	Rainfall for all mulberry vegetation period	- 0.031	y = -0.002*x + 53.858
	Sum of effective temperatures for	0.013	y = 0.001*x + 52.231
Branch frosting	Rainfall from September to May	0.038	y = 0.001*x + 4.053
	Rainfall for all mulberry vegetation period	- 0.203	y = -0.001*x + 5.776
	Sum of effective temperatures for	0.210	y = 0.004*x - 6.315
Leaf yield per one branch	Rainfall from September to May	- 0.069	y = -0.297*x + 247.631
	Rainfall for all mulberry vegetation period	- 0.008	y = -0.002*x + 231.711
	Sum of effective temperatures for	0.023	y = 0.008*x + 207.112

EFFECT OF SOME HEAVY METALS ON THE MAJORCHARACTERISTICS OF SILKWORM *BOMBYX MORI* L.

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ABSTRACT

The high level of industrialization of economy inevitably leads to global environmental pollution, both on a world scale and on the territory of our country. The effect of toxic and carcinogenic substances is particularly pronounced in the areas with developed chemical or metallurgical industries.

The aim of the present study was to follow up the effect of the heavy metals lead and zinc on the values of the main technological characteristics of mulberry silkworm. Silkworm larvae of hybrids Super 1 ×Hessa 2, Baksa 1 ×Svila 2 and of Kom 1 breed were fed onmulberry leaves with a high content of heavy metals, collected in the area of the Non Ferrous Metal Works – Plovdiv, reported in our previous studies.

The high content of heavy metals in feed resulted in a decreased cocoon weight, shell weight, filament length and weight. The values of the indicators characterizing the cocoon filament were significantly lower in larvae fed on contaminated mulberry leaves. They spun cocoonsof a lower weight, which influenced cocoon yield.

INTRODUCTION

Environmental pollution issues are particularly important in recent decades. There is a sharp rise in interest in heavy metals and the real threat they pose to human health.

In nature, heavy metals are widely spread and resistant to decomposition. They refer to the priority food and feed pollutants as they are elements included in the whole food chain.

Over the last 10 years, pollution has been limited and, in most cases, completely stopped by the introduction of new production technologies. Solving the pollution problem without affecting soil fertility is one of the greatest challenges facing modern science. The phytoremediation technologies are the most promising approach in thisrespect.

Phytoremediation is increasingly being applied to restore soils with a high content of heavy metals and persistent organic pollutants. Plants develop a thick root mass in the polluted soil layer and the rapid and vigorous growth enablesthe vertical migration of significant amounts of water from the soil, considerably reducing the level of heavy metals in groundwater.

The area around the Non Ferrous Metal Works– Plovdivis among the most polluted regions in Bulgaria. Pollution is spread in a radius of 3-4 km around the industrial site. In such areas, it is appropriate to develop agriculture for raw material production, not directly involved in the food industry.

Mulberry is one of the speciesstudied as a phytoremediator. For centuries, attention has been focused primarily on its use as a major source of nutrition for silkworms. Growing mulberry trees in polluted areas means the conversion of deserted lands into arable, from which income can be earned. A typical example in this regard is the cocoon production.

Silkworm (*Bombyxmori* L.) has the ability to accumulate large quantities of metals in its organs without significantly affecting its development. Our country has some of the richest silkworm genetic resources.

MATERIAL AND METHODS

The experimental work of the present study involved the use of polluted mulberry material from the mulberry plantation near the Non Ferrous Metal Works in Plovdiv, located in the village of Kuklen, near Plovdiv and Asenovgrad. Silkworm larvaewere fed three times a day with equal amounts of mulberry leaves.

The following characteristics were studied: fresh cocoon yield per box of silkwormeggs (kg), filament length (m), denier, filament weight (mg) and silk ratio (%).

When analyzing cocoons (silk filament), a comparative study of two methods of decomposition was tested – withconcentrated nitric acid and hydrochloric acid in a ratio of HNO_3:HCl = 1:3 or the so-called aqua regia, as well as by EPA 3050B:1996 with nitric acid and perhydrol. The decomposition in that method is more complete and the decomposed sample is clear. It is also used for determiningthe heavy metals in cocoons, filament and pupae.

Bulgarian F1 industrial hybrids of mulberry silkworm from the genetic resources of the Experimental Station of Sericulture and Agriculture– Vratsa: Super 1 ×Hessa 2; Baksa 1 ×Svila 2 and Kom 1 breed of Japanese origin were used in the research study.

The parameters of the most important technological characteristics of the cocoons and the silk filamentwere determined by the methods adopted in our country (Petkov, 1982;Petkov, 1995).

RESULTS AND DISCUSSION

The average freshcocoonyield was calculated based on the results obtained. For this purpose, all the cocoons with live pupaewere taken.

The results of one of the most important characteristics, i.e. freshcocoon yieldper box of silkworm eggs are presented in Figure 1. The productivity of fresh cocoons is measured by reporting the yield per standard box of viable silkworm eggs (20000±200). The values of that characteristic ranged from 6.6 kg to 10.9 kg in the experimental groups. The lowest yield was established in Kom 1 breed, in all the replications, 6.6-6.7 kg.

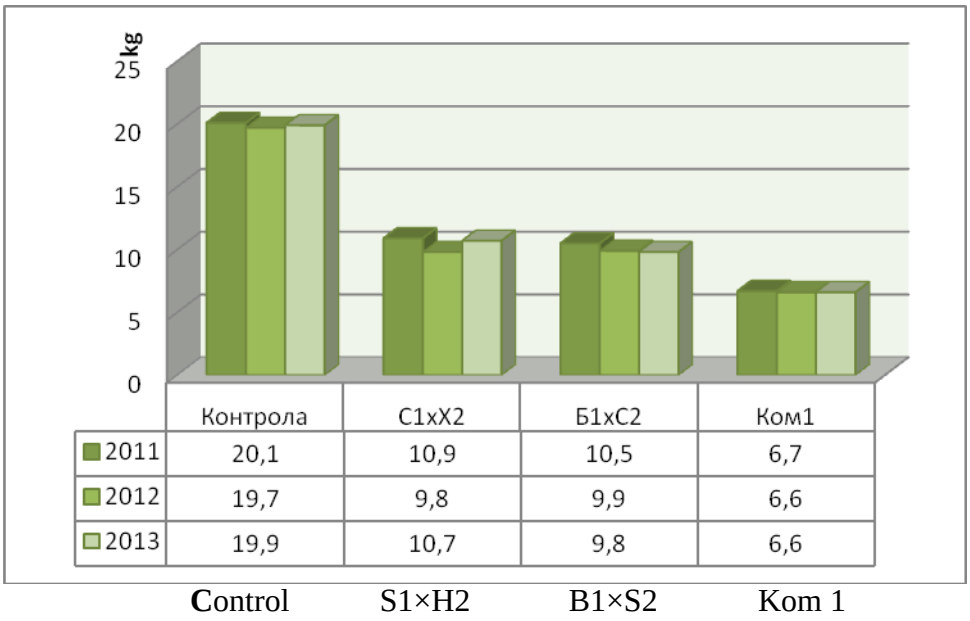

Fig. 1. Fresh cocoon yield

The low cocoonyield in the experimental groups was due to the lower pupation rate due to the effect of the heavy metals contained in the mulberry leaves from the region of the Non Ferrous Metal Works – Plovdiv.

The results obtained differed significantly from those of Petkov (1999). According to the author, the heavy metals contained in the mulberry tree leaves, regardless of the distance from roads, do not affect thatcharacteristic.

However, the results obtained in the present studywere closer to those of Tsenov (1997) and Grekov (1995).

In his studies, Grekov (1995) followed up the effect of heavy metals on the development of the mulberry silkworm. The author came to the conclusion that the heavy metals had an effect on some biological and technological characteristics.

That statement was also confirmed by Tsenov (1997). According to the author, the fresh cocoon yield per box of silkworm eggswas significantly lower because of the decreasedsurvival percentage of silkworms in the variants fed with mulberry leaves contaminated with Zn and Cu.

Comparable numerical data of the mean values of the most important technological characteristics of the silk filament are presented in Table 1.

Table 1 shows that the values of the studied characteristicsin the control and in the investigated groups differ significantly.

The technological characteristics of silk filamenthave a significant importancefor the quality of raw silk. Here again, the values are comparatively lower than those observed in the control groups fed with non-contaminated mulberry leaves. Silkworms fed with contaminated leaves spun cocoons with a lower weight, which influenced the fresh cocoon yield shown in Figure 1.

Table 1. Mean values of traits characterizing cocoon filament

Trait	Filament length, (m)	Filament size (denier)	Filament weight (mg)	Silk Ratio (%)
Control group 2011	1191	2,56	309	38,47
Experimental groupS1×H2, 2011	772	2,25	160	35,36
Experimental groupB1×S2, 2011	662	2,72	159	38,99
Control group2012	1274	2,48	319	45,91
Experimental groupS1×H2, 2012	777	2,41	158	35,91
Experimental groupB1×S2 – 2012	618	3,32	158	45,34
Control group, 2013	1243	2,3	300	38,15
Experimental groupS1×H2, 2013	788	1,7	145	32,99
Experimental groupB1×S2, 2013	701	2,11	144	53,07

The most significant differences between the groups were recorded for filament length and weight. Silk ratiowas less influenced by the presence of heavy metals in silkworm feed.

The results obtained in the present study were similar to those of other authors,for example Miyoshi (1978); Tsenov (1997) and Petkov (1999).

The statistical model analysis of variance (ANOVA) was used to determine whether or not there were significant differences in the mean values.

CONCLUSION

1. The high content of heavy metals in silkworm larvae feed results in a decrease of fresh cocoon weight, cocoon shell weight andfilament length and weight. The values of the traits characterizing the silk filament are significantly lower in silkworm larvae fed with contaminated mulberry leaves. They spun cocoons with a lower weight, which has an effect on fresh cocoon yield.
2. Silk ratio is influenced to a lesser extent by heavy metals.
3. Despite the high content of heavy metals in pupae, they do not pass into the cocoon shell and filament. The content of heavy metals in the final product (raw silk) is insignificant (<1.0 mg/kg). Thatsmall amount does not affect the quality of silk filamentproduced from silkworm larvae fed with mulberry leaves with a high content of heavy metals.

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EFFICIENCY OF ENRICHMENT OF FERTILITY AND REGULATION OF SOIL ACIDITY ON GROWTH AND YIELD OF MULBERRY

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ABSTRACT

Rwanda, located in Central Africa between 1°04' and 2°51' latitude south and between 28°45' and 31°15' longitude east, enjoys a tropical temperate climate due to its high altitude (900 ~ 4507 m ASL). It receives an annual rainfall of around 700-1000 mm/year. Almost all soils of Rwanda are reported to be acidic (pH 4.8-5.8), which negatively affects soil fertility and results in 50 % reduction in productivity of all basic grains and root crops. Of late, development of sericulture as a new branch of agriculture has started receiving great attention in Rwanda, as the state has big hopes to increase its export potential through it. Since mulberry plantation being the major economic component in sericulture, the quality of soil indirectly has a profound influence on silk production. Soils with the slightest tinge of acidity (pH 6.8) are ideal for good growth of mulberry plants. Both the lateritic and sandy types of soil observed in Rwanda are characterized by low concentration of K, Mg and other basic vital elements, low water holding capacity and low pH. Hence, administration of suitable soil reclamation measures is an essential step towards raising superior quality mulberry leaf. Usually dolomite limestone or wood ashes are recommended for regulation of soil acidity. Chemical analysis of mulberry wood ash has shown that the composition of basic elements, necessary for a plant, except for Ca, Mg and Zn surpass that in lime since the young branches are rich in macro and micro elements. Average calcium carbonate equivalent (CCE) in mulberry wood ash is 43.0 %. Use of mulberry wood ash as fertilizer in combination with other mineral and organic fertilizers improves the soil fertility, regulates acidity and enriches chemical compnents of soil, incidenatlly decreasing the incidence of dieases in a mulberry plantation and ultimately improving productivity and quality of leaves.
Key words: Leaf yield, mulberry, mulberry wood ash, soil chemical composition, soil fertility, soil pH.

INTRODUCTION

Soil quality is defined as its ability to perform a specific function within a managed or natural ecosystem that is essential to people and environment. It is known, that almost one fourth of soils on the planet is in a condition of degradation, the main reason of which is soil acidification. Soil acidification is a natural process, which usually takes hundreds, or even thousands of years to occur; however, atmospheric precipitates and incorrect management of the earth resources by humans accelerate this process enormously. For example, Rwanda, located in Central Africa between 1°04' and 2°51' latitude south and between 28°45' and 31°15' longitude east is characterised with almost all stretches of its soils being acidic (pH 4.8-5.8). This condition adversely affects the productivity of all basic grains and root crops.

Recently, sericulture has been progressing as a new branch under the ambit of Agriculture in Rwanda. As in the case of any plantation, the quality of soil of mulberry field has a profound influence not only on the leaf yield, but also on its quality, that ultimately affects growth of silkworms and thereby quantity and quality of cocoons produced. The soil of mulberry plantation must be capable of maintaining the mulberry plants for prolonged maximum productivity of quality leaves. Though mulberry is tolerant to a wide range of soil conditions, it grows well on highly fertile loamy soil. In general, the soil recommended for mulberry should be deep, well-drained, and clayey loam to loam in texture, friable, porous, and fertile with good water retention capacity. Soils with pH around 6.8 are free from injurious salts and ideal for good growth of

mulberry plants. Saline and alkaline soils and also highly acidic soils should be avoided and if not possible, should be suitably reclaimed. The present condition of soils in Rwanda makes it a requirement that suitable reclamation practices are undertaken so that mulberry can be safely grown. The aim of this work is to study the growth efficiency of vegetative organs of mulberry in response to various reclamation measures and fertilizer application under field experimental conditions.

MATERIALS AND METHODS

Study area and treatments

The experimental site is located in the mulberry plantation of Rubona Research Station, in mid-altitude agro-ecological zone in Southern Rwanda, 125 km from Kigali, the capital city. It's a hilly and mountainous station 1700 m above the sea level. It has a subequatorial climate with annual average temperatures around 18-21 ℃ and rainfall between 1300 -1800 mm/year.
There are basically two types of soil in this region: lateritic and sandy soil characterized with low concentrations of K, Mg and other basic vital elements required for plants, low water holding capacity and low pH.
The experiment was carried out on six rafts in three replications with 4-year-old Diamond (H) mulberry variety under an area of 1200 m^2. The fertilizer treatments imposed were organic manure (30,000 kg/ ha), mulberry wood ash (1125 kg/ha), lime (750 kg/ha) and $N_{30}P_{24}K_{18}$ (90 kg/ha) in different combinations. Control plantation did not receive any supplementary treatment.

Soil analysis

For interpretation of physiological state of trees in the experiment, the chemical composition of the growth substrate was analyzed in the sample plots after application of different combinations of fertilizers to soil. Soil samples were collected with a steel bore cylinder from depths of 30 cm, taking into account that approximately 80 % of feeder roots of mulberry trees are located in the layer of 10-40 cm depth (Homidy, 2012). Soil sampling was carried out once in every 12 weeks from each 10 m length of plots in four replications per treatment from May 2015 till June 2016. The soils were sieved through a 5 mm screen to remove root fragments and coarse gravel. The nutrient status of the soil upper horizon (30 cm) was determined in the Laboratory of Soil Chemistry of the Uzbek Agriculture Research Institute by adopting standard methods of soil analysis. Concentrations of P and K were determined by the Egner-Riehm double lactate method and that of Ca by the Egner-Riehm-Domingo ammonium acetate-lactate method (ISO/11260. 1995). Total N was determined by the Kjeldahl method (ISO/11261. 1995); Cu, B, Mn, Zn, and Fe were measured using a Shimadzu atomic absorption/flame emission spectrometer (AA-670), and the pH of the soil was measured as the potential acidity in H_2O (1:1 soil: water ratio) (ISO/10390. 1994).

Chemical analysis of mulberry wood ash

The characteristics and chemical composition of wood ash may vary depending on the type of raw bio material, incineration technique, additives, and storage conditions (Kofman, 1987). For our experiments, mulberry branches were used as raw material for producing wood ash. Dry wood ash was collected and mixed carefully to get homogeneous material. The same ash was used in all variants and replications. The chemical composition of wood ash was analyzed in the Laboratory of Biochemistry and Artificial Feed of the Uzbek Sericulture Research Institute.

Chemical analyses of mulberry leaves

Plant samples were taken treatment wise, 4 times during the vegetation as follows:
30.06. 15 (rainy season, after bottom pruning of mulberry plantation), 31.10.2015 (dry season,

after top pruning of mulberry plantation), 31.01.2016 (rainy and dry season, after second top pruning of mulberry plantation) and 30.04.2016 (rainy season, after second bottom pruning of mulberry plantation).

Leaves were cut into small pieces and oven-dried at 70 °C for 24 h to stop metabolic activity (Wilde et al., 1979; Landis, 1985). 1.2 g of dried leaves were ground and chemically analyzed in the Laboratory of Biochemistry and Artificial Feed of the Uzbek Sericulture Research Institute. The quantities of mineral elements viz., N, P, K, Ca, and Mg were determined. Concentrations of metallic elements were determined using an atom-adsorption analyzer AAA-1N (Karl Zeiss, Jena). For measuring N, the method of Kjeldahl was used, and P was extracted with vanadium molybdate yellow complex.

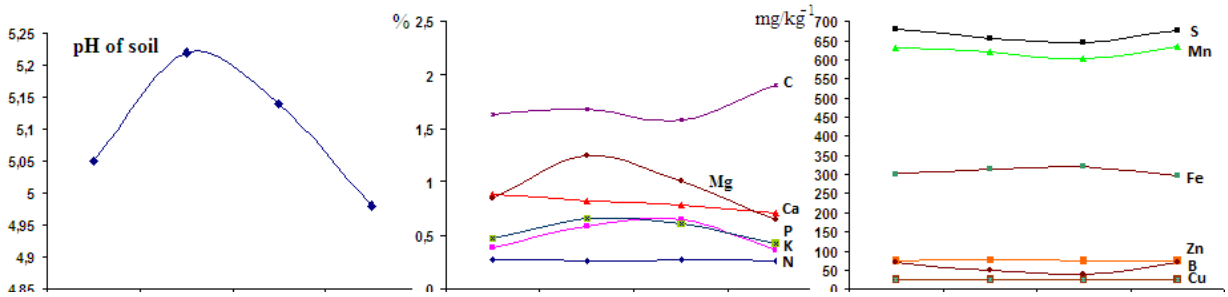
Statistical analysis

The statistical processing of the experimental data from each independent experiment with four replicates was done according to standard methods, using Microsoft® Excel 2003 program of Microsoft® Windows´2003. Average values were used for graphic presentation of results, with the significance of differences ($P<0.05$) calculated by the t test (Dospehov, 1985).

RESULTS AND DISCUSSION

Analysis of soil

Various macro and microelements are necessary for normal growth and development of plants. As known, there are around 20 of such elements, without which plants cannot complete a cycle of development and which cannot be replaced by others. As productivity of a field depends on fertility of soil and more on effective use of fertilizers, it is of great importance to define the type of soil in the field. Availability of nutrients in soil strongly depends on pH. Because of low or too high level of pH, nutrients in soil can be inaccessible for plants. The preliminary analysis of fertility of soil in the mulberry field has shown a low status of all basic vital nutrient elements and no conformity with the optimum level for mulberry (Figure 1).



M-J: May-July, A-O: August-October, November-January, F-A: February-April

Figure 1: Acidity and chemical composition of soil

It was noticed that the amount of nutrient elements in soil (except Ca, Mg and Cu) rose a little during the rainy season, in parallel with the decreased soil acidity. Such change directly depends on intensity of rains and moisture content in the soil. Moisture held in the soil promotes vital processes such as build up of microorganisms and in turn accelerates the splitting process of the biological material. Moreover, heavy rains incidentally lead to soil erosion which decreases acidity of soil.

Restoring the fertility of soil

Maintenance of soil's fertility and productivity of crops in Rwanda depends to a great extent on prevention of soil erosion and chemicalisation. However, use of fertilizers, being the leading factor in intensification of agriculture, has not reached the required level yet, which can

provide steady agriculture crop yield. For restoration of degraded soils' productivity and to receive a minimum yield of crops, Roose et al. (1988) recommended massive applications of organic manure (10 t/ha every 2 years), lime (2–4 t/ha every 3 years), and NPK fertilizer (50–100 kg/ha/yr of N, 40–100 kg/ha/yr of P, and 30– 200 kg/ha/yr of K). Due to financial constraints, farmers use only one third of the recommended manure and there are practically no actions being taken for correction of soil's acidity. Insufficient doses of fertilizers, unfavourable climatic conditions and unsatisfactory farming standards underline the need to formulate the cheapest and accessible means for promoting restoration of the productivity of degraded soils.

Mulberry plantation is a source of biomass production too. It is possible to receive more than 20 tons of firewood and more than 40 tons of mulberry leaves from one hectare annually, which creates great potential for production of organic fertilizer. The left over mulberry from silkworm rearing are being collected and converted into compost, which is then used as organic fertilizer. It is known that application of organic fertilizers leads to soil oxidation. Typically, deviations in the acidity of soil from slightly acidic or neutral status leads to an imbalance of nutrients available to plants and oppression of beneficial soil microorganisms. Majority of cultivated plants, including mulberry, and useful soil microorganisms grow well at low soil acidity (pH 6.5-7.0) It is recommended to add dolomite limestone into soil for neutralization of it super acidity. Practice shows, that application of limestone is very expensive for farmers (around 8000 USD/ha every 3 years). Besides that, the mineral limestone does not contain enough necessary vital elements for a plant. In this context, the wood ash which has been widely used as a fertilizer since ancient times, especially in those countries, where wood was in abundance, deserves a mention as an alternative to limestone. In our case, after each silkworm rearing, mulberry trees are being pruned, through which enough timber is being collected for production of wood ash (Figure 2).

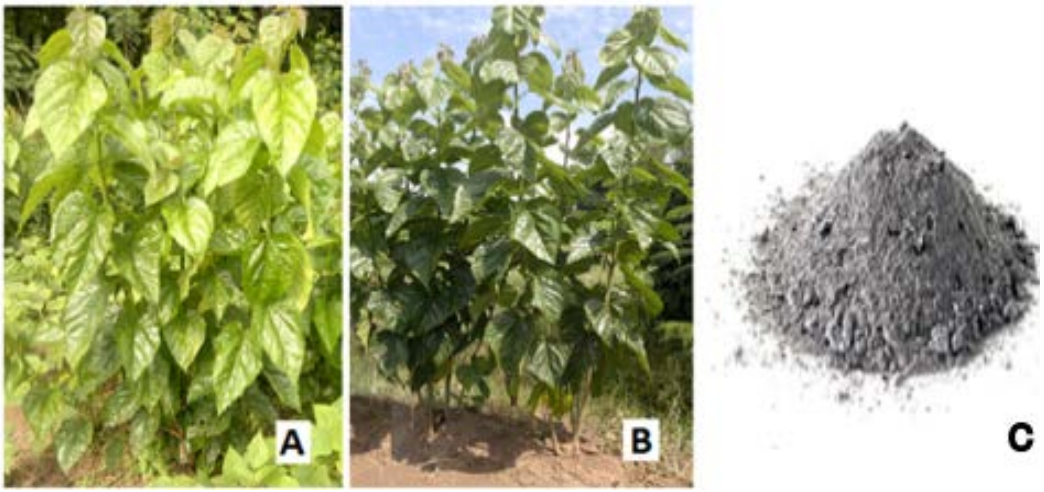


Figure 2: Mulberry plant grown in (A) acidic and (B) fertility of soil; (C) mulberry wood ash

Chemical analysis of mulberry wood ash

Before using mulberry wood ash as a fertilizer, chemical analysis of samples from different parts of the mulberry tree have been carried out and compared to limestone (Table 1).

Table 1. Range of chemical composition of the mulberry wood ash and lime

Range of chemical composition	Variant				
	Mulberry wood ash				Lime
	Stems	Branches	Leaves	Average	

Concentration in %					
Nitrogen	0,13	0,20	0,29	0,21	0,01
Potassium	0,17	0,26	1,21	0,55	0,13
Sodium	0,042	0,029	0,015	0,03	0,07
Calcium	17,32	13,21	11,43	13,98	31,1
Phosphorus	0,089	0,24	0,712	0,35	0,06
Magnesium	0,047	0,073	1,57	0,56	5,1
Carbon	1,02	1,67	2,08	1,59	-
Concentration in mg/kg^{-1}					
Iron	40,2	150,2	302,8	164,40	0,29
Sulfurous	200,0	355,1	780,9	445,33	-
Manganese	120,0	559,2	789,5	489,57	0,05
Zinc	47,0	56,5	75,5	59,67	113
Copper	20,02	23,09	27,66	23,59	6,87
Aluminum	60,68	40,10	20,3	40,36	0,29
Boron	25,00	27,00	31,50	27,83	-
Have metals					
Pb	12,05	8,01	6,21	8,75	-
Other Chemical Properties					
$CaCO_3$ Equivalent (%)	47,00	43,00	39,00	43,00	100
pH	10,80	10,40	9,80	10,33	9,9
Total solids (%)	**78,00**	**75,00**	**66,00**	**73,00**	**100**

As can be seen from the table, quantities of basic necessary elements for a plant, except for Ca, Mg, Na and Zn, in mulberry wood ash surpass those in lime. Chemical analysis of different tissues of mulberry showed the highest content of micro and macro elements in its young organs: shoots and leaves, which corresponds to the earlier literature (Hakkila, 1989; Wong et al., 2004; Werkelin et al., 2005). This is primarily due to the ongoing process of metabolism in growing organs of the plant. The increased content of elements in the leaf can be explained by the necessity for the photosynthesis process and accumulation of nutrients. Average calcium carbonate equivalent (CCE) in mulberry wood ash is 43.0 %. As the particle size of mulberry wood ash is much smaller, its acidity reducing effect considerably surpasses that of limestone. Mulberry wood ash contains a few elements that may pose environmental problems. But the heavy metal concentrations are typically low and not in a highly extractable or available form. Hence, taking into account the rich content of macro and micro elements in mulberry wood ash, it can be used as an effective valuable complex fertilizer for the restoration and maintenance of soil fertility.

Use of mulberry wood ash for regulating acidity and enriching fertility of soil

Wood ash has long been recognized as a valuable substance. Many centuries ago, ancient Roman scientists and scholars documented the value of returning ash to the land. In the 18th century, the benefits of ash-derived potash, or potassium carbonate, became widely recognized. There was a time when trees were felled in North America, burned and the ash was exported to Great Britain as “potash fever” hit. In 1790, the newly- independent United States of America’s first patented process was a method for making fertilizer from wood ash (U.S. patent number 1: “An improved method of making pot and pearl ash”). USA, Finland, Sweden and Denmark were the pioneers to undertake research on the composition and use of wood ash. In the USA, wood ash is derived from paper industry waste and power generation of which, 90 per cent share of many states goes to landfill. However, in the north-east states, only 15 per cent is land filled, as the remaining 80 per cent is land applied and 5 per cent co-composted with sewage sludge. This practice has

reduced the costs of disposal for the producing companies by up to 66 per cent in Maine and New Hampshire (Greene, 1988; Campbell, 1990; Vance, 1996).

In Finland, wood ash has been used as a soil ameliorant for second-rotation conifer stands on drained peats, on sites monitored since 1935 (Hakkila, 1989; Korpilhati et al., 1998). Research on the restoration of cut-over peat using ash as an ameliorant to change pH and restore biodiversity is underway (Näsi et al., 2005). In Sweden, ash is already produced in large quantities from energy generation and studies on recycling ash to forest sites on peats and podzols were undertaken in the 1970s itself (Högbom and Nohrstedt, 2001). Recently, efforts to restore acidified soils in the south of the country has explored the use of both wood ash and lime (Lundström et al., 2003).

In Denmark, ash is produced from community energy projects using mixed organic fuels such as straw, woodchip, green waste and tree thinning. This has resulted in a mixed quality ash of variable chemical content with some high levels of heavy metals and dioxins. As a consequence, 2500 tons of ash per year is disposed to landfill (Serup, 1999; Moller and Ingerslev, 2001).

In Rwanda, mulberry wood ash is used as a fertilizer for the first time. Chemical analysis of soil and determination of its acidity were carried out (Figure 3) every three months (seasonally) and the effectiveness of using mulberry wood ash, was compared with that of organic and chemical fertilizers.

The diagram shows that the use of lime and MWA in conjunction with other fertilizers has led to changes in acidity of the soil and its chemical composition. Adding only organic manure (OM) and NPK could not bring about a significant change. The acidity of the soil after adding lime and MWA linearly decreased and remained static during the year. MWA was proved the most effective component because within a short time after its introduction, the pH of the soil rose from 4.8 to 6.52 (slightly acidic), which appears to be a function of its structure and particle size, enabling its rapid interaction with the soil. It is known that the presence of nutrients in the soil and their dissolution directly depends on the pH level. Both the low or too high pH level are unfavourable to plant growth since the nutrients in the soil remain unavailable to plants. The content of the nutritious elements in soil depends on quality, quantity and combination of applied fertilizers. For example, the quantity of N, P and K in the soil sharply increased as a function of application of mineral fertilizer $N_{30}P_{24}K_{18}$ whereas, application of OM, Lime and especially MWA not only increased the quantity of N, P and K, but also Ca, C, Mg, Fe, Mn and Zn. It has to be taken care that lime or MWA should be applied one month before application of mineral and organic fertilizers.

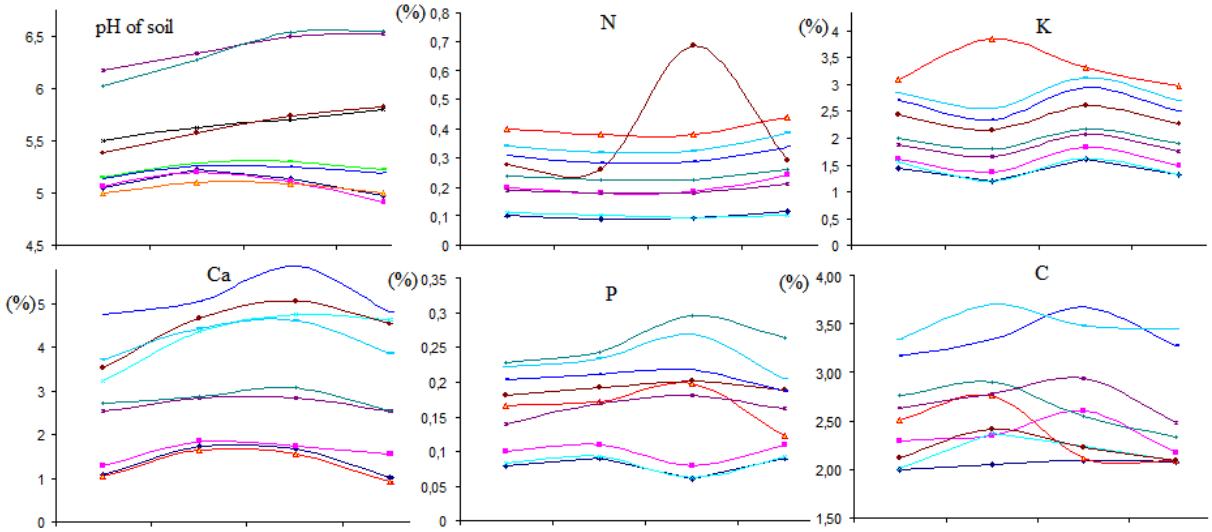
The soil nutrient elements show a specific response with regard to season and type of fertilizer applied (Figure 3). Some elements viz., K, Mg, Fe, Mn and C achieve their highest activity 6 months (August – October: a dry season) after fertilizing while the others such as P, Ca and Zn are the most active in the 9^{th} month after fertilization (November – January: rainy season) and S and B, on the contrary, are highly concentrated in May-June and February-April, the mild season.

Impact of regulation of acidity (pH) and fertility of soil on mulberry leaf yield

According to modern concepts, fertility refers to the ability of the soil to meet the needs of plants in terms of elements of nutrition, water and, ensuring their root systems of sufficient air, heat, and physical and chemical environment that is conducive to the normal growth and development. There are variety of other factors such as climate, plants, time, activity of the farmer and others, which are also playing a great role (Balloni and Favalli, 1987; Phelan et al., 1995). The main means of regulation of nutrients reserve in soil, in particular forms, accessible to plants, consist of regulation of its acidity and addition of necessary organic and mineral fertilizers (Tisdall and Oades, 1982; Korpilhati et al., 1998) which creates normal conditions for the life of Azotobacter and other organisms that assimilate nitrogen from the atmosphere (Balloni and Favalli, 1987;

Ledgard and Steele, 1992; Dewes and Hunsche,1998; Haynes, 1999; Doran and Zeiss, 2000). It makes no sense to saturate the soil with fertilizer and microelements, if the pH of the soil is not at the optimum. This is also verified from our studies (Figure 3).

At soil pH 5.2 (control), growth and development of mulberry was belated, leaves were subjected to various diseases, which led to an overall decrease in quantity (2.5 kg/tree) and quality of fodder for silkworms (Figure 4). Soil fertilization with OM and $N_{30}P_{24}K_{18}$ fertilizer has led to a slight decrease in pH and a slight increase in the incidence of diseases with a marginal increase in leaf yield (Wong et al., 2004). Organic and mineral fertilizer (especially NPK) lead to insignificant oxidation of soil. The role of MWA in enhancing the fertility of soil, has already been explained that its application gradually decreases the acidity of soil, and in a period of half an year, reaches up to pH 6.5 and remains stable at this level for about 1.5 years. Hence, application of mulberry wood ash in comparison with lime, is the most comprehensible and cheap means for regulation of acidity and fertility of soil, which essentially reduces incidence of diseases (leaf spot and chlorosis) in a mulberry plantation, thus leading to 3.5 times improvement in yield and quality of leaves.



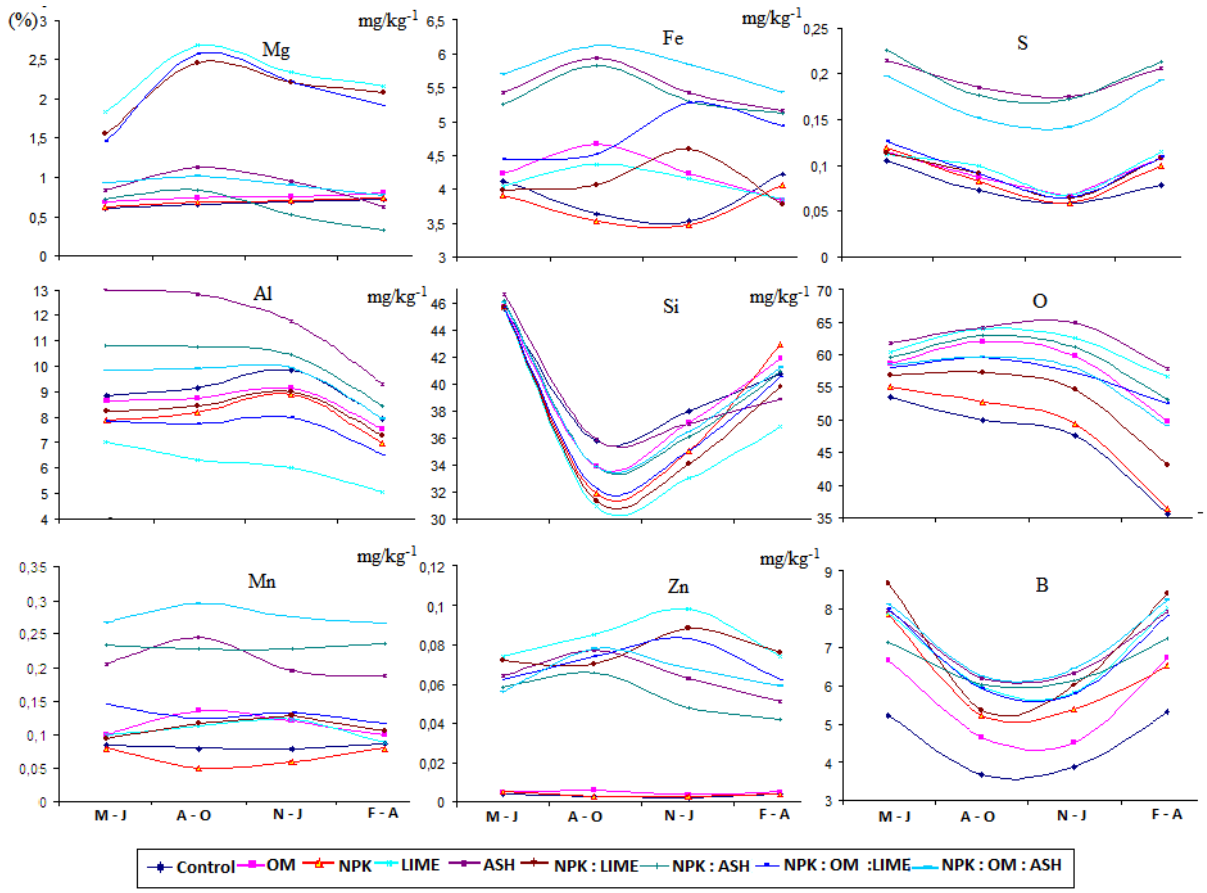


Figure 3: Change in acidity level and contents of chemical elements in soil after treatment with different fertilizers

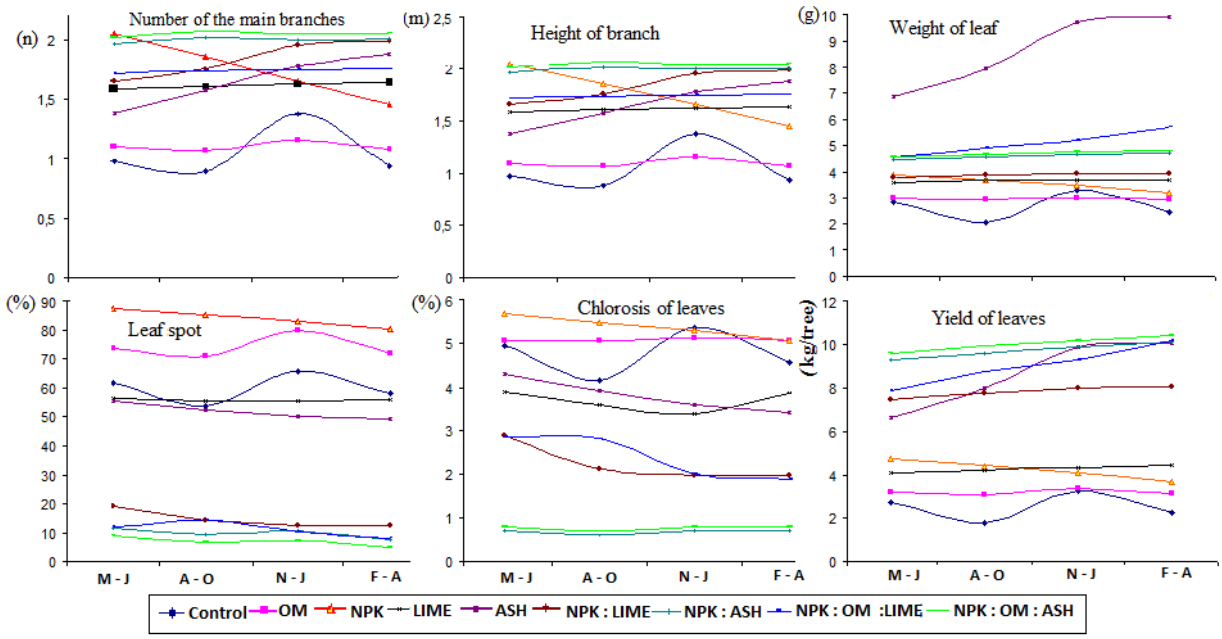


Figure 4: Effect of change of soil acidity (pH) after treatment with different fertilizers on economic parameters and yield of mulberry

CONCLUSION

Problems related to soil's acidity, the means of regulation and its fertility enrichment are central in agriculture. Various methods are being used for these purposes, among which is recommended the application of mulberry wood ash. Mulberry wood ash is richer than lime in terms of all necessary vital elements for plants, and is the cheapest and accessible alternative. It is noteworthy that mulberry wood ash is also alkaline and can cause crop damage if misused. It is imperative that the land owners follow the prescribed application rates and use common sense approaches to prevent decrease of yield and also ensure to avoid environmental contamination.

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The Correlations Between Larval Weight, Cocoon Weight, Shell Weight, Shell Ratio, Pupal Weight in Four Lines of Silkworm, *Bombyx mori* L.

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ABSTRACT

Silkworm, Bombyx mori, is one of the most significant insects in silk production as well as in biological studies. The objective of this research was to investigate the correlations between larval weight, cocoon weight, shell weight, pupal weight and cocoon shell ratio of M, Showa (China), N, Kinshu (Japan) lines of Silkworm, Bombyx mori. The relationship in quantitative characters and the possibility of using them in selection were also investigated. Lines were reared in the standart and optimum conditions. Each line had 3 replications, with 250 larvae for each. Analysis of variance showed that, the mean values for cocoon characters of lines were not to be significant, on the contrast larval weight was found to be significant ($P < 0.05$). Significant and high positive correlation was observed between larval weight and cocoon weight ($r = + 0.787$), pupal weight ($r = +0.742$). In other characters, cocoon weight was correlated with pupal weight ($r = +0.926$) and shell weight with cocoon shell ratio ($r = +0.596$) for all lines. From obtained results, the correlations coefficient of Chinese lines lines were found more significant thanJapanese lines. Both cocoon weight and pupal weight has positive correlation with larval weight, and also cocoon weight with pupal weight in Chinese and Japanese lines. In addition to that, the correlation between shell weight and shell ratio were found to be significant for Chinese lines. As a result, genetic correlation for the quantitative characters, the application of appropriate method for selection and estimating genetic improvement is possible.

Key words: Silkworm (Bombyx mori),correlation,larval weight,cocoon weight, pupal weight, cocoon shell ratio.

Introduction

The purpose of silkworm breeding is the genetic improvement of characters to increase profitability of the sericulture industry (Ghanipoor et al.2006; Talebi & Subramanya 2009; Mubasher et al. 2010,; Seidavi 2010a,). Silkworm, Bombyx mori, is one of the most significant insects in silk production as well as in biological studies.(Neshagaran et al.,2016). Various genotypes have shown that there are many differences in quantitative and qualitative traits which have an effective part in silkworm efficiency (Nagaraju & Singh 1997). Seidavi(2010b), demonstrated that the best characters can be incorporated through breeding He also reported that the best silkworm modification for improvement can be determined.

İn silkworm breeding characters correlation has very important.Many researchers have investigated for estimation of correlationamong economic characters of silkworm to develop production through selection systems (Seidaviet al. 2004; Seidavi et al. 2008 , Sing et al,2011).Ghanipoor et al. (2008) found that high positive correlation in six commercial lines of silkworm . Kumar et al. (1995) observed that there is a high correlation between cocoon weight characters, cocoon shell weight, and also cocoon weight and cocoon shell ratio.

Ksham et al. (1995) found that high positive genetic and phenotype correlation between cocoon weight and total cocoon production.Grekov (1989) observed thatthere is a strong mutual effect between genotype andthe environment which causes a positive correlationbetween cocoon shell weight and cocoon weight(+0.659).Mirhosseini et al. (2010) determined that a highand positive genetic correlation exists between cocoonweight and cocoon shell weight. These two

importanteconomic characters in which selection was on cocoon weightcaused the increase of cocoon shell weight.

Sing et al(2011) , determined that high significant positive correlations between cocoon weight and pupal weight (r= + 0.994), coccon weight and shell weight (r = + 0.614), pupal weight and shell weight (r = + 0.527), wheras negative values between pupal weight and cocoon shell ratio (+0.827).Study conducted by Ghanipoor et al. (2006) denoted a negative correlation betweencocoon weight and cocoon shell weight.In the literature, Sumioka et al. (1982) have observed that the leaf consumptioninfluencedthe body weight, which influences the silk output. Other studies, on body weightof larvae were made (Ueda and Suzuki, 1967; Singh and Ninagi,1995), correlation betweenshell weight and filament length (Petkov, 1981), shell ratio and cocoon quality (Singh et al.,992), cocoon weight and larval weight (Satenahalli et al., 1990).

Materials And Methods

Four silkworm genotypes , M, Showa (Chinase), N, Kinshu (Japanese) lines of silkworm were considered for the present investigation.The project was carried out in silkworm rearing and egg production units thatbelonged to Sericulture Research Institue which was closed down in 2004, then these units were transfered to Bursa Agriculture Provincial Directorate by the Ministry of Food, Agriculture and Livestock and these are used with the union of cocoon producers cooperatives (Kozabirlik).Lines were reared in the standart and optimum conditions (Krishnaswami, 1978). Each line had 3 replications and each replication were kept 250 larvae after four instar.The commercial characters selected in this study includedfifty instar larval weight,cocoon weight, pupal weight, shell weight, cocoon shell ratio.

50 larvae (4 thday of fifty instar)were randomly selected from each replication of each lineand theywere weighted to determine the weight of the larvae. Similarly 50cocoons(25 female, 25 male) from each replication were selected and cocoon characters were measured. Data were analysed one- way ANOVA using the general linear model procedure of the Minitab software (Minitap, 1998) of variance and correlation .

Results and Discussion

The mean values oflarval weight, cocoon weight, pupal weight, shell weight and cocoon shell ratioat different Lines. In the present study, analysis of variance showed that the mean values for cocoon characters of lines were not to be significant, on the contrast larval weight was found to be significant ($P< 0.05$, Table 1)

Larval weight was ranged between maximum of 2.85g (N)and minumum Kinshu (2.57).The highest cocoon charecters was observed in N lines.. Larval weight is one of the important parameter which determines not only the health of the larvae, but also the quality of the cocoon spun. The larvae reaches maximum size and weight in the V ınstar largely because of the fast development and higher rate of metabolism in silkglands (Ueda et al,1971).

In this study, larval weight was determined on 4thday of fifty instar, therefore this value was lower than some previous studies, which larval larval weight was determined that on the V instar -5th day (Umushankara and Subramanya, 2002, Paland Moorthy, 2011). In addition that, mean of values cocoon characters were founded similar or different previous research results (Mahashaand at al, 2013; Nagalakshmamma and Jyothi, 2010; Anantha and Subramanya, 2010). Because , the most of the genetic characters in silkworm are under polygenic control, under the influence of enviromental factors and nutrition like other system (Yokoyama, 1979).

Table 1. The mean values of larvalweight, cocoon weight, pupal weight, shell weight and cocoon shell ratioat different lines.

Characters	Chinese		Japanese	
	M	Showa	N	Kinshu
	$\overline{X} \pm S_{\overline{X}}$	$\overline{X} \pm S_{\overline{X}}$	$\overline{X} \pm S_{\overline{X}}$	$\overline{X} \pm S_{\overline{X}}$

Larval weight (g)	*	2,58±0,03b	2,72±0,09a	2,85±0,04a	2,57±0,07b
Cocoon weight (g)	NS	1,49±0,01	1,55±0,05	1,56±0,04	1,44±0,04
Pupal weight (g)	NS	1,17±0,01	1,21±0,04	1,21±0,03	1,09±0,05
Shell weight (g)	NS	0,327±0,01	0,340±0,02	0,353±0,01	0,350±0,03
Shell ratio %	NS	21,9±0,50	22,1±0,39	22,8±0,34	22,5±0,63

Means in the same line with no common superscript are significantly different at P< 0.05,
NS: not significant

Tablo 2. The correlations between larval weight, cocoon weight, pupal weight, shell weight, cocoon shell ratio at different Lines

	Larval weight	Cocoon weight	Pupal weight	Shell weight	Shell ratio
Larval weight, g	-				
Cocoon weight, g	0,787**	-			
Pupal weight,,g	0,742**	0,926**	-		
Shell weight, g	0,202	0,299	-0,083	-	
Shell ratio ,%	0,082	0,087	-0,145	0,596*	-

Means in the same line with no common superscript are significantly different at P< 0.05

Tablo 3. The correlation between larval weight, cocoon weight, pupal weight, shell weight, cocoon shell ratio at Chinese and Japanese Lines.

Lines		Larval weight	Cocoon weight	Pupal weight	Shell weight	Shell ratio
Chinese	Larval weight, g	-				
	Cocoon weight,g	0,84*	-			
	Pupal weight, g	0,839*	0,982**	-		
	Shell weight, g	0,717	0,894*	0,793*	-	
	Shell ratio , %	0,427	0,516	0,345	0,84*	-
Japanese	Larval weight, ,g	-				
	Cocoon weight,g	0,844*	-			
	Pupal weight, g	0,866*	0,928*	-		
	Shell weight, g	-0,091	0,154	-0,226	-	
	Shell ratio %	-0,295	-0,055	-0,204	0,396	-

Means in the same line with no common superscript are significantly different at P< 0.05, P<0.01

In the present study, significant and high positive correlation was observed between larval weight and cocoon weight (r = + 0.787), pupal weight (r = +0.742). In other characters, cocoon weight was correlated with pupal weight (r = +0.926) and shell weight with cocoon shell ratio (r = +0.596) for all lines.

From obtained results, the correlations coefficient of Chinese lines were found more significant than Japanese lines. The correlation between shell weight and shell ratio were found to be significant for only Chinese lines. Besides both cocoon weight and pupal weight has positive correlation with larval weight and also cocoon weight and pupal weight in Chinese and Japanese lines.Rajanna and Sreeramareddy (1990) reported that increase in body size of the larvae is largely dependent on the rate of growth and development in silkwormduring the 5. Instar which contributes to the phenotypic expression of cocoon characters.

The results obtained in this study showed that larval weight plays important role in estimating the total cocoon productivity of the lines. There is importance of larval weight for getting higher cocoon weight thereby more silk yield. These results are supported by many

research results.Umashankara andSubramanya(2002) optained that the correlations with cocoon weight and pupal weight in females of all the races undertaken except oneLine. Similarly, Mahesha et al.(2013), reported that the there were positive correlation between larval weight and cocoon weight, shell weight, shell ratio.

Singh et al. (2011) found that high significant positive correlation between cocoon weight and pupal weight (r=+0.994), shell weight (r=+0.614) (P <0.01). They found that positive correlation between pupal weight and shell weight (r=+0.527), while significant negative values between pupal weight and cocoon shell ratio (r= - 0.827) (P <0.01).

Pal and Moorthy (2011), reported that expected cocoon weight had a significant and positive correlation with cocoon shell weight and also cocoon shell weight had a significant and positive correlation with cocoon weight. (Petkov,1981a). Satenahalli et al, (1990) and Rajanna and Reddy, (1990a) were found correlation between cocoon weight with larval weight, pupal weight respectively.On contrast, negative correlations were determined ; shell ratio and pupal weight(Sing et al, 1992a), cocoon weight and cocoon shell weight(Ghanipoor et al. 2006).

Conclusion

The knowledge of correlation among various commercial characters is one of the important in breeding programme. İnformation generated from this study may be used during the selection process in the breeding programmes for new lines of silkworm with the better cocoon characters. Because, the hight cocoon yield is important for producers to earn much money .

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The Development of Sericulture History and Present Situation in Turkey

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ABSTRACT: Turkey has major factors for silkworm rearing in terms of historical background of 1500 years in sericulture industry with experience and traditional technologies. Anatolia and especially Bursa has been an important centre for the silk road, silk trade and silk woven fabric production. Silk weaving started during the XIV century, developed during XVth century and peaked at the XVI century. The first silk reeling mill was opened in Bursa by Konstanz Bey in 1833 followed by the founding of an imperial silk mill by Sultan Abdulmecit in 1852. When Suez Canal opened in 1869 Anatolia started to lose its presence on the silk road and cocoon and silk production decreased dramatically. After World War I ended and Republic of Turkey was found in 1923; new laws were implemented to protect the sericulture industry. In 1970s, government support came into effect to rearing polyhybrid eggs instead of native monohybrid eggs and also fresh cocoon trade was encouraged to develop sericulture in 1980s. Thanks to the continuous government support, cocoon production increased every year and in 1990 it reached its peak point at 2000 tones annually. However, this trend came to an end and due to several reasons, total production started to decline like in many other countries. Recently, the government implemented new measures to support the sericulture sector by offering a direct purchase guarantee through sectoral organizations. Also quality improvement for cocoon has been under consideration and plastic mountages have been distributed to local producers to support this policy. Turkey has a very long tradition and a huge market potential for local silk handicraft and silk carpets; and a rising chance to export some abroad. Especially, handmade silk carpets of Hereke, which can be found in many royal palaces around the world reflects the elegance of Turkish silk crafting. Given the precious experience of traditional silkworm handicraft and weaving like needle art, beading, edging embroidery and silk carpet waeving, the industry still has a room to expand. Today, handcrafting is supported by many local governments, like Bursa and Diyarbakır. Recently, 216 looms were distributed for carpet weaving and employment opportunities were provided for young women in the rural areas. However, despite the growth potential for silk made products, local cocoon and silk production is not sufficient to meet the demand, even today.

Key words: Turkey, history of sericulture Industry, silk weaving, handcrafting

Indroduction

Turkey has major factors for silkworm rearing in terms of historical background of 1500 years in sericulture industry with experience and traditional technologies. Silkworm rearing which came to anatolia for the first time in the year 552 during the byzantine empire had started to spread beginning with the Marmara region. Silk cottage industries were first established in Turkey during the 14th Century, and developed in a short time to become world famous.Anatolia had became an important centre for the silkroad and a magical city Bursa started to become the capital of silkworm for the middle east in the silkworm history. Transportation of silk and spice as well as other products from east to west, is formed commercial roads named as "Silk Road" today and reaching Europe from China. Silk Roads were not only the commercial roads but also maintained cultural relations between east and west for centuries.

1.Silk Roads of Anatolia

Some important silk roads in Anatolia cover the following regions as follows,

At north; Trabzon, Gümüşhane, Erzurum, Sivas, Tokat, Amasya, Kastamonu, Adapazarı, İzmit, İstanbul, Edirne;At south; Mardin, Diyarbakır, Adıyaman, Malatya, Kahramanmaraş, Kayseri, Nevşehir, Aksaray, Konya, Isparta, Antalya, Denizli centers are followed.

It is known that Erzurum, Malatya, Kayseri, Ankara, Bilecik, Bursa, İznik, İzmit, İstanbul route is also used. Extension of Antalya - Erzurum route, composed with connections of Sivas and Kayseri on North and South routes, is connecting Anatolia to Iran and Turkmenistan.

For a long time silk was taken from the Iran, after that this policy was abandoned and silkworm rearing was started at Bursa in 1587. Bursa had been a historic silkworm center for both silk trade and silk woven fabric production.Silk weaving which was started during the XIV century and developped during XVthcentury and peaked at the XVI century.

2. Silk handcraft cottage industries in the past

In 1500 there were about 1500 silk weaving looms in Bursa.From XVIthcentury silk weaving deceased, and Turkey become a raw silk exporting country. The first silk reeling mill was opened in Bursa by Konstanz Bey in 1833, and a second by Boduryan Efendi in 1843. Imperial Silk Mill was opened by Sultan Abdulmecit in 1852.

Especially three different types of materials in this century as ‘Kadifa, Kemha and Tafta’ were wowen in Bursa and these were sought after in european countries, Iran and even China. The silk processing plants in Bursa and İzmit had reached a total of 85 until the year 1860.

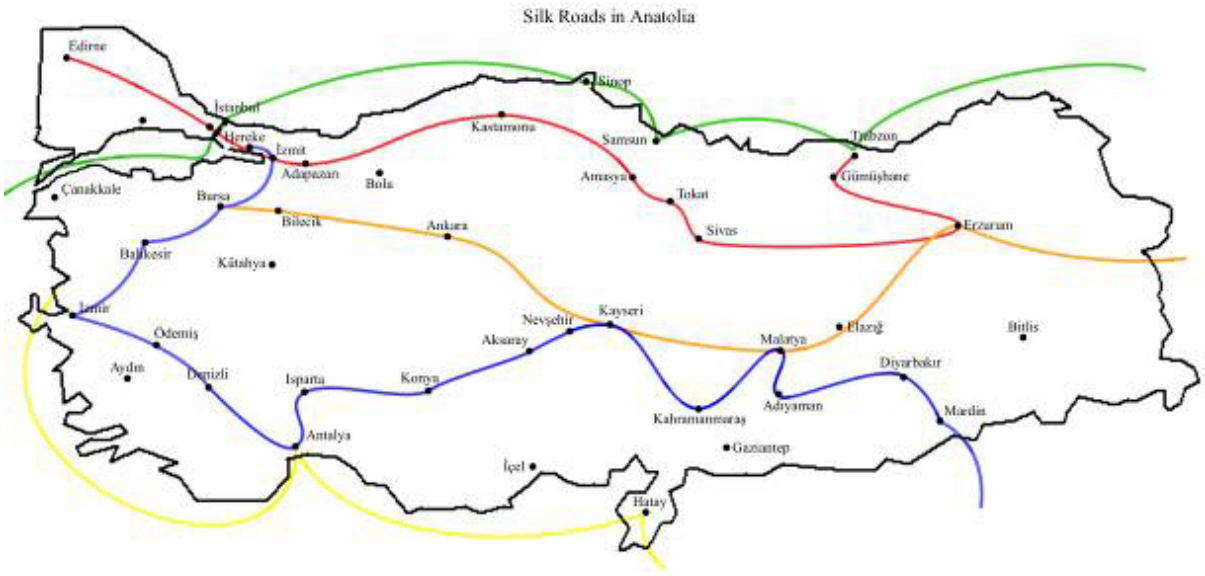

Figure 1. Silk Roads in Anatolia

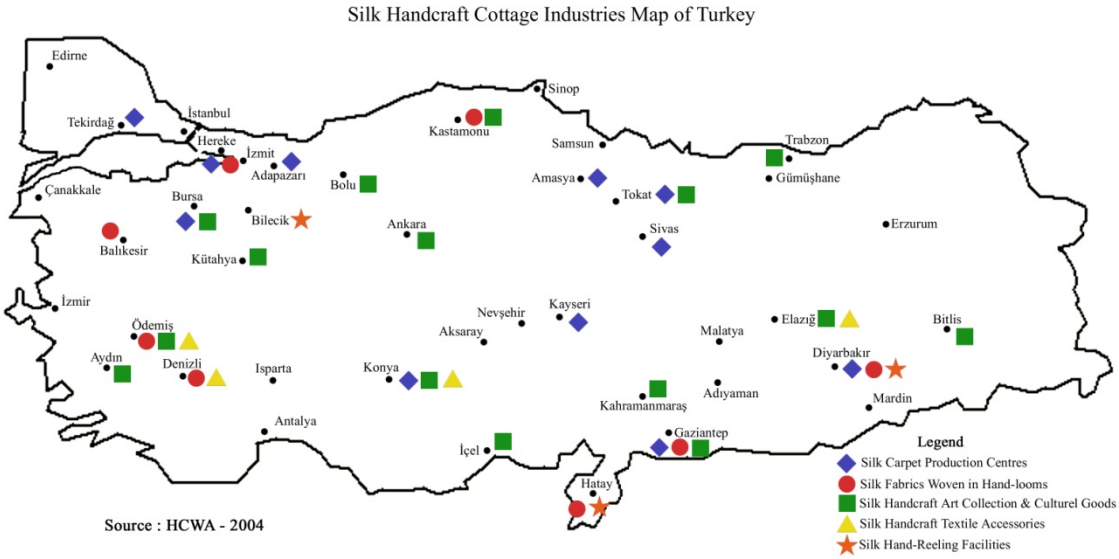

Figure 2. Silk Handcraft Cottage Industries Map of Turkey

3.Development of Sericulture in the past

Because of the pebrin disease which was seen for the first time in France in the year of 1865 and the cheap raw silk from the far east which penetrated the Eeuropean market due to the opening of the Suez canal, these caused a regression in sericulture and silk industry .

Affter discovering the disease free-egg (seed) production method by pasteur and the establishment of the school named ‘ Harir-Darül-Talimiin 1888at Bursa. The school’ was the basis of the silkworm research institute in Bursa for the aim of producing disease free egg and to educate technical staff. After many student graduated from this school cocoon production started to increase and the highest cocoon production reached 18,338 tonnes in 1908 and was obtained 1970 tonnes of raw silk in 1910.However, during the first world war and the war of independence there were big production decreasing again and cocoon production dropped the between 250-300 tons.

In addition, after the globalisation movement in the 20thcentury and especially China opened the doors for international trade. As a result of that, Turkey’s sericulture and cottage industries effected negatively.After World War I ended and Republic of Turkey was found in 1923; new laws were implemented to protect the sericulture industry. In 1970s, government support came into effect to rearing polyhybrideggs instead of native monohybrid eggs and also fresh cocoon trade was encouraged to develop sericulture in 1980s. Thanks to the continuous government support, cocoon production increased every year and in 1990 it reached its peak point at 2000 tones annually. However, this trend came to an end and due to several reasons, total production started to decline like in many other countries.

Figüre 3.‘Harir-Darü’t-Talimi’is the first

Turkishsilkworm
education center in Bursa, 1893.

4 .PresentSituation in Sericulture

Although Turkey’s silkworm rearing and fresh cocoon production has passed through a crisis period in recent years, it has continued to maintain its characteristic of being a traditional production which the producers can not give up. The fresh cocoon production in Turkey intensively done in the cities of Diyarbakır, Bursa, Bilecik, Eskişehir, Sakarya and Antalya. Cocoon production which was 2000 tones annually until the year 199. However, after large decreases were experienced between the years 1990-2000 and dropped to 46.621 kg in the year 2001, fresh cocoon production entered once more into an increasing trend and in the year 2016, 104 tones of fresh cocoon was bought by Kozabirlik.After the year of 2000s, various studies have been organized to improve the sericulture industry all over.

However, there has been several problems in Turkish sericulture which caused important decreases in production after 1990’s.

1)The migration of people from villages to cities speeded up due to the industrial development in the Bursa, Diyarbakır, Antalya, Sakarya and other cities where the silkworm production is dense,
2)The increase in the use of pesticides and chemicals depending on the development of marketing channels in agriculture ,

3)The yield of alternative agricultural products is better than cocoonand low sericulture productivity,
4) Difficulties in silk carpet export caused by the First Gulf War,
5)Competition of silk carpet market with Iran after the war against Iraq,
6) Smuggling silk yarn into Turkey.

Table 1.Recent trend in sericulture production in Turkey

Years	Sericulture farmersNumber	Fresh cocoon production (tones)
1940	63.498	3.014
1960	60.370	2.444
1980	43.025	1.707
1990	44.541	2.127
2000	2.210	60
2005	2.729	160
2010	2.183	129
2012	2.572	134
2014	1.760	84
2015	2.015	115
2016	2.001	104

Asian Online Journals (www.ajouronline.com), Kozabirlik, 2010.

Turkey has a huge potential for local silk market development, which still needs more than 200 tons of raw silk. There are more than 2000 active families engaged in cocoon production activities in upper land villages where they do not have any alternative cash crops and several companies are engaged in silk carpet business. As a result of decrease in cocoon production since 1990s, the country imported about 200 tonnes of raw silk to meet the domestic demand of silk carpet industries. Therefore recently the Government is providing a support for the sericulture sector by paying direct income supporting fee to the cocoon farmers, to increse the cocoon production and silkworm handicraft.

Recently, handcrafting is supported by many local governments, like Bursa and Diyarbakır. İn Bursa, 216 looms were distributed for carpet weavingand employment opportunities were provided for young women in the rural areas. However, despite the growth potential for silk made products, local cocoon and silk production is not sufficient to meet the demand, even today.There were two main organizations involved in sericulture industry up until July 2005: the Sericulture Research Institute (SRI) under the Ministry of Agriculture and Rural Affairs and Kozabirlik,(the Union of Sericulture Cooperatives. After, the Institute was closed by the goverment and now Kozabirlik is the onyl orginazed institue, which harbours in its structure all the stages from egg to the silk.

It has known that our genetic, native races like Bursa's White, Hatay's Yellow have been used to produce cocoon and eggs for many years in Turkey. In Turkey, instead of the native race polyhybrid rearing started, in1974. Today native races and foreign origin are preserved as genetic resource by the Ministry of Food, Agriculture and Livestock. In Turkey, İn Turkey cocoon production has been making with producing of hybrid eggs by using M and N lines. It is necessary to breed new varieties adaptable to the natural conditions in Turkey with resistance to silkworm diseases and high productivity.Therefore, we carried out the Project between 2014 and 2016 years with the aim of identifying new parents and hybrids by determination of general and specific combination ability (GCA and SCA) and heterosis in the pure lines and their hybrids, that were selected from our gene source, to determine new hybrid combinations that could be

alternative or have superior yield compared to MxN hybrid that is used in production. According to the results, the best hybrid determined under controlled conditions andwe will test the new hybrid under producers conditions in this rearing season.

Strengthes, Weakness, Opportunity, Threat for the sericulture development in Turkey for todays as follows;

Strengthes	**Weakness**
Government supportting to encourage cocoon and silk production by providing subsidy of cocoon purchase and silkworm eggs in free of charge Natural and social conditions are suitable to improve sericulture industry Climate conditions and unemployed manpower in the countryside Accumulation of technology in silk carpet making by long tradition and history	Low cocoon productivity due to traditional way of silkworm rearing and improper rearing conditions Poor resources of silkworm varieties – only one variety of silkworm for cocoon production Rearing houses and equipment are not suitable for high quality of cocoon and silk Lack of young generations in the villages to continue sericulture activities in the country
Opportunities	***Threat***
International price of raw silk is increasing due to decreasing silk production in the major countries World famous Turkey carpet is welcomed by European countries and America ***Turkey has a historical background of 1500 years in sericulture industry with experience and traditional technologies***	Import of raw silk from China and Uzbekistan with lower price than the domestic product Relatively small amount of cocoon and silk production is not sufficient to have strong competition with foreign products

5.Major Problems of the Sericulture Industry in Turkey

Mulberry cultivation: Most of mulberry trees are more than 30 years old, dispersed around farmers' houses and roadside without applying pruning method.

Rearing houses: The farmers reared the silkworms in their living rooms and bedrooms, because they did not have separate rearing houses; it is acceptable considering investment cost and only one rearing in a year. Some farmers used their warerooms for silkworm rearing without sanitary treatment and disinfection, which resulted in poor cocoon production or failure of silkworm rearing.

Control of rearing conditions: The silkworm rearing duration from initiation of rearing to spinning cocoons took nearly 30 days, which are very long larval duration due to low temperature during young silkworm stage. It is recommendable to introduce cooperative rearing system for young silkworms to provide the optimum conditions for the early stage, which will reduce the larval duration and improve quality and production of cocoons.

Cocooning frames: At the end of silkworm rearing, the farmers put the bushes and small branches onto the rearing bed to provide spinning space, which affect negatively to formation of good cocoons. The standard types of cocooning frames should be provided to the farmers for improvement of cocoon quality.

Low cocoon productivity: The average cocoon production was low with approximately 25-30kg of cocoons per box of silkworm. The cocoon productivity per unit silkworm eggs in Turkey should be improved by providing good quality of mulberry leaves and adequate rearing.

6.Silk Weaving and Cottage Enterprises

Turkey has a very long tradition and a huge market potential for local silk handicraft and silk carpets; and a rising chance to export some abroad. Especially, handmade silk carpets of Hereke, which can be found in many royal palaces around the world reflects the elegance of Turkish silk crafting. Given the precious experience of traditional silkworm handicraft and weaving like needle art, beading, edging embroidery and silk carpet waeving, the industry still has a room to expand.

Embroidery (Nakış)

Embroidery is the ornamentation of materials such as leather, cloth or felt with silk, wool,linen, cotton and metal threads and needles.

Knitwear

Turkish handicrafts have a rich accumulation of thick and thin fabrics made with hooked andknitting needles, hairpins and shuttles with silk, cotton and woollen threads. Knitting is doneby holding the thread with loop knots with the help of the needle.

Edging Embroidery (Oya)

Oya is the name of ornamentation knitted by a coloured thread in the shape of a leaf or flower and a kind of lacework. It ischaracteristic of Turkey.

Needle Embroidery

Turkish needle embroidery is known as Turkish lace and does, indeed, resemble lacework at first sight. Turkish embroidery is three-dimensional and may be used as separate, distinct ornament. Silk is the material most generally used for needle embroidery.

Cocoon Embroidery

The materials used in cocoon embroidery are pieces of cocoon and silk. The main decorative elements are made with cocoons, and then parts knitted with pins or hooked needles are added to the cocoons.

Bead Embroidery

As good news in sericulture industry in terms ofBread embroidery is done with silk, cotton and synthetic threads and by using beads. The beads are added onto the edge of the embroidery, which is itself made by pins or hooked needles.

Socks

Knitted socks which occupy an important place and have a particular significance in Turkish handicrafts with their different materials and meaningful designs began to lose importance with the advent of machine-made products.

Weaving

Weaving can be defined as the production of a plain surface created by horizontal and vertical passing movements of weft and warp loops.

Kilim Weaving: This is a weft surfaced weaving, in which the weft threads are passedthrough the warp threads, one to the front and the other behind, and in which the warp threads are tightened and hidden.Intricate Silk Weaving At The Carpet Cooperative In Ortahisar, Cappadocia, Turkey is a photograph by David Lyons which was uploaded on March 15th, 2016.

Zili (sili) weaving: Design threads are applied three on the surface and one below the surface in their own design area. After the line is completed, one or more wefts are applied and tightened. In diagonal designs, this process is continued with the sliding of the thread on each line. Sometimes both diagonal and perpendicular designs are applied in the same weaving.

Sumak weaving: In sumak weaving, design threads are continuously wrapped around the warp loops in the same coloured design area.

Kirkit Weaving With Pile (Carpet Weaving):

Carpets: A warp skeleton is constituted by placing bristle, cotton, silk and wool threads side by side. In Turkey, two-wefted carpets are generally more common. After completing each line, pile is cut to the desired length with the help of carpet scissors.

Hereke Carpet

Hereke carpet is the cultural heritage of Turkey. The worldwide famous silk carpet called "Hereke" has been very attractive to both internal and external markets. Hereke are double-knotted, this results in the carpets having higher durability and the knots can not be undone and taken out unlike single knotted carpets which can come undone if pulled with force. Turkish Knot is used for weaving hereke carpets in Turkey.

Figure 4. The Picture of Hereke carpet factory from İzmit
Natali Avazyan archive in 1967

7. The major problems in the artisanal / traditional silk handcrafts cottage industries development in Turkey are as follows.

Low labour and materials costs in competing countries: Due to the low production and labour costs in silk producing and processing countries like, China, India and Pakistan, Turkish silk cottage industries recessed since 1990. EU policies for agriculture, arts and crafts are not applied in silk industries in Turkey.

Replications of Turkish traditional designs: The replications of traditional Turkish motifs and designs applied in carpets by those countries reduced the international market share and prices of Turkey.

Imports of cheap products: Import of cheap far-eastern products is threatening Turkish producers, and jeopardizes the silk handcraft cottage industries. High costs and insufficient income levels does not motivate the local production.

Market trends and consumer demands: Cottage industries lag behind the fashion trends, and consumer expectations. Development of new designs and use of new colours are very limited.

8. Conclusion

Turkey has a historical background of 1500 years in sericulture industry with experience and traditional Technologies. Although Turkey's silkworm rearing and fresh cocoon production has passed through a crisis period in recent years, it has continued to maintain its characteristic of being a traditional production which the producers can not give up. Because the sericulture industry in Turkey has played an important role in improving livelihoods of small farmers in rural areas and silk weavers with traditional small looms, providing employment and income generation and earning hard currency for the nation.

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THE EFFECT OF BIOLOGIC ACTIVE SUPPLIMENTS ON PRODUCTIVITY OF THE SILKWORM AND ON THE QUALITY OF SILKWORM COCOONS.

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ABSTRACT: The demand of many sectors of inductry for natural silk is constantly growing. Industry can be achieved by increasing yield and grade of produced raw materials.
Key words: silkworm, the caterpillar, the environment, heavy metal

Несмотря на прогресс человеческой цивилизации, обусловленный научно – технической революцией, возникают негативные экологические явления: прогрессирующие истощение природных ресурсов, потеря буферности биосферы в результате объединения ее видового состава, загрязнение окружающей среды, рост радиационного и теплового шока, что в значительной степени отражается на характере жизнедеятельности живых организмов, их адаптивных возможностях, ведет к снижению устойчивости к действию факторов среды.

Все это ставит задачу разработки новых подходов к вопросам оптимизации разведения полезных видов животных, в том числе и тутового шелкопряда.

По данным японских исследований (Такида, 1987), гусеницы тутового шелкопряда очень чувствительны к содержанию в атмосфере и почве плантаций солей тяжелых металлов. При использование листа с таких плантаций отмеченный случай появления уродливых гусениц, нарушается деятельность в организме, резко возрастает их гибель.

Так, наблюдались случай массовой гибели гусениц отзагрязнение окружающей среды выбросами Черкасского химического комбината (А.З. Злотин, 1984).

В последние годы в Таджикистане появились низкоурожайные, недоброкачественные коконы тутового шелкопряда, которые очень плохо разматываются. Как показали наши исследования, причина этого явления – загрязнения почвы тутовых плантаций солями тяжелых металлов. На таких выкормках наблюдается значительные гибель гусениц в результате снижения их устойчивости к заболеванию и экстремальным факторам среды.

В сложившихся условиях стало очевидной необходимость разработки новой стратегий оптимизаций шелководства в Таджикистане.

Анализ современного состояния изученности вопросов оптимизации разведения насекомых (А.З. Злотин, 1989), а также исследованные данные (В.А.Головко, 1991 - 1992), привели нас к мысли о необходимости разработки стратегии повышения уровня общей устойчивости тутового шелкопряда к негативному воздействию экологических факторов среди и разработки на этой основе приёмов оптимизации шелководства.

По нашему мнению, такая стратегия должна включить два важнейших направления оптимизации разведение тутового шелкопряда:

-поиск и применения биостимуляторов, БАД (биологический активных добавок к пище), повышающих устойчивость и продуктивность тутового шелкопряда;

-разработка приёмов повышения гетерогенности тутового шелкопряда и подбор пород устойчивость к негативному воздействию факторов окружающей среды;

-разработка способа повышения оживляемости грены и ее профилактика антибиотиками, антисептиками.

Исследования проводили в лаборатории республиканской опытной станции шелководства ТАСХН и кафедра экология ГМИТ Согдийской области республики Таджикистан.

Исследования проводили в нескольких направлениях, следующие методические приемы:

1. Методика обработки грени пред инкубацией с БАД (азанатором и хитозан).

2. Методика обработки кормового листа шелковицы (азанатором и хитозан) при кормлении 4-5возрастов наЕвроазиатских пород тутового шелкопряда.

Таблица 1

Разработки способов повышения оживляемости промышленной грени
(Весна 2016 г**)**

Варианты	С экспозицией минут и концентрация	Оживляемость грен		Жизнеспособность гусениц	
		%	% к контролю 2	%	% к контролю 2
Обработки грены	15	96,2	105,9	94,8	105
	30	98,4	108,4	96,6	107
Обработка грены с хитозаном в водном растворе 1 литр	1 капсула -	95,3	104,9	93,8	104
	2 капсула	96,6	106,4	94,6	104,9
Обработка грены водой (контроль 1)	-	92,9	102,3	91,4	101,3
Грена без какой либо обработки (контроль 2).		90,8	100	90,2	100

Таблица 2

Влияние обработки кормового листа шелковицы с озонированными водами и хитозаном на показатели жизнеспособности гусениц и качества коконов.

Варианты	Экспозиция капсулах	Жизнеспособ-ность		Количество сортовых коконов		Содержание больных и отстающих гусениц %
		%	% к кон. 2	%	% к кон.2	
Кормление гусе-ницлистом обработанным азонированным водой.	15	93,2	107,3	90,6	103,7	5,82
	30	95,4	109,9	93,4	105,9	5,60
Кормление гусе-ниц листом обра-ботаннымхито-заномв капсулах	1капсула	92,6	106,7	91,2	103,4	4,82
	2капсула	94,6	109	92,8	105,2	5,46
Кормление гусениц листом обработанным водой (кон. 1).		88,1	101,5	87,4	99,1	10,6
Кормление гусениц листом без какой либо обработки (кон. 2)		86,8	100	88,2	100	10,2

Таблица 3

Влияние обработки листа шелковицы азонированными водами и хитозаном на продуктивности гусениц тутового шелкопряда

Варианты	Концентрация	Средняя масса кокона.		Средняя масса шелковой оболочки.		Шелконос-ность	
		гр.	% к кон. 2	мг	% к кон. 2	%	% к кон. 2
Кормление гусениц листом обработан-нымазонатором	15	1,9	111,8	480	126.3	25,2	113
	30	2,1	123,5	510	134,2	24,3	109
Кормление гусениц листом обработанным хитозаном	1кап-сула	2,0	117,6	470	123,7	23,5	105,4
	2кап-сула	2,1	123,5	490	128,9	23,3	104,5
Кормление гусениц листом обработан-ным водой (кон. 1).		1,80	105,8	420	110,5	23,3	104,5
Кормление гусениц листом без какой либо обработки (контроль 2).		1,70	100	380	100	22,3	100

В период исследование проведено химический анализ почв, корм и отходов (экскриментов).

На основании результатов исследование можно сделать следующие выводы:

1. Обработка способов повышения оживляемостипромышленномгрени с азонированием воды с экспозицией 15 – 30 минут обеспечивает повышения оживляемостигрени на 5,9 – 8,4% по сравнению с контроля (грени без какой либо обработки).
2. Влияние обработки кормового листа шелковицы с азонированием воды с экспозицией 15 – 30 минут обеспечивает повышение жизнеспособности гусеницы на 7,3 – 9,9% по сравнению с контроля (без какой либо обработки).
3. Влияние обработки листа шелковиц хитозаном и азонированном водой обеспечивает повышение средней массы коконов на 17,6 – 23,5 % по сравнение контроля (без какой либо обработки).
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PULLING THE THREAD OF RAW SILK WHILE COILING FROM ROTATING REEL

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ABSTRACT: This article discusses the causes of the tension peaks in the start-up period when the thread is wound with a rotating coil. Proposed design scheme winding elastic thread from the spool through which are determined depending on the analytical calculation of the peak tension.
Keywords: tension peaks, friction, coil uneven.

Актуальность задачи: В период пуска сматывание с вращающейся катушки нити послужило высокой неравномерностью натяжения. Это приводит к увеличению обрывности на ткацких станках и снижению производительности станка.

Постановка задачи: Сматывание с вращающейся катушки в установившемся режиме характеризуется высокой равномерностью натяжения. Однако в период пуска неравномерность гораздо выше, что послужило причиной отказа от этого способа сматывания при подготовке основ к ткачеству. Проведем анализ неравномерности натяжения с целью разработки предложений по его снижению.

Решения задачи:Расчетная схема сматывания упругой нити с катушки приведена на рис. 1. Катушка с нитью может вращаться вокруг оси О, при этом на нее действует момент трения в опорах $M_{тр}$. Упругая нить, с коэффициентом жесткости с, в начальный момент конец нити (точка М) начинает двигаться с постоянной скоростью v.

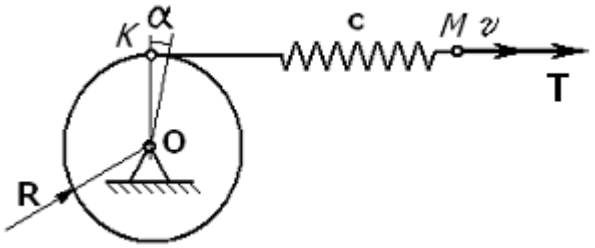

Рис. 1. Расчетная схема сматывания с подвижной катушки.

Силу натяжения, действующую на катушку со стороны деформированной нити, в момент времени t можно рассчитать по формуле

$$T = c(vt - \alpha\ R),$$

Тогда дифференциальное уравнение движения катушки будет иметь вид [1]

$$J\ddot{\alpha} = FR - M_{TP}, \qquad (1)$$

где J – момент инерции катушки с намоткой.

Подставив в (1) значение силы получим

$$J\ddot{\alpha} = Rc(vt - \alpha R) - M_{TP}\ .$$

После очевидных преобразований, введя обозначения

$$m = \frac{Rcv}{J}$$

и

$$k^2 = \frac{R^2 c}{J} \qquad (2)$$

получим

$$\ddot{\alpha} + k^2\alpha = mt - \frac{M_{TP}}{J} \quad . \qquad (3)$$

Выражение (3) представляет собой линейное дифференциальное уравнение второго порядка с правой частью. Его решение, как известно [2] состоит из общего решения уравнения без правой части и частного решения уравнения с правой частью. Таким образом, найдем решение уравнения

$$\ddot{\alpha} + k^2\alpha = 0 \quad .$$

Характеристическое уравнение для него имеет вид $q^2 + k^2 = 0$, а его решение

$$q = \pm i\,k \quad ,$$

где i – мнимая единица.

Таким образом, общее решение дифференциального уравнения (6) будет иметь вид

$$, \ \overline{\alpha} = C_1 \cos kt + C_2 \sin kt$$

где C1 и C2 – константы интегрирования.

Частное решение (3) будем искать в виде

$$\alpha^* = At + B \quad . \qquad (4)$$

Продифференцируем (4) дважды

$$\dot{\alpha}^* = A \quad , \quad \ddot{\alpha}^* = 0 \quad .$$

Подставим полученные значения в (2)

$$k^2 At + k^2 B = mt - \frac{M_{TP}}{J}$$

Приравнивая коэффициенты при соответствующих степенях t получим

$$k^2 B = -\frac{M_{TP}}{J} \quad .$$

Из полученных выражений найдем

$$A = \frac{m}{k^2} \quad , \qquad B = -\frac{M_{TP}}{Jk^2}$$

Таким образом, частное решение будет иметь вид

$$\alpha^* = \frac{m}{k} t - \frac{M_{TP}}{k^2 J} \quad .$$

Тогда общее решение (3) будет иметь вид

$$\alpha = C_1 \cos kt + C_2 \sin kt + \frac{m}{k^2} t - \frac{M_{TP}}{k^2 J}$$

Продифференцируем это выражение

$$\dot{\alpha} = -C_1 k \sin kt + C_2 k \cos kt + \frac{m}{k^2}$$

Начальные условия имеют вид

При $t = 0 \ \alpha = 0$ и $\dot{\alpha} = 0$.

Подставляя в начальные условия значения α и соответствующей производной, получим

$$C_1 = \frac{M_{\grave{O}\text{Ð}}}{k^2 J}, \quad C_2 = -\frac{m}{k^3} \ .$$

Окончательно решение (3) будет иметь вид

$$\alpha = \frac{M_{TP}}{k^2 J} \cos kt - \frac{m}{k^3} \sin kt + \frac{m}{k^2} t - \frac{M_{TP}}{k^2 J} \quad ,$$

или

$$\alpha = \frac{m}{k^2}\left(t - \frac{1}{k}\sin kt\right) + \frac{M_{TP}}{k^2 J}\left(\cos kt - 1\right).$$

Подставим в полученное выражение k и m из (2), тогда

$$\alpha = \frac{v}{R}\left(t - \frac{1}{R}\sqrt{\frac{J}{c}}\sin R\sqrt{\frac{c}{J}}t\right) + \frac{M_{TP}}{R^2 c}\left(\cos R\sqrt{\frac{c}{J}}t - 1\right)$$

Определим линейную скорость катушки, т.е. точки K на ее поверхности

$$v_K = \dot{\alpha}R$$

Для этого продифференцируем выражение (21)

$$\dot{\alpha} = \frac{v}{R}\left(1 - \cos R\sqrt{\frac{c}{J}}t\right) - \frac{M_{TP}}{R\sqrt{cJ}}\sin R\sqrt{\frac{c}{J}}t$$

Подставим полученное в (2)

$$v_K = v\left(1 - \cos R\sqrt{\frac{c}{J}}t\right) - \frac{M_{TP}}{\sqrt{cJ}}\sin R\sqrt{\frac{c}{J}}t \qquad (5)$$

Проведем анализ полученных результатов для случая когда МТР=0. Тогда (5) приобретает вид

$$v_K = v\left(1 - \cos R\sqrt{\frac{c}{J}}t\right).$$

Графики изменения скорости движения конца нити (точка М), к которому приложена сила *Т* и точки*К* – схода нити с катушки, приведены на рис.2. Скорость точки М по условию задачи остается постоянной, а скорость точки*К* увеличивается. Так как нить образует освобождающую связь, т.е. она не может создать отрицательную (толкающую) силу натяжения *Т*, то скорость v_K будет увеличиваться до тех пор, пока сила *Т* не станет равной нулю. Определим этот момент времени. Подставим в (1) значение α из (4) и приравняем нулю.

$$T = \frac{cv}{R}\sqrt{\frac{J}{c}}\sin R\sqrt{\frac{c}{J}}t = 0 \qquad (6)$$

Из (6) следует, что при $t_2 = \frac{\pi}{R}\sqrt{\frac{J}{c}}$ натяжение *Т* становится равным нулю, при этом скорость схода нити в два раза превосходит скорость ее конца, точки *М*. В результате нить образует петлю.

Согласно (6) максимум натяжения нити приходится на момент времени

$$t_1 = 2\frac{\pi}{R}\sqrt{\frac{J}{c}}.$$

Т. к. момент трения на оси отсутствует, то вращение катушки будет происходить бесконечно долго и нормальный процесс сматывания не восстановится [3,4].

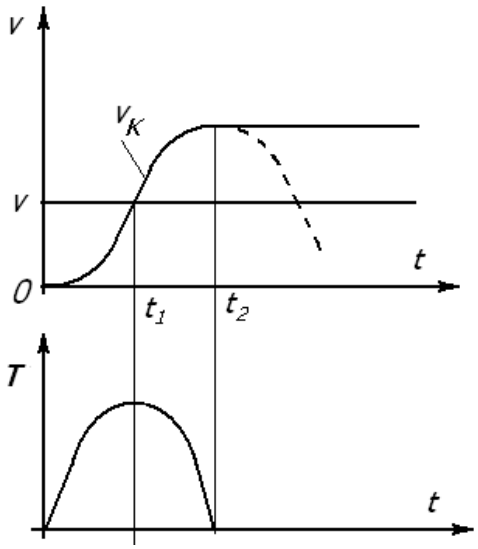

Рис.2. Изменение скорости схода нити с катушки и ее натяжения при отсутствии момента трения на оси катушки

ВЫВОДЫ

1. Установлены причины возникновения пиков натяжения в период пуска при сматывании нити с вращающейся катушки.
2. Получено выражение для расчета пикового значения натяжения

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STUDY OF EXTRACTION PERFORMANCE SERICIN

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ABSTRACT: The results of the physico-chemical studies on the extraction of waste not recycled silk, the aim of which is to obtain a sericin powder preserving its initial properties for future use as an adhesive when sizing yarns.
Key words: cocoon, waste, powder, silk, sericin.

Согласно данным статистического управления при президенте Республики Таджикистан[1], на кокономотальных фабриках республики ежегодно образуется более 150 тонн шелковых отходов: неподдающихся размотке коконы, волокнистые отходы кокономотания и куколки.

Утилизация этих отходов имеет большое народнохозяйственное значение для экономики Таджикистана, так как на каждый килограмм выработанного шелка-сырца приходится более 1 *кг*.различных отходов. Оболочка дефектных коконов и волокнистые отходы кокономотании являются ценным текстильным и биологическим сырьем имеющим до 30 % клеящего вещества- с е р и ц и н а пригодного для технического, санитарно-медицинского, косметического и др. назначения.

Известны отечественные и зарубежные работы [1-5] которые направлены на утилизацию шелковых отходов, для получения из них порошка натурального шелка или серицина путем экстрагирования под давлением и при высокой температуры, где в качестве растворителей применяются щелочь или кислота.

Общим недостатком указанных работ является невозможность использования полученного порошка в текстильной промышленности в качестве клеящего вещества для шлихтования нитей. Так как в качестве растворителя используются щелочь или кислота высокой концентрации и процесс экстрагирования проходить под давлением и при температуре 105-120^{o} С. При такой обработке разрушаются водородные связи, стабилизирующие В- клетчатый структура серицина шелка, нарушается ионное взаимодействие между радикалами аминокислот, стабилизирующее третичную структуру молекулы шелка, нарушаются молекулярные взаимодействия между фибриллами в результате чего теряется клеящий свойства серицина. Полученный порошок непригоден к использованию в текстильной промышленности. Что касается физико - механических свойств волокнистой массы натурального шелка, она теряет прочность после экстракции и становится также непригодным для дальнейшего использования в текстильной промышленности.

С целью настоящей работы является утилизация шелковых отходов кокономотальных фабрик Республики Таджикистан, путем экстрагирования серицина с сохранением ее исходных (клеящих) свойств для дальнейшего использования в текстильной, санитарно- медицинской и косметических отраслях.

Методика работы

Экстрагирования шелковых отходов производилось в двух вариантах:

А- на щелочном растворе карбоната натрия;

Б - дистиллированной воде.

ВАРИАНТ- А. Щелочная раствор приготовили в соотношении 0,02 м. для этого 5 г. порошка карбоната натрия растворили на 1 л. дистиллированной воде. Затем в стеклянную посуду объемом 1,5 л. засыпали 50 г. разрезанных на мелкие фрагменты оболочек бракованных коконов и туда залили 1 л. щелочного раствора. Полученный раствор при комнатной температуры (32^{o} С) кипятили в водяной бане в течении 60 минут. Полученный экстракт фильтровали через тканный мешочек и концентрировали на вакуум- роторе "Unipon-35P" (Польша). В концентрированный раствор объёмом 50 мл.добавили этиловый спирт в соотношении 1/3 и оставили для осадки на 24 часа. Через сутки осадок серицина отфильтровали через тканное полотно и полученную массу промывали спиртом. Затем раствор экстракта серицина отжимали на центрифуге, высушивали при комнатной температуры и измельчали на шаровой мельнице. Полученный порошок весом 2,3783 г. мягкий, шелковистый на ощупь с характерным скрипом "туше", однородной консистенции с темно-коричневым цветом.

По результатам расчетов установили, что выход порошка серицина из первоначальной массы оболочек бракованных коконов составило 4,76 % или 15,85 % из имеющегося серицина на волокнах шелка-сырца.

ВАРИАНТ- Б. Разрезанных на мелкие фрагменты 50 г. оболочек бракованных коконов кипятили в течении 60 минут на 1 л. дистиллированной воды в водяной бане. Полученный экстракт фильтровали, концентрировали на вакуум- роторе, промывали этиловым спиртом. Также раствор экстракта серицина отжимали на центрифуге, высушивали при комнатной температуры и измельчали на шаровой мельнице. Полученный порошок весом 1,8271 г. мягкий, шелковистый на ощупь с характерным скрипом "туше", однородной консистенции с светло-коричневым цветом.

Выход порошка серицина составило 3,65 % к первоначальной массы оболочек или 12,18 % из имеющегося серицина на волокнах шелка-сырца.

Исходя из вышеизложенного можно сделать следующие выводы:

1. Известные способы утилизации шелковых отходов путем их экстрагирования и превращения в порошок исключает их применение в текстильной промышленности.

2. Оптимальными параметрами экстрагирования шелковых отходов для сохранения их исходных свойств являются: температура растворения 85-90^{o} С и время экстрагирования 60 минут.

3. Для всестороннего анализа экстракционных характеристик серицина извлекаемого из шелковых отходов необходимо проведение фракционирования состава серицина.

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HETEROSIS MANIFESTATIONS AND DEPRESSION BY SURVIVAL AND LARVAL DURATION OF *BOMBYX MORI* L. HYBRIDS REARED WITH ARTIFICIAL DIET

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Abstract

The aim of this paper was to study the influence of the degree of heterosis (compared to higher parent value – HP and mean parental values – MP) and inbred depression on the signs, survival and larval duration of *Bombix mori* L. hybrids.The study was conducted at theTrainingExperimental Station of the Sericulture section of the Faculty of Agriculture at Trakia University. Object of the study is a hybrid, created in Sericulture and Agriculture Experiment Station(SAES)-Vratza, with the participation of maternal breed with high survival rate and shorter larval duration ("Vratza 55" – 83.08% and 92 h) and a father's breed with very low survival rate and extended larval duration ("Baneasa P" – 57.44% and 107 h). Silkworms were reared with artificial diet containing 15% powder of dried mulberry leaf produced at SAES –
Vratza and prepared by methods, developed by the manufacturer, whereby 250g of dry substance and 675ml of distilled water are homogenized using a mixer. The mixture is cured thermally in a microwave for 10 min at 800W.

The susceptibility of hybrid, heterosis manifestations of the signs in F_1 and the depression in F_2 was determined based on the results from the survival rate and larval duration in the Istinstar of the larval stage by the parental breeds (P_1 and P_2) and hybrid generations (F_1, F_2, BCP_1 and BCP_2).

The results (90.94% survival and 88 h duration of larval duration) show that hybrid "Vratza 55 x Baneasa P" shows a high degree of susceptibility to artificial diets with reduced content (15%) of mulberry leaf powder. Better results were seen in BCP_1 hybrid generation with the participation of breed "Vratsa 55" as a donor. It was found a high degree of heterosis expression for F_1, as compared MP and as to the HP for the both analyzed signs. The high degree of heterosis in F_1 was accompanied by depression in F_2.

Keywords: Silkworms;*Bombyx mori* L.; Artificial diet; Hybrids;Heterosis, Depression

Introduction

In the area of application of artificial food for silkworms the issue of determining the susceptibility to artificial diet feeding of *Bombyx mori* L. breeds and hybrids and the creation of forms adapted to raising with artificially prepared food can be pointed out as the main one. To increase the efficiency of cocoon production, the optimization of food composition is also sought (Horie, 1981).In this respect, researches on genetic control of feeding behavior in silkworms havesubstantial contribution.

As a result of the studies on the genetic control of the eating behavior in silkwormsit was found that their susceptibility to artificial food was controlled by a recessive gene and was inherited as a dominant indicator, and their adaptation to artificial food expressed through cocoon growth and yield was different depending on the breeds and was likely to be controlled

by many genes (Fujimori et al., 1982; Yamamoto & Shimizu, 1982; Yamamoto, 1983; Tanaka & Midorikowa, 1984).

Nutritional test of silkworms of F_1, F_2 and BF_1 between breeds with high and low adaptability show that susceptibility is controlled by recessive genes. The histogram of the larval weight of F_2 and BF_1 individuals indicates that susceptibility is determined by a major recessive gene and some modified genes(Kanda et al., 1988; Kanda and Tamura, 1989)

According to Nair et al. (2013), the susceptibility of silkworms to artificial diet varies within breeds, between breeds and between generations. They clearly demonstrate the possibility of change by prolonged selection and changing the frequency of many genes that could not have much influenceseparately.

Lizuka et al. (2007) conduct genetic studies on silkworm breeds with low and high susceptibility to artificial diet and their crosses in order to localize the locus (genes) in the genetic map controlling susceptibility to artificial food.

Tamura (1988) explores the nutritional behavior of non-mulberry plant sources of 106 breeds and the character of it's inheritance. The breeds differ in the degree of susceptibility to artificial diet and therefore they can be differentiated into two grups: with high (polyphagous) and low (stenophagic) susceptibility.

To determine the character of inheritance, high and low-foodsusceptibility breeds were used. The results show that F1 hybrids between forms with high susceptibility to artificial diet were alsowith high susceptibility, and hybrids between low susceptibility breeds showed low susceptibility. Hybrids between breeds with different susceptibility show high or low rates of food intake.Therefore, the inheritance of the susceptibility to non-traditional dietis not always controlled by dominant genes, and it has a recessive type of inheritanceof the nutritional preferences.

In order, to implementthe artificial diet breeding technology massively in the practice, it is necessary to select breeds and hybrids of silkworms capable of producing a large amount of silk by efficiently transforming food into textile fibers so that the production to artificial food be cheap enough and affordable. This complexity in the qualities of breeds and hybrids can only be achieved through the selection pathway (Kato et al., 2010, Tatemastu et al., 2012) or as a biological model (Hamamoto et al., 2005, Kaito and Sekimizu, 2007).

In terms of the specificity of the different breeds susceptibility to artificial diet and the creation of high-productive hybrids, of a great interest is the problem of using of artificial food for the rearing of their parental forms (Furusawa et al., 1982).

Breeds, in wich a strict selection to susceptibility to artificial food is conducted, can be a starting point for creating hybrids whose productivity can be further improved by heterosis (Singh et al., 2012, Saviane et al., 2014).

This study aims to determine the degree of heterozis (relative to MP and HP) and inbreeding depression on the traits of survival and duration of development in *Bombyx mori* L. hybrids when grown with artificial food with a reduced (15%) content of mulberry leaf powder.

Material and methods

The study has been conducted at the Training Experimental Station of the Sericulture section of the Faculty of Agriculture at Trakia University. The object of the study is a hybrid "Vratza 55 x Baneasa P", created in Sericulture and Agriculture Experiment Station (SAES)– Vratza, with the participation of maternal breed with high survival rate and shorter larval duration ("Vratza 55" – 83.08% and 92 h) and a father's breed with very low survival rate and extended larval duration ("Baneasa P" – 57.44% and 107 h).

Silkworms were reared with artificial diet containing 15% powder of dried mulberry leaf produced at SAES-Vratza and prepared by the following scheme - 250g of dry substance and 675ml of distilled water were homogenized using a mixer. The mixture was thermally processed

in a microwave for 10 min at approximately 800W. The prepared food was kept in a refrigerator at temperature 2-5^{o}C until the moment of its use for feeding.

During rearing, the food was given immediately after the mass hatching of larvae and on the third day of the first instar.

The traits survival and duration of development in the I-st instar of the larval stage were controlled.

Heterosis effect was calculated on the basis of the formula of Kremky (1970),as in relation to the meanparental value /MP/ so and tothe parent with higher value /HP/.

- compared to HP

$$HP = \frac{F_1 - HP}{HP} \times 100\ (\%)$$

- compared to MP

$$MP = \frac{F_1 - MP}{MP} \times 100\ (\%)$$

Depression was determined using the formula of Omarov (1975)

$$\frac{F_1 - F_2}{F_2} \times 100\ (\%)$$

For all studied traits we calculated the basic statistical characteristics of specimens of all breeds. The obtained data were systemized and processed with the respective modules of STATISTICA software of StatSoft andMicrosoft Excel 2010.

Results and discussion

One of the first and basic traits, by which conclusions about the susceptibility of individuals to artificial diets can be made, is their survival.For the selection process and the creation of forms with high susceptibility is of great importance the character by which susceptibility is transmitted through generations when implementing the various schemes of hybridization.

Figure 1 presents data on the average values of the trait survival in parental breeds and their F_1, F_2, BCP_1 and BCP_2 generations.

From the results on the table can be seen, that the generation and the scheme of hybridization were influencing the phenotypic manifestation of the trait. With the highest survival were the individuals in F_1. The next generation (F_2) was characterized by 13.44% lower survival rate in comparison with F_1.

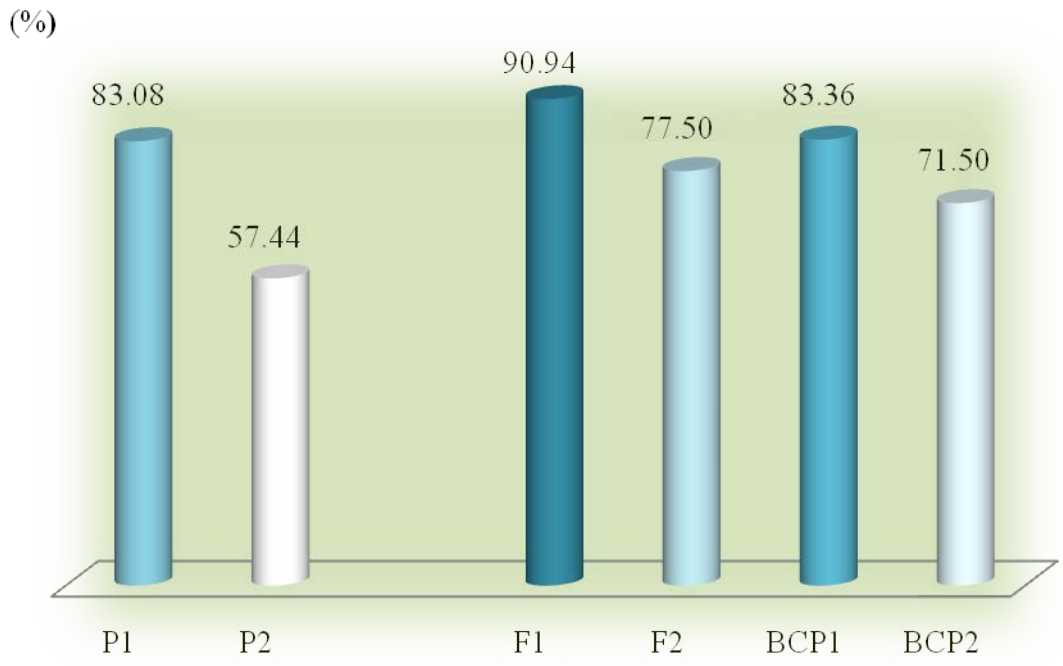

Figure 1. Survival of hybrids and their parental forms (%)

The results of Figure 1 show also that in the back crosses, the effect depends on the level of the trait in the breed used for paternal form. When it was with a higher value, the resulting generation also had a higher value. At low survival rate of paternal form, the generation was with the lowest rate individuals passed in the next instar (71.5%).

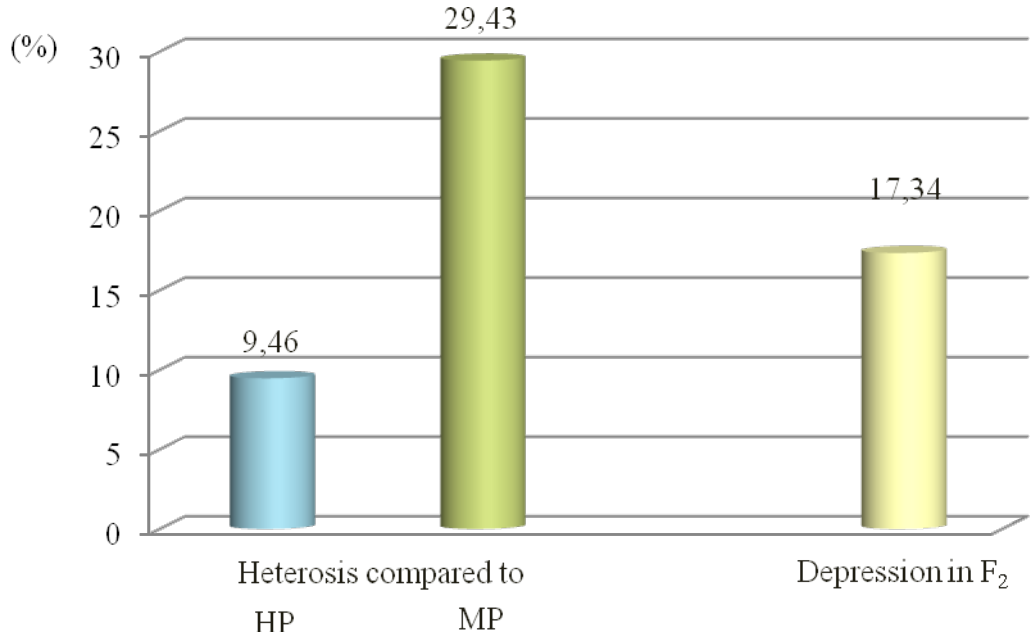

Figure 2. Heterosis manifestations inF_1 and depression in F_2 by survival(%)

From the results of the degree and character of heterosis manifestations it was seen that F_1 generation excelled as the mean parental (MP), so and the values of the better parent (HP). The data in Table 1 also showed that heterosis manifestations in F_1were related to a depression in F_2.

Unidirectional as a trend with the results for the survival were and the results for duration of larval development. With the shortest development were individuals of F_1, and with the longest – on the F_2 generation(Figure 3). Beck cross forms were with a longer development period than parental breeds. This was expressed more weakly when the paternal form was breed with a shorter larval development.

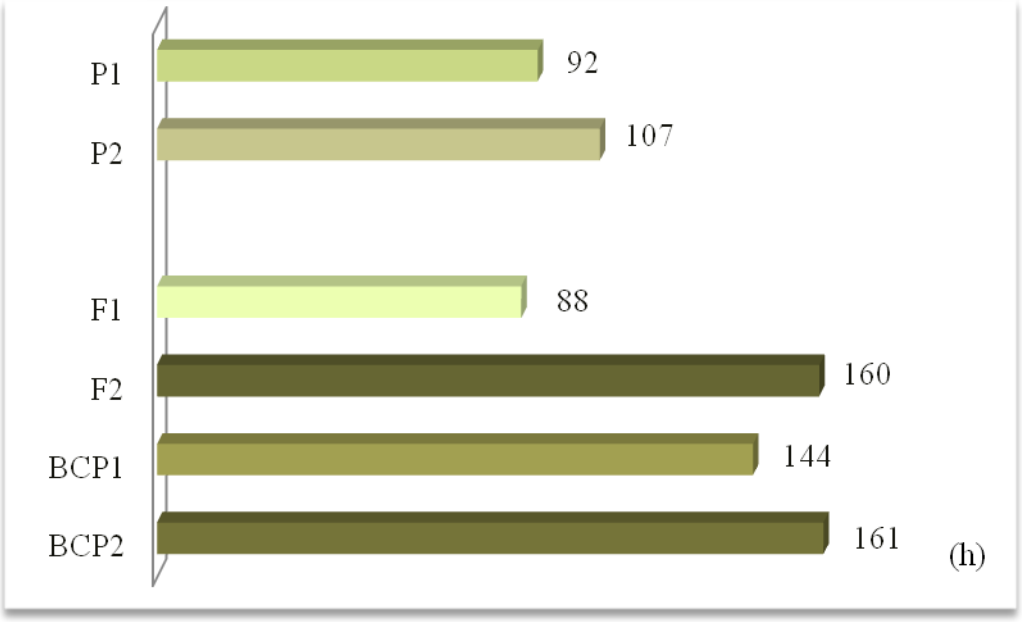

Figure 3. Development duration in hybrid generations and their parental forms (h)

From the data presented on a Figure 4 for the heterosis manifestations of the trait duration of larval development was seen that F_1 hybrid had a shorter development than the better parent (by 4.35%) and the mean of both parents (with 11.56%). As well as the trait survival heterosis manifestation in F_1 were related to depression in F_2.

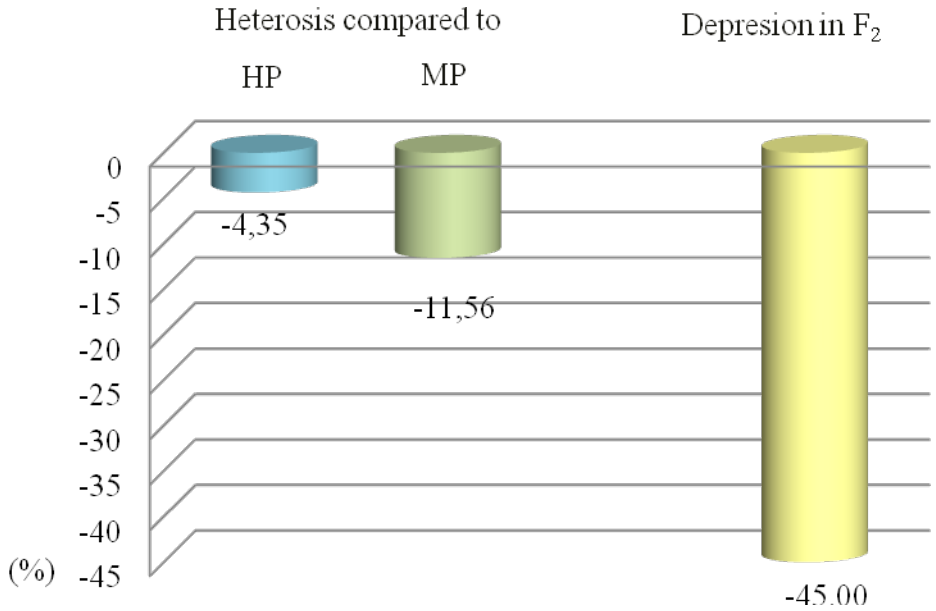

Figure 4. Heterosis manifestations and depression by development duration (%)

Conclusion

- The results obtained (90.94% survival and 88 h duration of larval development in the first instar) showed that the hybrid "Vratza 55 x Baneasa P"had high degree of susceptibility to artificial diet with reduced content (15%) of mulberry leaf powder.
- Better results were observed in the back cross form with the participation of breed "Vratza 55" as a donor.
- The tested hybrid manifested heterosis for the both analyzed traits in F_1, as in relation to the mean parental value /MP/, so and to the parent with higher value /HP/.
- The heterosis manifestation in F_1 was related to depression in F_2 for the both analyzed traits.

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EFFECT OF THE BLUISH-GREEN ALGA *SPIRULINA* ON MULBERRY SILKWORM DISEASE "NUCLEAR POLYHEDROSE"

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Annotation. Properties of microbes that is of pathogenic agents which produce diseases are conditioned by their virulence and toxicity. At the infestation they collide with active opposition of the organism, that is, with the immunity reaction.

Our research pursues to control the productivity and it aims to prepare high grade grain, resistant to the disease - nuclear polyhedrose.

With this in view, to induce mulberry silkworm disease - nuclear polyhedrose, we have developed a method of artificial infestation of mulberry silkworm. As a result of application of various concentrations of *"Spirulina"* we managed to increase silkworm viability, that is, elevated silkworm immunity, and this, in its turn, resulted in the increase of silkworm viability and finally, significant increase of cocoon output.

Effect of the leaf enriched with the biostimulator, on the mulberry silkworm productivity is very important; additional nutrient solution contributed to the processes of metabolism, ferment activation, assimilation of protein and phosphoric compounds, mono- and disaccharides and other substances, which improved silkworm body immunity and protein synthesis.

According to the economic indices obtained as a result of experiments carried out by us, the priority was granted to 5.0% solution of the biostimulator.

K-words: mulberry silkworm, disease, biostimulator.

Introduction. Technology of mulberry silkworm nutrition conditions obtaining of high quality silk cocoon; it implies not only the study of the effect of ecological factors on mulberry silkworm growth and development but also the application of modern biotechnology, one of the means of which is enrichment of feed with various biological admixes. Mulberry leaf, as such, should contain sufficient quantity of organic substances, which is necessary for obtaining healthy generation; it should also contain protein substances and nitrogen in big quantity, which contribute to the increase of output of raw silk thread.

To increase the nutritive value of the basic feed for mulberry silkworm, that is the leaf, the specialists use to add to it biostimulators, proteins, fats, carbohydrates, microelements and vitamins.

At the Scientific-Research Institute of Sericulture the bluish-green alga *Spirulina* was tested. It is the 100 % natural, ecologically pure substance and it improves immunity of live organism. As a result, the mulberry silkworm resistance to various diseases was increased.

The present paper deals with the method of application of *Spirulina* as a biostimulator in admix to the feed of mulberry silkworm.

Selection of the biostimulator concentrations is the very important issue, since a silkworm, by its nature, is very sensitive to the feed and reacts to every concentration correspondingly.

Objects and methodology. Experimental works were implemented at the Laboratory of Sericulture of the Georgian Agrarian University.

The object of the research was the mulberry silkworm /Bombyx mori L./ breed -Mziuri-I, of local selection, which was obtained at the Scientific-Research Institute of Sericulture (Author N.Sanadze).

Initial material for the researches dealing with mulberry silkworm is its grain. The results of feeding such as silkworm viability, cocoon weight, silk capacity and other biotechnological characteristics depend on the healthy grain and its adequate incubation.

In our experiments we used the grain prepared by the cellular method, and we used the method of grain incubation at constant temperature, at the terms of natural illumination.

The goal of our research was determination of the effect of the biostimulator *"Spirulina"* on the worm infested with the nuclear polyhedrose virus.

Experiment was carried out on 4 versions. The following three concentrations of the biostimulator were tested. 1.0%. 2.0%, 5%. The IV group, the control was given common mulberry leaf. Each version – was performed in three repetitions.

Mulberry silkworm nutrition was performed by the observance of all requirements stipulated by agro-rules for moriculture and sericulture. In particular, in the, I-III instar temperature in the silkworm room was 24-26◦C, in the IV-V instar - 21-22◦C, relative humidity of air was 70-75% and 60-65%, respectively;

From the second day of the fifth instar, after artificial infestation, silkworm was given, in the morning, on an empty stomach the mulberry leaf, wetted in the solutions of the above listed concentrations by the observance of norms stipulated by agro-rules. The leaf was weighted and immersed in the concentrated solution of the preparation 30 minutes before its giving to the silkworm; after its wetting the leaf was stayed to dry, because wet leaf could result in silkworm disease.

Within the period of feeding the quantity of the leaf consumed by the worm as well as number of diseased worm were recorded. The obtained results are given in the Diagrams 1 and 2.

Diagrams show the apparent effect of the biostimulator on the biotechnological indices of the infested silkworm, especially when the leaf is treated with high (5.0%) concentration solution. Namely, as a result of application of 5.0% solution of the biostimulator in the worm phase the silkworm viability increased by 12.3%, compared with other experimental versions and by 31.3% compared with the control version.

Thus, the positive effect of the 5.0% concentration of the biostimulayor was vivid, which was expressed in biotechnological indices of cocoon. It was expressed as follows: at the application of the 5% concentration solution, cocoon output exceeds by 0.8 – 1.0 kg those of other experimental versions and by 1.4 kg that of the control version; cocoon mass exceeds by 0,15-0,2 g those of other experimental versions and by 0.4 kg that of the control version, cocoon silk capacity exceeds by 5,7-4,9 % those of other experimental versions and by 5.9%- that of the control version;

As is seen from the Table 1, as a result of variation treatment, the accuracy and reliability factor of the research jave been proved, since all data are within norm.

It is true that biotechnological data of our experiments are far lower than the characteristics inherent to the breed Mziuri, but we have to consider here that in research we aimed to obtain individuals which would be relatively resistant to nuclear polyhedrose and finally to receive the resistant breed, for it, we infested the worm artificially.

We aimed to study the effect of the biostimulator on the infested silkworm, at its feeding in provocative conditions, and namely the influence of the biostimulator, especially on its viability, since mulberry silkworm in unfavorable conditions is easily infected, especially in the worm-phase. The existing infection diseases use to spread swiftly, shift from the diseased body to the healthy ones and to acquire mass character.

Properties of microbes which incite diseases are determined by their virulence and toxicity. At the infestation they come across with active opposition of the organism, that is, immunity reaction (intactness to infection diseases), which can resist microorganisms.

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Diagram 1. Effect of *"Spirulina"* on the infested mulberry silkworm viability

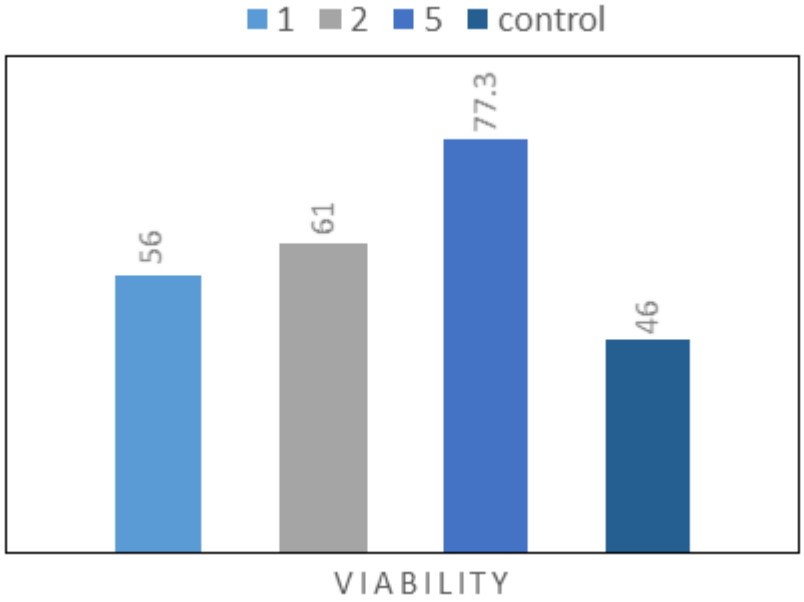

Diagram 2. Effect of "*Spirulina*" on the economic indices of the infested mulberry silkworm

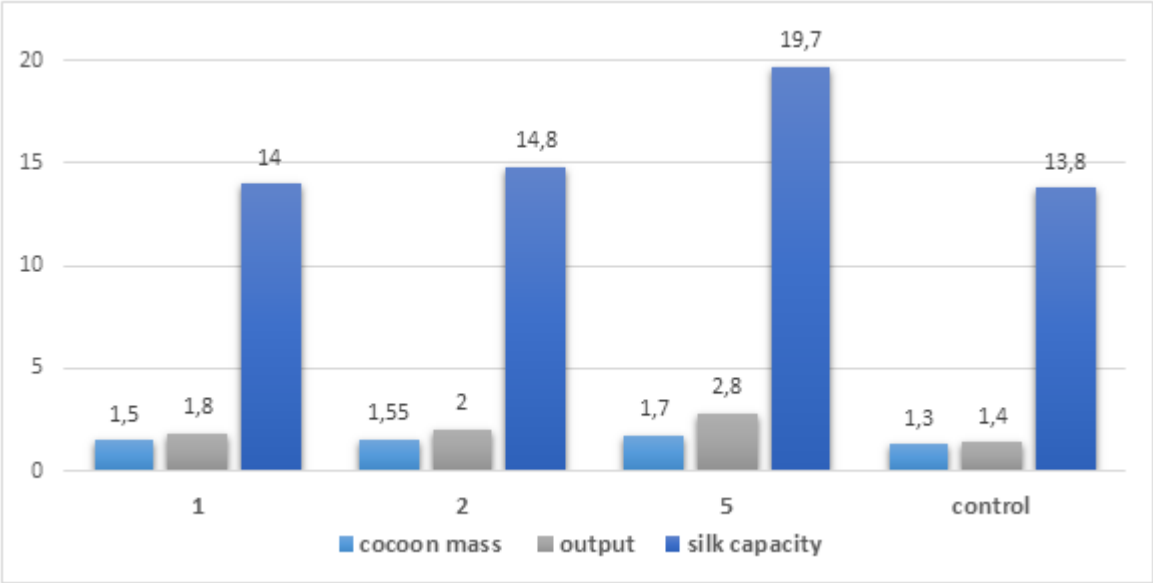

Table 1. Effect of the feed admix on some biological indices of mulberry silkworm

Concentration	biotechnological indices	x±mx	σ	C%	P%	t>3
5,0 %	cocoon mass,g.	2.6±0.2	0.2	7.6	4.3	9.0
	silk capacity, %	21.4±0.41	0.2	7.6	4.3	8.6
	cocoon yield per g. worm, kg.	5.2±0.54	0.3	5.8	3.4	6.5
2,0 %	cocoon mass,g.	2.6±0.21	0.12	4.6	2.6	5.6
	silk capacity, %	23.1±0.6	0.37	7.0	4.2	5.5
	cocoon yield per g. worm, kg.	5.5±0.3	0.3	6.4	3.7	6.5
1,0 %	cocoon mass,g.	2.0±0.1	0.12	6.0	0.6	7.6
	silk capacity, %	23.1±0.6	1.3	3.0	4.2	8.5
	cocoon yield per g. worm, kg	5.1±0.3	0.3	5.4	3.2	6.5
Control	cocoon mass, g.	2.0±±0.1	0.2	12.5	0.7	8.0
	silk capacity, %	23.7±±0.7	2.7	2.4	1.4	9.0
	cocoon yield per g. worm, kg.	5.1±0.54	0.3	5.5	3.2	6.5

where, X- experimental data
mx – mean error
σ - mean quadratic deviation
C% - variation factor
P% - research accuracy (should be lower than 5)
t - reliability factor (should exceed 3);

Conclusion. As a result of the influence of the biostimulator the silkworm viability compared with the control one was increased, that is, mulberry silkworm immunity was increased and it, in its turn resulted and conditioned the elevation of silkworm viability and sharp increase of cocoon yield.

Thus, effect of the leaf enriched with the biostimulator on the productivity is rather significant; it contributed to the metabolic processes, ferment activation, assimilation of protein and phosphor compounds, mono- and disaccharides and other substances, which significantly improved protein synthesis in worm organism.

Taking into consideration the economic indices obtained as a result of the experiments carried out by us, the advantage was granted to the 5.0 % solution of the biostimulator.

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Effect of sericincontentonsomebasictechnologicaltraitsin*Bombyxmori* L.

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ABSTRACT:

Sericin content is of great importance in the production of raw silk. The study has been carried out at the educational and experimental base of the Silkworm breeding section of the Faculty of Agriculture at TrakiaUnivercity, Stara Zagora-Bulgaria. The aim of the study was to investigate the effect of sericin content in the Bombyxmori silk thread on the phenotypic manifestation oftechnological characters: raw silk ratio (%), reelability (%), total and non broken filament length (m), filament thickness (denier) and initial rate of dissolution of sericin. Analysis of variance showed that the sericin content had significant effect on the technological characters raw silk ratio ($p \leq 0.01$), reelability ($p \leq 0.01$), non broken filament length ($p \leq 0.01$) and initial rate ofsericin dissolution ($p \leq 0.001$).

Keywords: Bombyxmori, sericin, silk threads, technologicaltraits.

INTRODUCTION

The silk bave composed of two protein substances viz., fibroin and sericin of wichsericin represents for 20-30% of the weight (Prasong et al., 2009; Seetharamulu et al., 2013, Chellamani et al., 2014).It is affected by factors with genetic (Gamo and Hirabayashi, 1984; Sinha et al., 1992; Basavaraja et al., 2000; Radhavendra Rao et al.,2004 etc.), as well as non-genetic features (Sanappa, 2002, Amala Rani et al, 2011; Padma and Ramani., 2015).

Silk sericin is one of major components of cocoon produced by silkworm.Its content, physical-mechanical and chemical properties are the main factors determining the technological qualities of the cocoons and the silk thread (Sadov et al., 1987).

During the course of breeding process, the boil-off ratio with reference to cocoon shell has been given utmost importance along with other qualitative and quantitative traits (Gamo and Ichida, 1971; Mano et al., 1988).

Cocoon sericinplais an importan role in the reeling of silk. Quantity and nature of sericin are fundamental characteristics in conferring distinctive traits to the cocoon (Sadov et al., 1987). The percentage of boil-off loss ratio has paramount importance in reeling and weaving activities (Kannan, 1986). According Gamoand Hirabayashi**(**1984) low boil-off loss ratio improves cocoon reelind qualities.

The content of sericin had certain effect on silk solubility. As the content of sericin reduced, the dissolution speed was faster and the silk solubility was greater. The properties of the silk fibroin membranes with some sericinare much better than those degummed completely (Jiang and Zhang, 2013).

The content of sericinaffects also the characteristics of silk fiber-*B. mori* silk with and without sericindiffered dramatically in FT-IR spectra, structure and thermal behavior. Silk without sericin showed higher stability than another one(Lee et al., 2005; Prasong et al., 2009).The content of sericinaffect the sustainability of raw silk to friction (Kuwahara et al., 1978).With higher resistance is lower sericin silk.

Acording Gouda et al. (2013) evaluation of boil-off loss ratio among the breeds (hybrids) will enhance qualitative merit of raw silk.

MATERIALS AND METHODS

Silk threads of B. mori L. cocoons with different fluorescence (violet, intermediate and yellow) were used for the material. Fluorescence was determined using an ultraviolet lamp with a filter transmitting ultraviolet rays within the range 334-400 nm.

The sericin of silk threads was dissolved using the method of Komatsu (1975), through 180-minuteboiling of silk skeinsat 98 ^{0}C in M/5 boratebuffer with pH 9, at a ratio of 1:750, modified by Bobov et al. (2006) by addition of 100µl /ml 0.1 nNaOH.

The content of sericin was evaluated on the basis of absorption measuredon the 180th min from the beginning of boilingusing the following relationship between sericin amount and absorption:

$$Sa\ (\%)=88.578xA + 6.5576,$$

Where Sa - is the percentage of sericin determined by spectroscopy;

A – sericin solution absorption on the 180th min of boiling

Spectroscopy was performed in the UV-rangeata wave length of 280 nm.

To evaluate the effect of sericin, characters are divided into three classes (low - 18.00 – 23.00, average- 23.01 – 28.00, high"-28.01 – 33.00%) and participate in the models as fixed ones. The width of the class interval was defined by the formula:

$$l = \frac{X_{max} - X_{min}}{k},$$

where l is the width of the interval;

X_{max} –the largest value of the character;

X_{min} -the smallest value of the character;

K – number of classes.

The influence of sericin content on the analyzed technological features was determined by a one-factor dispersion analysis.Through analysis of variance (ANOVA) the least square means (LSM) and the least square estimates (LSE) that are sums of the squares of deviations from means derived by the model are calculated.

RESULTS

From the results from the variance analysis, mean values and estimates of the effect of sericin contenton silk yield presented in Table 1 it was found that the amount of sericin in the silk thread has high lyreliable effect on the values of the analysed trait (p≤0.01).

Table 1.Effects of sericin content on the raw silk percentage

Source of variation	df	F	P
Sericin content	2	5,02	0,007*
Ls-means and LS-estimatefor influenceof the sericin content on the raw silk percentage			
Level factor	n	LS-mean ±SE	LS-estimate
Mean of the model	617	41,46±0,19	
Sericin contentin classes (%)			
"low" (18.00 – 23.00)	159	41,89±0,37	+0,44
"average" (23.01 – 28.00)	430	41,47±0,23	+0,01
"high" (28.01 – 33.00)	28	38,84±0,89	-2,62

*$P \leq 0.01$

The class with low sericin content (from 18.00 to 23.00%) is distinguished by higher yield (+ 0.44%) than the average for the model. Silk skeins with high sericin content (from 28.01 to 33.00%) have a significantly lower yield than the average for the model (-2.62%).

Similar results were also observedin the variance analysis, mean values and estimates of silk thread reelability (Table 2). Their analysis shows that sericin contenthashighlyreliable effect on the reelabilitytrait (p≤0.01).

Table 2.Effects of sericin content on the reelability of silk thread (%)

Source of variation	df	F	P
Sericin content	2	5,96	0,003*
Ls-means and LS-estimatefor influenceof the sericin contenton the reelability (%)			
Level factor	n	LS-средно±SE	LS- estimate
Mean of the model	617	88,38±0,20	
Sericin contentin classes (%)			
" low " (18.00 – 23.00)	159	89,10±0,38	+0,72
" average " (23.01 – 28.00)	430	88,28±0,23	-0,10
" high " (28.01 – 33.00)	28	85,77±0,91	-2,61

***P**≤0.01

Silk thread with low content (from 18.00 to 23.00%) have high reelability (89.10%) and LS-mean of +0.72% compared to th eaverage for the model, while that with high content (from 28.01 to 33.00%) show relatively lowreelability (85.77%) and LS-mean -2.61% relative to the model average.

Tables 3 and 4 show the results of the variance analysis, mean values and estimates of the effect of sericinecontenton the total and continuousunwindable length of the silk thread. The calculated values for the F-criterion indicatet hat the amount of sericin has highlyreliable effect only on the variation of the traitnon-broken filament length (p≤0.01). The effect on the total length of the thread is unreliable.

Table 3.Effects of sericin content on the total filament length (m)

Source of variation	df	F	P
Sericin content	2	1,99	0,138
Ls-means and LS-estimatefor influenceof the sericin contenton the on the on total filament length (m)			
Level factor	n	LS-средно±SE	LS- estimate
Mean of the model	617	1111,94±7,62	
Sericin contentin classes (%)			
"low" (18.00 – 23.00)	159	1129,29±14,99	+17,34
" average " (23.01 – 28.00)	430	1109,24±9,11	-2,70
" high " (28.01 – 33.00)	28	1054,96±35,71	-56,98

It has been found that for both attributes, the LS-means compared to the average for the model, for the matching classes divergein the same direction, but the difference between the final mean valuesat the total filament length is small (74.32 m) and several times small erthan that of the non-broken filament length (151.08 m). This is insupport of the established reliable effect of the fixed factor on the second of the above signs.

The data about the trait non-broken filament length of the silk thread reveal that the low sericin content (from 18.00 to 23.00%) has contributed to the production of a considerably longer uninterrupted thread (59.78 m more than the average for the model) and the opposite the high sericincontent (28.01 - 33.00%) has resultedin a relatively short, interruptedly unwound thread (91.30 m shorter than the average for the model).

Table 4.Effects of sericin content on the non-broken filament length (m)

Source of variation	df	F	P
Sericin content	2	4,92	0,008*
Ls-means and LS-estimatefor influenceof the sericin contenton the non-broken filament length (m)			
Level factor	n	LS-средно±SE	LS- estimate
Mean of the model	617	984,05±12,35	
Sericin contentin classes (%)			
"low" (18.00 – 23.00)	159	1043,82±24,18	+17,34
" average" (23.01 – 28.00)	430	967,87±14,70	-16,16
"high" (28.01 – 33.00)	28	892,75±57,61	-91,30

*$\mathbf{P}\leq 0.01$

Table 5 shows the results of variance analysis, meanvalues and estimates of the effect of sericin contenton the silk thread on the initial sericin dissolution rate. The calculated value for the F-criterion indicates that the effect is high lyreliable ($p\leq 0.001$).

Table 5.Effects of sericin content on the initial rate of sericin dissolution

Source of variation	df	F	P
Cericin content	2	57,32	<0,001*
Ls-means and LS-estimatefor influenceof the sericin contenton theinitial rate of sericin dissolution ($x10^{-3}gl^{-1}min^{-1}$)			
Level factor	N	LS- mean ±SE	LS- estimate
Mean of the model	617	9,5±0,13	
Sericin contentin classes (%)			
"low" (18.00 – 23.00)	159	7,5±0,23	-2,0
"everage" (23.01 – 28.00)	430	10,0±0,14	+0,5
"high" (28.01 – 33.00)	28	12,4±0,55	+2,9

*$P\leq 0.001$

The average values and estimates for the traitobtained for the individual classes indicate that at low sericin contentin the silk thread (from 18.00 to 23.00%) its initial dissolution rate was also low (7.5 x10-3g/l-1min-1), with L-mean of -2.0x10-3g/l-1min-1 compared to the average for the model. Conversely, the class with highsericincontent (28.01 - 33.00%) is characterized by relatively highinitial sericin dissolution rate (12.4 x10-3g/l-1min-1), with LS-mean +2.9 x10-3g/l-1min-1 compared to the average for the model.

Inourview, the established dependence could be explained by the flow of smaller or greater amounts of sericin in the solution perunit of timeas a result of the lower or higher content of easily soluble sericin in the silk thread. The claimis supported by the fact that the initial dissolution rate of sericin is determined by the ratio between the amount of dissolved sericin and the dissolution time. Probably the decrease or increase of the total sericin content in the thread results in proportional decrease or increase in the amount of individual fractions (easily and poorly soluble sericin). Insupport of this is the different dissolution rate of sericin as found by Lee (1999) and Takasuetal., (2002; 2005) depending on its location around the silk thread. The highest is the solubility in the surface layers, and the lowest – around the fibroin fiber.

CONCLUSION

The summarised analysis of the results from this study show that the amount of sericin has highly reliable effect on the phenotypic manifestation of thetraits laboratory silk yield, unwindability, continuous unwindable length, initialdis solution rate of sericin, and hasno effecton the total length of the silk thread. Except for the traitinitial sericin dissolution rate, the highe stare the values in the cases with the lowest sericin content.

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ШЕЛКОВОДСТВО ГРУЗИИ –ВЧЕРА, СЕГОДНЯ, ЗАВТРА

Е.Шапакидзе – академик Академии сельскохозяйственных Наук Грузии, доктор технических наук, профессор (Грузия)

Шелководство Грузии – древнейшая отрасль сельского хозяйства, которая успешно выдержала серьезные исторические испытания страны и стала источником устойчивого валютного дохода. Оно является наилучшим показателем культурного наследия нации, средством массовой занятости населения, значительным источником денежных доходов и предметом постоянной заботы. Производство, переработка и вязание являлось самым престижным занятием. Высококачественный Грузинский шелк пользовался большим авторитетом на мировом рынке, а "Великий шелковый путь" проходил и через Грузию.

Грузинский шелк получил высокую оценку и медали на международных выставках в Турине еще в XIX веке, в 1850 и в 1862 годах в Лондоне.

Организаторы международных выставок обращали также внимание на состояние и уход тутовых растиений, их посадку и размножение. Так , например. два века тому назад на английской международной выставке был отмечен успех тутовых плантаций г. Вани (Западная Грузи).

Ткани, изготовленные на комбинате "Цисарткела" (г.Тбилиси, Грузия), полученные из нити грузинских шелкопрядов ("Мзиури 1" и "Мзиури 2") в 1998 году на международной выставке в Мадриде получила высшую награду европейского сообщества "Платиновую звезду".

Географическое расположение Грузии благоприятно для развития шелководства, где хорошие природные условия, древнейшие традиции шелководства , высокое качество продукции, полученные награды на мировых выставках, малоземелье и существование свободной рабочей силы, все это создает благоприятные условия для привлечения инвестиций и в случае разумного их использования, еще можно спасти отрасль.

В 60-ые годы прошлого столетия в Грузии ежегодно производилось 4,0 – 4,2 тыс. тонн живого кокона, 4,5 -5, 0 тонн грена, 450-500 тонн натуральной шелковой нити, 4,5-5,0 млн. метров натуральной ткани и др. продукции, доходом от реализации которых пополнялись все уровни бюджета страны.

Шелководство - классический пример замкнутого безотходного природного цикла. Оно дает ценный продукт-шелковый кокон, из чего получаем шелковую нить и ткань. Отходы корма червей наилучшее естественное удобрение для почвы. Отходы куколок после обмотки нитки используются в фармокологии, косметологии и для корма животных. В результате измельчения (дробления) оставшихся голых веток, приготовляются высококачественные строительные плиты.

Население сел Грузии, только после реализвции живого кокона , ежегодно получало 16-17 млн. рублей дохода , при этом в отрасли было занято 100-120 тыс. семей -14,5- 15, 0 тыс. рабочих мест, в промышленности 5, 5 - 6,0 тыс., а в системе Управления шелководства Министерства сельского хозяйства Грузии - большой коллектив.

К сожалению, именно на этом этапе (1964 г.) в зонально-опытной станции Кутаиси, была выявлена болезнь –"курчавая мельколистность", которая уничтожила почти до 15 млн. сортовых тутовых деревьев. К этому добавились трудности, связанные с переходом на рыночную экономику , что и вызвало окончательное падение отрасли. На сегодняшний день отрасль уничтожена, выкарчевывются оставшиеся тутовых насаждения тогда , когда в случае целенаправленного развития отрасли, тысяча жителей сел смогли бы дополнить свой прожиточный минимум. К

этому еще добавляется сведение до минимума научный потенциал отрасли, что вызвано ликвидацией НИИ шелководства.

Отстранением шелководства из исторически установленной отраслевой структуры сельского хозяйства, ухудшилась экологическая среда, ускорился процесс миграции, сократился семейный бюджетный доход и катострофически уменьшился уровень занятости населения. Исходя из создавшегося положения в шелководстве, срочно должны осуществляться радикальные меры по восстановлению реабилитации и дальнейшего развития шелководства, в противном случае может произойти полная ликвидация отрасли.

С учетом создавшейся экстренной ситуации в шелководстве и для осуществления поставленныхз задач, интенсивно и эффективно в этом направлении работает Академия сельскохозяйственных наук Грузии, которая Указом № 4 от 25. 06. 2010 г. рассмотрела вопрос «Разработки мер по реабилитации шелководства Грузии и ее научное обеспечение.» Была разработана « Концепция развития шелководства 2015-2025 годы» и жизненно важные рекомендации по восстановлению отрасли, инструкции, ценные научные труды, которые были посланы в государственные и законодательные структуры.

В этом направлении следует отметить роль Ассоциации шелководства стран регионов Черного, Каспийского морей и Центральной Азии (BACSA), вместе с его президентом, доктором, профессором Паномир Ценовым, который поддерживает восстановление и развитие шелководства Грузии и все мероприятия Академии.

Шелководство как одно из значительных отраслей национального хозяйства, должно сформироваться заново. Для этого необходимо:

- всестороннее восстановление, укрепление и развитие кормовой базы шелководства;
- приобретение необходимого оборудования для первичной обработки коконов и для производства сухой нити, обеспечение процесса обмотки, приобретение технических средств малой механизации (технические средства для заготовки и подготовки тутового корма, несложные конструкции для выкормки гусениц тутового шелкопряда и модернизированные или менханизированные установки для выкормки, устройства для очистки коконов от сдыра, механические станки для индивидуальной намотки нити из сырого кокона, для создания и подачи рынку с учетом потребности, производство конкурентноспособной продукции;
- реабилитация гренажных заводов и селекционных станций и на их базе производство гибридной грены на основе устойчивых сортов тутового шелкопряда (группа “ Мзиури” и “ Дигмури”), в том числе на экспорт;
- восстановление забытых традиций кустарного производства и обеспечение потребностей туристов на местные изделия;
- многоцелевое использование тутовых растений , углубление интеграции, усовершенствование системы управления и осуществление других необходимых мероприятий;
- научное и образовательное обеспечение отрасли шелководства.

В деле укрепления кормовой базы шлководства максимально должны использовать все методы выращивания тутовых насаждений и в том числе собственно корневую систему. Особенный интерес представляет укоренение черенками озимые устойчивые тутовые сорта в грунтах, утепленных термическими водами, из которых время выращивания саженцев сокращается на 2 года по сравнению с привитыми, а себестоимость сокращается в 2,5-3,0 раза (см. рекомендации “Укоренение тутовых саженцев в утепленном грунте и экономическая эффективность “).

Начались тревования о научной помощи в деле восстановления шелководства в регионах страны, так муниципалитет Ванского района уже обратился с помощью к

Академии сельскохозяйственных наук Грузии, и Академия разработала проект: “Инвестиционный проект реабилитации и восстановления шелководства и кооператива Сачино в Ванском районе”.

Тутовые насаждения - эта основа развития шелководства. При этом тутовые насаждения , с точки зрения многоцелевого использования, они выделяются как самые лу на земле среди растений.

В прошедшем тысячилетии изучено много полезных свойств тутовых , но как выясняептся их возможности неисчерпаемы.

В этом направлении следует отметить предложения, разработанные Грузинскими учеными о целесообразности и высокой экономической эффективности производства традиционных кормов для животноводства из опавших осенью листьев (побеги и ветви) тутовых насаждении. Усовершенствованный материал представлен в рекомендации : “Возможность, технология и экономическая эффективность нетрадиционного корма Некери”

Отмеченный метод успешно внредряется в Аджарии в фермерских хозяйствах Кедского района, а в будущем , в случае помощи малого бизнеса, будет распространен во всех районах шелководства. Это будет способствовать восстановлению как шелководства, так и повышению производства нетрадиционного корма в животноводстве (мясное , птицеводство, рыболовство), оздоровлению малого бизнеса и укреплению села.

По направлению восстановления кормовой базы шелководства, возможно использование тутовые насаждений в ветрозащитных зонах, ввдоль дорог и орошаемых каналов , на склонах, где ожидаются оползни и т . д.

Здесь же представляем литературу и справочный материал, подготовленный Академией сельскохозяйственных наук Грузии по восстапновлению, реабилитации и возрождению шелководства, который будет полезен не только для конкретных инвесторов, но и для заинтересованных лиц отраслью шелководства, фермеров, специалистов и занятых в сельском хозяйстве людей.

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Правительство Грузии усиленно работает по восстановлению отрасли – уже функционириют шелководческие кооперативы в Харагулском, Ахметском и Ланчхутском районах. Готовится правительственная программа восстановления и развития отрасли, автор программы Министерство сельского хозяйства Грузии.

Мы надеемся, что проекты восстановления и развытия шелководства в Грузии успешно будут реализоваться и оно станет средством массовой занятости населения, значительным источником денежных доходов и предметом постоянной заботы правительства, ученых и специалистов-шелководов.

SERICULTURE IN GEORGIA: YESTERDAY, TODAY AND TOMORROW

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Sericulture is one of the most ancient fields of agriculture in Georgia which has successfully survived crucial challenges of history and is now a source of steady country income in foreign currency. The well-known route, so called “Silk Road” was through Georgia. Sericulture is a distinguished example of cultural heritage of Georgian nation, as well as a cause of massive involvement of the population in production of silk, and a source of income. The production, processing and weaving of silk was one of the most wide-spread and prestigious occupations of Georgia farmers. Georgian silk earned a reputation of fine quality at international market, for example, in earned a gold medal at International Exhibition in Turin in the 19th century, also, got high appreciation in London, in 1850 and 1862.

The silk cloth produced by “Tsitsartkela”, Tbilisi, Georgia, was created from indigenous Georgian fiber *Mziuri -1*, and *Mziuri -2*. In 1998, at Madrid International Exhibition it earned the highest award of the European Association - *Platinum Star*.

In the 1960s, about 4,0- 4,2 thousand tons of live cocoon was produced in Georgia, 4,5-5,0 thousand tons of silk-egg, and 450-500 tons of natural silk thread. The income from selling 4,5 -5,0 million meters of silk cloth was a significant share of Georgian budget. About 100 -120 thousand families were involved in the field of sericulture, and Georgian population annually received 16-17 million ruble income from trading live cocoon. Also silk production created 14,5-15 thousand working places, plus 5,5-6,0 - quite a large staff of scientists working at research institutes and testing plots of sericulture.

During this period, (1964) unfortunately, a mulberry leaf disease - *Leaf curl* was spread in Kutaisi Regional Testing Station which devastated about 15 million mulberry trees. In the 1990s, when the country moved to market economy, marketing and other economic problems became very sensitive which totally destroyed the field of sericulture in Georgia.

The collapse of a historical field of agriculture in Georgia incurred many problems, such as deterioration of ecology, increase of migration of population as they lost a source of regular

income, and in the result, the number of those involved in sericulture decreased drastically. Some urgent measures were needed to address the existed problems effectively – to design and implement an action plan for its further development; otherwise the field of sericulture might be totally eliminated in Georgia.

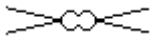
Considering the great importance of the problem, the Academy of Agricultural Sciences carries out intensive work for rehabilitation of the field of sericulture, based on the Order No. 4 from 26.06.2010, which addresses the issue of "Working out necessary measures for restoration of sericulture in Georgia and its provision with scientific basis." The Academy formed a theoretical foundation for development of the field of sericulture for 2015-2025 which includes the most essential scientific recommendations necessary for the revival of the field, also practical instructions and directions which were sent to government and to all relevant organizations. Sericulture, one of the most significant fields of national agriculture, should be created anew.

To achieve this goal it is necessary to:

- Develop and strengthen the feed base for sericulture;
- Purchase necessary equipment for the first stage processing of cocoon and production of rough thread, buying technical means for small scale mechanization of the production (technical equipment for preparation of mulberry feeding base, mechanical devices for cleaning cocoon; also weaving looms for individual application to create competitive production in compliance with market demand;
- Restore silk-egg producing silk-mills and selection stations, create hybrid silk-egg and steady varieties of silkworm, such as ***Mziuri*** and ***Dighmuri*** to be sold at international market;
- Renovate old manufacturing traditions satisfying a demand on souvenirs produced by local artisans from silk;
- Use Multi-functionally mulberry plants, support broadening international integration process, and improving organization and management systems;
- Provide scientific and educational assistance to further development of the field;

The Government of Georgia is focused on revitalization of the field of sericulture. For this purpose the following measures have been already carried out: Silk production cooperatives in regions of Georgia, such as Kharagauli, Akhmeta and Lanchkhuti have been set up and they are working currently. The government program aiming at recovery and development of the field is being worked out. The author of the program is the Ministry of Agriculture of Georgia.

We hope that the present projects seeking the sustainable ways of restoration and further development of Georgian Sericulture will be successfully implemented; hopefully, it will embrace a large number of population and will contribute to increase of regular income for each household involved in silk production. The government, business sector and researchers should continue to apply all efforts in successful completion of the task.



WAYS OF INFLUENCING OF SERICULTURE TO THE DEVELOPMENT OF TOURISM INDUSTRY

IN SHEKI-ZAGATALA ECONOMICAL-GEOGRAPHICAL REGION

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ABSTRACT:

Lately, social-economical development of regions caused reviving imnon-oil sector that, its main field is agrariom industry complex. Agrarion industry complex develops in mutual relation with agriculture and insures several fields with fudstock . If we have a look to the historical development period of sheki-Zagatala economical-geographical region, we can use see that, weaving, mainly sericulture have developed well. This factor has reflected in the article and influence ways to the of sericulture to the development of tourism economy have been noted. Because new producing institution are opened in the region with the development of sericulture, people ensured with job, tourists benefited from the products of sericulture industry.

Keywords: Sheki-Zagatala, tourism, sericulture,nonoil sector, agrarion industry, agricuture, investment, economical-geographical development,economical development strategy.

Sheki-Zagatala economical-geographical region located in the north-western part of the Azerbaijan Republic, in the southern slope of the Great Caucasus include the administrative regions of Balakan, Gakh, Zagatala, Oghuz and Gabala. The area of the economical-geographical region is 8.84 thousand km and covers 10.2% of the republic territory, the total population is 606.1 thousand people (2015) and covers 6.24% of the republic population. The population density is 69 people in every kilometer, which is significantly less than the country indicator. There are, 6 districts, 6 cities, 8 settlements, 336 villages, and 181 municipals in the economical-geographical region. Sheki-Zagatala economical-geographical region is bordered 185 km distance with the Russian Federation (Dagestan Republic), with Georgia 150 km. Yevlakh-Balaken railways and highways passing through the economical and geographical region play an important role in its domestic and foreign economic relations.

Economical structure of Sheki-Zagatala economical-geographical region formed on the basis of agricultural cultivation and producing of some products. Althougth the region is rich with natural resources, they are used rarely. Here, besides Filizchay polymetallic ore deposit, forests, mineral springs, water and climate-spa resources are enough. Economy has developed in one direction for not having production and service objects based on using them for many years, and serious difficulties appeared in the use of labor resources. Sheki Silk factory which is the main economic objects of economical-geographical region works partly althought stopping the function of enterprises of tobacco, tea, and fruit-vegetable production in certain period [1].

Lately, dynamics of economic, social and demographic oriented reforms in the Republic of Azerbaijan and the changes happened in the level of people life demonstrate itself in the development of regions. It reflected the "State programs on social-economical development of the Azerbaijan Republic regions" covering 2004-2008, 2009-2013 and 2014-2018 years. In the frame of realizing state programs it has been achieved sustainable development of non-oil sector, improving the business environment, reconstruction of social infrastructure fields, opening new

business and job institutions, increasing the level of people employment partly. In addition, it should be noted that, socio-economic development of the regions tourism sector is more promising field, and has great potential opportunities. But, for using these opportunities a number of measures have to be realized. For this, it must be paid attention the problems of people employment exploring each economy area of the region. Because labor resources create favorable condition territorial organization of the economy, efficient use from economic and social development potentials of the regions.

Today, in our republic increasing the capacity of investments in non-oil sector and in regions, especially for the purpose of creating new work places in mountainous areas incuring migration the maximum limit of the tax of individual people lowered 35%, the rate of income tax and social security contributions 22%, agricultural producers have been released the other taxes except land tax.

The development of non-oil sector is closely connected with the economic sustainability of the region, settling productive forces and so on.. It depends on the natural condition of the area, economical-geographical development and impacts arranging of economical areas and, deployment level. Because of the efficient use of labor resources, it is possible to achieve agro-industrial complexes in intensive assimilated regions [3].

Resently, one of the developing fields of non-oil sector is light industry. One of the leading field of light industry is textile. The most profitable area of weaving is sericulture. It must be noted that, althought the development of sericulture in Azerbaijan during of the Soviet period, and specially in Sheki-Zagatala economical- geographical region, today this field declines. Because of the reducing of cocoon production in our republic, has made a number of problems in the equipment of sericulture institutions with raw material. However, if we analysed statistical indicators, an increase was recorded in the production of silk (272.4 thousand meter silk in 2015) for foreign cocoon feedstock.

According to the statistics of 2015, 109 million manat industry production has been produced in Sheki-Zagatala economical-geographical region that, 1% of it is non-oil sector. But, 1.8% of common industrial product produced in this economical-geographical region known as textile, specially sericulture is textile industry. More miserable is existing textile only in Sheki (99.6%) and Zagatala (0.4%) [2]. If we take into consideration of this indicator beeing poor, This is a very low figure given that the future development of sericulture new jobs angles, which could be of interest to tourists in the production of better quality and have a positive impact on the tourism sector.

If we take into consideration of this indicator beeing poor, the new work places will open with the development of sericulture in the future, and it will influence tourism industry.

In general, the development of sericulture in Sheki-Zagatala economical-geographical region can be considered one of the factors influencing positively to the development of tourism in the region. Because kelaghayi, yaylig, and towel made from silk cause the interest of tourists and bought them as souvenirs. These propagate as both an advertisement, and cultural heritage.

The majority of tourist companies acting in our republic study the tourism market of the distant countries, and offer tourism routes which are traditional for world tourism. Opportunities of tourism business limited not only by the excursion type of tourism. To expand the scope of its operating, companies are able to use the other types of tours. First of all, it allows the opportunity of paying the vast majority of tourist companies to the tourist firms [5]. Besides to organize new routes, firms must realize local souvenirs which can cause interest of tourists coming to the region, traditions, advertisement characteristic propaganda works. Rural tourism is considered more promising in Sheki-Zagatala economical-geographical region, that sericulture can belong its main area. But for it special attention must be shown to the feedstock base of sericulture, credit should be given with concession to local farmers, the products made from silk must prefer.

Tourism service is a labor-intensive field, and opens broad prospects for the development of small and medium business. Getting income in short period of time causes the interest of entrepreneurs. The development of the tourism sector is great importance in opening new work places, reducing unemployment, preventing migration flows, creating new settlements. Some work places have seasonal characteristics in tourism institutions and requires more women workers (housemaid, laundress, kitchen worker, etc.) in some cases. It creates an opportunity to earn extra income, to improve the social status of the family to local residents [4].

One of the main factors influencing the use of financial resources is tourism. Effective management of financial resources in market economy is considered one of the priority issues facing each economical subject. Financial is considered the only resource being transformation in less period. Exceptional role of financial resources in market economy requires the establishment of its independent management system [6]. If we consider the positive affection of sericuture to the development tourism economy, in Sheki-Zagatala economical-geographical region it needs to expand its activities, to increase level of technical armament in this area, to produce products which are interesting to tourists. Only this time, the production-economical action of ownership subjects has been extended, investment has been increased, the service must improve for meeting the tourists, having a meal and remaining.

The successful continuation of the economic development strategy in Azerbaijan let increasing potential opportunities of country economy and as a result a sustainable and stable economic system formed. Capital investments made by the state, preferential loans allocated to the development of entrepreneurship, realizing infrastructure projects, making favorable condition for foreign investors has created favorable condition for the development of regions with high economic potential. Recently, economic reforms in our republic has shown itself in the development of tourism industry.

If we take into acount noted above, the development of tourism sector in Sheki-Zagatala economical-geographical region, may let the region enter international tourism industry and remove unemployment partly.

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DYEING OF SILK WITH NATURAL DYE SUBSTANCES GETTING FROM AUTUMN

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ABSTRACT:

It is important being clean of the products of food and light industry which are directly related to human hygiene. Having antibacterial antioxidant and antifungal properties of natural dye substances match with the conditions and it is applied with the purpose of painting protein-based materials with natural dye. So, it has a special urgency getting the natural dye substances, especially antocians (antociandins) without damaging the environment, modification of silk and other protein-based materials.

In the presented article, the main result is getting dye matter from the instruction of feedstock (autumn leaf of the plant) expending less energy, that without the use extaction. With this dye matter the natural silk was painted step by step.

Keywords: antocian, dye substances, natural silk

Fulfilling method of the work:

Getting the dye – Obtained autumn leaf samples are dried in drying cupboard in 40^0C until getting constant weight. The dried leaves are used. It is boiled adding 30 gram F(6) precipitator, 15 grams grinded autumn leaves and 300 *ml* water. Amount of the precipitator with grinded autumn leaf was adopted 1:2 ratio. The same mixture was made precipitate in centrifuge after the brewing precipitation and limped dye matter are separated each other.

Dyeing of silk: For the coloring of natural silk, the preparation of the material to be painted is carried out. In preparation, 2 grams of pure and dry silk is immersed in 20 ml 1% ($CS(NH_2)_2$) solution and is aged for 1-2 hours and then extracted and dried.

Then it soaks with 30 *ml* 3% acetic acid (CH_3COOH). After it, the silk is considered ready for dyeing stage. The silk that ready for dyeing is inserted to the dye matter and boiled in it for 1-2 hours. The case which has dye matter and silk in it is put aside, and the silk dried after cooling completely. For durability and luster, the dyed silk is immersed in a 1% solution Na_2SO_3 and aged for 10-15 minutes and dried in open air drawing off. After, it is steamed in 120^0 C. The dyeing silk was dried once again being washed in soapy water for being ready to use (Fig. 1).

Fig. 1. Painted fibroin with amaranth juice.

The results:

It is determined that silk stained with antosyan dye deposited F-6 is resistant to ironing, washing and porphyry products. Under the influence of sunlight, silk colored by this dye slightly fades.

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OBTAINING OF COLOR COCOONS WITH FLUORESCENT SUBSTANCES

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ABSTRACT: When feeding caterpillars of a silkworm a natural forage, on fresh leaves of a mulberry sprayed a 0,025% aqueous solution rhodamine-B and received color cocoons that silk threads received from these cocoons give a fluorescence (bloom) in the light of UF-lamps. By application of repeated feeding of caterpillars and cleanings of a fibroin, we specified that molecules of fluorescent substance are included into structure of proteins of a fibroin. Therefore, these threads can be used with success as protective threads for identification in case of falsification of nonfoods and banknotes.

Keywords: protective thread, luminophore, rhodamine, identification and falsification, fluorescent threads, protection of banknotes, nonfoods

Introduction

As is well known, a fluorophore is a carboxylic or heterocyclic core, which absorbs the energy of a certain wavelength and then releases energy with a different wavelength.

The development of market relations in the modern world has brought both positive and negative changes in the economy. There are positive aspects of this period: providing the population with high quality products in a necessary range, achieving a certain image, competitiveness and demand for manufactured goods. But the growth of inflation, the gap of economic ties, raw materials and production problems, low solvency of the population, the constant competition of manufacturers entail negative consequences, most important of which is the spread of industrial goods and banknotes falsification. Imperfect laws and regulations, low consumer awareness and weak protection of their interests favor the development of falsification and various types of violations and abuses, which must be prevented. Since the object of falsification is a product and bank notes submitted to the open market by competing entities, the consumer gets an objective need to identify product and banknotes.

Identification and falsification of non-food products and banknotes as a specialized discipline based on scientific research. For example, chemistry helps in the identification of raw materials and raw products, physics allows identifying the mechanical, electrical, thermal and other physical properties of products, biology - to identify the nature of origin of raw materials. Of course, in this case the manufacturer needs to choose such a remedy that will cost inexpensive, but it may cause great (or even insurmountable) problems for falsifiers. [1]

Protection of banknotes by phosphors - paints, fluorescent under ultraviolet light (drawings and colored fibers). The recognition of such fluorescent paints is intended more for visual perception as emission spectrum from invisible ultraviolet area is actually transferred into the visible area of the corresponding color.

It is known that one of the most widely known and most reliable ways to protect products, banknotes, securities and light industrial products from counterfeiting is using a variety of

security threads. A security thread is a security feature of many banknotes to protect against counterfeiting, consisting of a thin ribbon that is threaded through the note's paper.

Currently, more than 80% of the banknotes of the world are provided with them. Security threads may be solid and windowed, metallic and non-metallic, with ferromagnetic characteristics and without them, metallized and unplated, with text and without it, fluorescent, with optical-variable effects, and others. There are also windowed threads, luminescent under UV light. [2].

Authors of works report that they have developed a simple, rapid, commercially viable method to isolate fluorophores (from sericine Sh.Y.) from the cocoon of the silkworm shell. According to the authors received silk fluorophores can be used as a fluorescent dye in the bio-imaging.

As we can see, the **actuality** of the issue is specified by economic factors (economic disbenefit lay on producers), as well as great importance has the human health preservation since falsified products often appear to be simply dangerous for human health. Under the fierce competition in the market, crisis in the global economic system, accession to the World Trade Organization (WTO), it is necessary to improve the technology of identification and falsification of non-food items, and notes.

The **aim** of this research is to develop a method of direct integration of the chromophore in the fiber, i.e., inclusion of luminescent substances - rhodamine-B into silk fibers and to receive fluorescent silk threads in the UV-lamp light as well as to offer to use these threads as the security thread. **The goal was achieved** by simply changing the food ration for silkworm caterpillars - the introduction of rhodamine-B to the natural food of the silkworm - spraying an aqueous solution of a fluorescent substance on mulberry leaves as a food addition.

Research methods

Depending on the type of silkworm, cocoon color varies from white to yellow, golden yellow and brown. Colored substance is contained in the sericin and is deleted during the removal of sericin from silk yarn or fabric by boiling them in soapy water. The necessity of such removal related to the fact that the natural coloring is not very resistant in future complicates the yarn dyeing. [4]. Consequently, molecules of dye or fluorescent substances molecules should be included into the macromolecules of fibroin for the stability and resistance of color in silk yarn or fabric,. Because the main thread of silk is obtained after removal of sericin and consists of fibroin protein substances.

Pic.1 Fluorescent silkworm cocoons. Credit image: Natalya C.Transil, DOI:10.1002/adma.201003860

We selected rhodamine B and the choice of this substance was related to the fact that rhodamine dyes have high absorption factor, broad fluorescence in the visible range of the spectrum, a high quantum yield of fluorescence and light fastness. All these properties of Rhoda mine-B make it a very good fluorescent probe. The main xanthene dye is a fluorophore. [5]. Among the most frequently used types of rhodamines are Rhodamine 101 and Rhodamine-B. [6]. Moreover, there are a sufficient number of scientific papers devoted to feeding of silkworm by rhodamine and obtaining the modified fibroin from these substances. [7]. The authors of works for studying the fluorescence characteristics of Rhodamine-B in different fibroin samples containing different amounts of fluorophores generated by UV radiation at λexposure=546nm. Fluorescence spectra are displayed with maximum intensity at λexposure = 568 nm.

Nowadays, modifying of the fibroin by fluorescent substance is performed mainly by the addition of these substances in the feed of silkworm. Researchers at the Institute of Materials Research and Engineering in Singapore have registered how silkworms fed on by fluorescent

chemical dye - Rhodamine-B [9]. The authors of these works are sure that the process of adding these substances in feed of silkworms could eliminate the traditional staining methods that pollute sewage. They are starting from the third day of the fifth instar, mixed Rhodamine-B in artificial feed the silkworm, at a concentration of 0.05% by weight of feed. Caterpillars have begun to curl a normal, full dyed cocoon on the tenth day of the fifth instar. Besides color, no other physical difference was observed between the colored and white cocoons which have been produced by the experimental and control batches of silkworms eating food laced with rhodamine B, and without it. In experimental batches the body of silkworms and silk produced by them thread are fluorescent; appear to be orange emission under ultraviolet light. (pic.1).

Рис. 2. У гусениц питающихся листьями тутового дерева или шелковицы, после трех дней от начала вскармливания кормом, в котором имеется родамин-В, начинается изменение цвета покрова тела.

Main Part

We also performed experiments since the third day of the fifth instar of caterpillars, breeds SHZEM-4. Used 0.025% aqueous solution of rhodamine-B, as the fluorescent substance. The solution was sprayed on mulberry leaves. An experimental batch of caterpillars was fed by this food. A control batch of caterpillars mulberry received feed without any additives. Keep strict watch the caterpillar eat only fresh food. The control and experimental batch supported the same conditions and feed is evenly distributed over the entire surface of their feedlot. Both batches received the same portion of food and developed equally.

Рис. 3. Цветные коконы, полученные в Шекинском Региональном Научном Центре Национальной Академии Наук Азербайджана.

On the picture 2 are shown the caterpillars of a silkworm, as seen caterpillars fed by mulberry leaves or mulberry, after three days from the start of feeding, which has a rhodamine-B, begins change of the body cover color.

Silkworms of an experimental batch curled cocoons successfully (Pic. 3). After that, we have determined the content of sericin and fibroin in cocoon shell. It was found that the content of sericin and fibroin in cocoon shell of an experimental batch makes up to 25.5% and 74.5%, while in the control the party - 26.1% and 73.9%, respectively.

We have found that when leaving the cocoon, butterflies from an experimental batch (taking food with the addition of rhodamine-B) have a dark brown color with orange shades. And butterflies from the control batch have typical for SHZEM-4 breeds - white color. It is known that newly laid eggs of the silkworm have pale yellow color. Then they gradually darken, turning orange, red, purple and finally becoming dark gray or slate-gray (4-6 days after depositing). As we can see from Pic.4, the butterflies from experimental batch laid graines of orange colors and butterflies from control batch of pale yellow.

Рис. 4. Бабочки тутового шелкопряда и откладенные ими яйца (грены):
a - из контрольной партии; b - из опытной партии.

After processing the silkworm eggs in a known manner - with hydrochloric acid larvae hatched from the eggs and the second feeding loop started. When caterpillars grown enough, rhodamine B is added into their ration by spraying 0,025% water solution, later the cocoons appeared. Unlike the first generation, the second generation of cocoons is heavier in weight and has a thread longer than about 100-150 meters. However, they need less feed.

A caterpillar grows about 27-days. During this time, its weight increased approximately 10 thousand times. Experiments show that the process of integration of the chromophore into the fibers has rich nature.

Proteins that are closely related to the chitin give durability to the cuticle of insects. In the fully hardened cuticle they lose their flexibility and ability to stretch, turning in particularly strong *sclerotin*. Consequently, sclerotization of cuticle can be seen as a process of formation of sclerotin. [9]. All these facts show that during feeding the silkworms by feed with addition of rhodamine B, the fluorescent substance molecules easily enter not only the structure of fibroin and sericin, but also in the structure of other proteins.

Conclusion

When feeding silkworms by natural forage of mulberry by spraying of 0,025% rhodamine B water solution on the leaves, fluorescent substance molecules enter fibroin and sericin protein structure which enables to obtain the fluorescent silk threads in the light of UV lamps. These threads can be successfully used as a security thread to identify in case of falsification of non-food products and banknotes.

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THE ROLE OF ADAPTIVE SELECTION IN CREATION OF BREEDS' PRODUCTIVITY

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ABSTRACT: The results of the experiment show that spring, summer and autumn feeding has highly effectiveness in the method of selection. Analysis of the scientific research has been identified that some biological features of mulberry silkworm such as the weight of moist cocoon, the weight of cocoon shell and the silkiness of moist cocoons change in response to changing environmental conditions.

Key words: weight of moist cocoons, the weight of cocoon shell, moist silk cocoons

B.H Abbasov has listed few factors in his work that are impact on effects of selection and genetic improvement of populations. He founded that there are a significant correlation between transferred by inheritance and large-scale farm selection characteristics.

R.A.Huseynov, A.Q.Bekirov has indicated that ability of living increases by 6.6%, weight raises by 5.8% and productivity of 1 gram worm cocoons increases by 15.8% and also silk production improves by 15%-20% among cocoons hybrid with (Japan bivoltin 110) cocoon and lived in the same conditions.

A.H.Mustafazada is noted in his whitepaper named "Silkworm Guideline" that there is a significant correlation between time to revive of cocoons and the time to begin incubating. The climate in our Republic is quite diverse.

R.Hajiyev is noted in his whitepaper named "Ways to enhance the economic benefits of silk" that productivity decreases per box per collective-farm when re-feeding during the summer time.

Z.A.Akhundov, N.M.Mammadov has mentioned that 5th age mulberry silkworm cocoons that sitted on the roof ties up on average 12,9-14,9% less cocoon compared to silkworm feeding inside the building - 8.2kg less cocoon generated per box per stall-type buildings and 9.6kg less cocoon generated per box ceramic-covered buildings.

With no doubt, there were some scientific achievements of selection science during the twenty-first century. Over the years, many efforts of breeders of all species, varieties and hybrids putted to achieve the high-performance under the favorable conditions and all of these leaded to get the great results.

Therefore, the most important issue in front of breeders was to create new breeds and hybrids with an ability to live different agro-ecological climatic conditions which can also give a stable product and has a long life expectancy.

Creating mulberry silkworm breeds with capacity to generate enough productivity in the different agro-ecological climatic conditions, particularly the unfavorable environment is one of the significant economic issues.

Scientific research has been done by "Mulberry silkworm selection" section of the Sheki Regional Scientific Center

Couple of factors have taken into account to improve the selection process of mulberry silkworm. Such as weight of the moist cocoon, life expectancy of mulberry silkworm and ability of silk-production. The biological parameters of selection lines were determined in the following order. Duration of feeding, start and end of the mulberry silkworm feeding period is recorded. Dead mulberry silkworm and the remaining have been registered.

Biological indicators of cocoon have been defined based on the weight of mulberry silkworm, weight of cocoon's lines which were taken from 25 male and 25 female families.

There were conducted experiments among Yagub, Chingiz and Sheki-1 x Sheki-2 (control) species and hybrids during the spring, summer and autumn period. Fourth line of Chingiz, selective signs of spring and summer of the other two lines of second generation, the average prices of the selective signs and environmental settings presented in table 1-3№.

Table №1

Names	Optimal conditions (spring)			Pesimal condition (spring)		
	Weight of moist cocoons, g	Weight of cocoon's line, mg	Silk-production capacity of moist cocoon, %	Weight of moist cocoons, g	Weight of cocoon's line, mg	Silk-production capacity of moist cocoon, %
Sheki-1x Sheki-2 (control)	1,96	469	21,3	1,80	428	20,9
Chingiz	2,32	492	23,9	2,12	444	23,8
Yagub	2,27	498	22,7	2,06	453	22,4

Table №2

Names	Optimal conditions (spring)			Pesimal condition (spring)		
	Weight of moist cocoons, g	Weight of cocoon's line, mg	Silk-produc-tion capacity of moist cocoon, %	Weight of moist cocoons, g	Weight of cocoon's line, mg	Silk-produc-tion capacity of moist cocoon, %
Sheki-1x Sheki-2 (control)	1,94	470	21,4	1,86	442	21,2
Chingiz	2,30	492	24,2	2,23	471	23,7
Yagub	2,28	505	23,1	2,23	488	22,7

Table №3

Names	Optimal conditions (spring)			Pesimal condition (spring)		
	Weight of moist cocoons, g	Weight of cocoon's line, mg	Silk-production capacity of moist cocoon, %	Weight of moist cocoons, g	Weight of cocoon's line, mg	Silk-produc-tion capacity of moist cocoon, %
Sheki-1x Sheki-2 (control)	1,98	482	22,4	1,82	452	22,2
Chingiz	2,29	514	24,3	2,25	499	23,8

Yagub	2,39	530	23,7	2,39	530	24,6

A comparative analysis of the figures in this table shows that author compared the average price of breeding lines and masses of cocoons' lines, especially average prices which collected in pesimal conditions. Price of selection index was much higher in summer feeding compared to spring feeding. Once adaptive selection and breeding lines are being carried out correctly and the next generation of high intensity, it gives reason to expect a significant increase in parameters.

Mulberry silkworm breeding adaptive clarified during the breeding experiments. One of these genotype (family) with the sign of the productivity and efficiency of the environmental sustainability of its strong negative correlation between whether or not the issue.

Taking all these into account, selection project proceed in two direction. Means, spring and summer feeding divided into two parts per each family.

It is clear from the table that highest results of moist cocoon weights in spring feeding have been observed among Chingiz, Yagub species by 2.27 - 2.32 in optimal conditions and by 2.06 - 2.12 gram in pesimal condition. Weight of moist cocoon's lines recorded 492-498 mg in optimal condition, 444-453 mg in pesimal condition. Silk-production capacity of moist cocoon was 22,7-23,9%, in optimal condition, while 22,4-23,8% in pesimal condition.

The weight of moist cocoons' during summer feeding was 2,28-2,30 gram among Chingiz and Yagub species in optimal conditions, while 2,23 gram in pesimal condition.

The weight of cocoon's line during summer feeding was 492-505 gram among Chingiz and Yagub species in optimal conditions, while 471-488 gram in pesimal condition.

The silk-production capacity of Chingiz and Yagub species during summer feeding was 23,1-24,2 % in optimal conditions, while 22,7-23,7% in pesimal condition during the summer feeding.

As a result of selection process, weight of cocoon was 2,29-2,39 gram during the autumn feeding under optimal condition, while 2,25-2,39 gram under pesimal condition.

The weight of cocoon line was 514-530 mg during the autumn feeding under optimal condition, while 499-530 mg under pesimal condition.

The silk-production capacity of moist cocoon was 23,7–24,3% during the autumn feeding under the optimal condition, however, this was 23,8–24,8% in pesimal condition.

The study among experimental species of Yagub, Chingiz, found that weight of moist cocoon and silk-production capacity during the summer feeding has been 0,31-0,36 gram higher compared to other cocoon species' lines.

The weight of the moist cocoon Yagub, Chingiz lines in summer feeding 0,26-0,32 gram per item was higher in pesimal condition.

In general, our practice has identified major indicators during the spring, summer and fall feeding per lines. Then all of these have been compared to the average prices of the leading symptoms of qualifying during the spring, summer and fall feeding in optimal and pesimal conditions. We have identified during the process that the weight of one moist Yagub, Chingiz cocoon during the spring, summer and fall feeding under optimal condition was 2,27-2,39 gram. The weight of one moist Yagub, Chingiz cocoon lines during the spring, summer and fall feeding under pesimal condition was higher 2,25-2,39 gram.

The weight of one Yagub, Chingiz cocoon during the spring, summer and fall feeding under optimal condition was 514-530 gram. However, the weight of one Yagub, Chingiz cocoon during the spring, summer and fall feeding under optimal condition was 499-530 gram.

The silk-production capacity of one moist Yagub, Chingiz cocoon during the spring, summer and fall feeding under optimal condition was specially distinguished and increased by 22,7-24,3%.

The silk-production capacity of one moist Yagub, Chingiz cocoon during the spring, summer and fall feeding under pesimal condition was specially increased in fall by 23,8-24,6%.

The results of our experiment proves that selection method is highly efficient during the spring, summer and fall feeding. As a result of the analysis of scientific studies have come to the following conclusions:

1. That has been determined, biological features of the moist mulberry silkworm cocoons, weight of their lines and silk-production capacity are changes in response to changing environmental conditions.
2. Results of new adaptive selection methods on Yagub, Chingiz and Shecki-1xSheki-2 species and hybrids by using new methods, 2 new Yagub, Chingiz species have been created with high environmental tolerance and performance.

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THE INFLUENCE OF ETHOLOGICAL DIFFERENCES IN OAK AND MULBERRY SILKWORMS ON THEIR CULTIVATION TECHNOLOGY IN TODAY'S ENVIRONMENTAL CONDITIONS

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ABSTRACT: The article presents the results of studying the influence of ethological characteristics of mulberry and oak silkworm on the degree of intensification of their cultivation technologies. Anthropogenic silkworm is adapted to the highly intensive cultivation in artificially created environmental conditions. Semi-wild oak silkworm is better adapted to extensive farming in natural conditions. With the advent of the market economy, new materials and technologies, a significant intensification of oak silkworm cocoon production is possible.

Keywords: ethology, oak silkworm, mulberry silkworm, breeding, intensification

Chinese oak silkworm (*Antheraea pernyi)* originated in north-eastern areas of China (Shandong Province and Manchuria). This area is characterized by hot and humid summers and is also a habitat of wild Chinese oak silkworm. Here the main world oak silkworm breeding centers are located. All of the evidence in the available historic records suggests that Chinese oak silkworm was first domesticated around the 16th century, and then it was introduced directly and indirectly into the present habitations (China, Japan, Korea, Russia, Spain, etc.) after the late 17th century. In Russia Chinese oak silkworm first appeared in 1873, when Russian merchants brought silkworm cocoons from China [1].

Researches on acclimatization and selection of oak silkworm in USSR began at our research station (Federal State Budget Scientific Institution Research Station of Sericulture) in 1929. Researches on in-forest rearing of imported oak silkworm breeds were also conducted in Ukraine, Belorussia, Bashkiria, Chuvashia, Mari Autonomous Soviet Socialist Republic and central part of Russian Soviet Federative Socialist Republic. It was impossible to rear bivoltine oak silkworms twice a season due to long larval stage and short vegetation period of forage plants. Sericulture farms were short of forage for the second generation of silkworms and were unable to obtain reproductive material. To solve this problem, they started to breed monovoltine oak silkworms.

As a result of long-term line selection conducted under the guidance of Ukrainian prof. Sinitsky, a new monovoltine breed of Polesie tassar appeared in 1973 [2]. Breeders also found the way to feed oak silkworm with leaves of other plants (willow, birch) and to increase its breeding rate.

Researches were conducted in Belorussia to put oak silkworm into industrial production as a forage for silkworms. The scientists of Zoology Department in Vitebsk State University L. I. Radkevich, V. L. Radkevich and S. Babitsky were managing those rearings. They took over the researches on breeding local oak silkworm breeds fed on different types of forage and adapted to Belorussian environmental conditions. These researches still continue [3]. Rearing is performed in plastic-covered greenhouses with high air humidity and high temperature. Plant leaves are stored in underground store rooms with low temperature and high air humidity.

According to A. A. Litvinenkov, who studied oak silkworm rearing in Belorussia and fed leaves of *Salix cinerea L.* and *S.vi-minalis L.* (plants recover quickly after cutting) to the larvae, during the forth year of vegetation, when *Salix cinerea L.* is cut 100 cm above the ground, the recoverability of leaf-bearing shoots is 106.8% and the leaf biomass increases on 102.8%. Besides, the willow planting material for forage plantations is cheap. After two years of

researches the acclimatization of Salix Sinerea L. with cleft-graft scions has reached 50.8% on the average. It is possible to obtain up to 23 tons of leaf-bearing branches or up to 9 tons of willow leaves from 1 ha of willow plantations. This gives the possibility to feed up to 2 kg of oak silkworm eggs on 1 ha of willow plantations thus obtaining 300-500 kg of raw cocoons. According to our findings, this corresponds to the productivity of mulberry silkworm when taking 1 ha of today's rainfed mulberry plantations. However, it is important to note that forage to silk conversion rate is lower in oak silkworms. It happens because oak silkworm cocoons contain twice less silk than cocoons of mulberry silkworms.

The article presents the results of studying the influence of ethological characteristics of mulberry and oak silkworm on the degree of intensification of their cultivation technologies. We have analyzed Russian and foreign scientific literature and articles (including results of earlier researches conducted in the past century at our Research Station of Sericulture) as well as the results of modern laboratory experimental rearings at our Research Station [5,6].

While undergoing domestication mulberry silkworm's productivity has increased and it has suffered a number of ethological changes that have influenced its rearing and breeding technology. Among them are simplified behavioral response, loss of function of some organs (sluggishness of silkworms of late instar, adult moth's inability to fly due to wing muscle atrophy) and intensification of breeding and metabolism rates due to environmental and feeding changes at larval stage [7]. After several thousand years of selection mulberry silkworm has become fully domesticated and, as opposed to oak silkworm, has lost its ability to survive in wild nature. Mulberry silkworm larvae are reared on racks in special facilities with regulated climate (heating and ventilation) with constant supply of forage and waste removal.

As opposed to mulberry silkworm, oak silkworm larvae hold tightly to leaves and branches and that's why they can be reared on bushes (oak, willow and birch). It is important to protect them from birds with a net or framed polymer covers with polyethylene film or unwoven textile that create favorable microclimate conditions for the silkworms and plants. Such rearing plantations, especially grown from cleft-graft scions of willow, are several times cheaper than mulberry ones, grown from grafts. Besides, there is no need in expensive stationary rearing facilities.

When comparing inside rearing on racks and outside rearing on bushes it is necessary to note that due to substantial changes in night temperatures the larvae take longer (plus 18.6 days) to grow and develop outside. The survival rate of the larvae also becomes low. Up to 52% of larvae on bushes die and this is 32.8% higher in comparison with the survival rate of the larvae on racks. Loss of mulberry larvae is also high, about 50% from their initial number. It is very difficult to control the number of oak silkworms placed on the bushes, however it is also difficult to place them on cut branches during rack-type rearing [4].

Larvae of first and second instars are restless, they sprawl over to high places and seek light. To keep them gathered, it is better to rear them in air permeable containers all day long (with two-hour intervals) and to feed with soft and tender young leaves. The most suitable temperature for them is 20-25 ^{o}C with relative air humidity 60-75%. Late instar larvae become green (mulberry silkworm caterpillars are white) and one should be careful not to throw them away with wastes while changing the forage. In this case two-stage control shall be performed. It is also a difficult task to place the larvae on fresh forage. It should be noted that if placed on fresh leaves randomly, the larvae will be kept in different temperatures and feeding regimes. Oak silkworm has twice long larval stage (compared to mulberry silkworm) and this leads to non-uniform development of caterpillars, obtaining cocoons of different sorts and decrease in rearing productivity. Mulberry silkworm develops uniformly and this prevents food competitiveness, increases the survival rate and productivity of rearing.

As a result of our researches we came to the following findings: when rearing oak silkworms indoors on racks, the cocoon output from 1g of eggs is 2.28±0.23kg (with 70% survival and 84% revival rates). Silk content is about 11.17%±0.47%. Cocoon output of

mulberry breeds B-1 and B-2 from 1g of eggs is 4.23±0.14kg (with 94% survival and 96% revival rate) with silk content — 23±0.12%. When fed with birch and willow leaves, oak silkworms can produce cocoons for commercial purposes. But to obtain reproductive material oak silkworms should be fed with oak leaves.

Oak silkworms spin cocoons right in the forage so it becomes hard to collect those cocoons and this also increases labor and cocoon production costs. Mulberry silkworms spin cocoons simultaneously on special racks. And in the result farmers obtain cocoon of high quality and it becomes easier for them to remove cocoons from racks.

Low domestication level of oak silkworm hardens obtaining of reproductive material. Oak silkworm moths mate in flight at the first night after emerging from the cocoons and lay 200-400 eggs during the second night. After that the incubation takes place and larvae emergence. Mulberry silkworm moths are unable to fly, they are sluggish and mate in the first half of the photoperiod. They lay up to 600-800 eggs in the afternoon and this cheapens and eases the process of obtaining reproductive material. Mulberry silkworm eggs are ten times lighter than the eggs of the oak silkworm. Mulberry larvae and cocoons are twice lighter.

Oak silkworm pupae diapause makes the storage, transportation, microanalysis and grading difficult and expensive. Mulberry silkworm with its diapause at the egg-stage leaves enough time to perform microanalysis of the adult moth and to check it for *Nozema bombicis Naegeli.*

Oak silkworm is genetically very sensitive to unfavorable inbreeding that dramatically (up to 20-30%) decreases the survival rate of reproductive material during selection in primary female lines. This can be avoided by feeding silkworms with huge amounts of forage and frequent adding of genetic material from other non-relative breeds [8]. Inbreeding almost does not affect survival rate of mulberry silkworms. Considering this, cost of eggs in production cost of cocoons is not more than 5% and in oak silkworm it can be up to 15%.

All the factors described above make oak silkworm breeding very troublesome. Industrial production and breeding of oak silkworm has not been yet performed (without taking into consideration bioresearch stations in universities and outdated breeding centers).

As an anthropogenic object mulberry silkworm is more adapted to high-cost (facilities and special rearing farms) and intensive cultivation in artificially created environmental conditions. Less productive oak silkworm is more adapted to extensive technology of its cultivation with less costs, but at the same time it requires additional costs on labor to rear and to obtain reproductive material. Breeding process should be organized properly to obtain reproductive material of oak silkworm (after conducting additional researches).

In non-chernozemic regions of Russia about 40 mln. ha of low-productive land plots are not used. Presently they are covered with birches and willows and can be viewed as perfect plantations to rear oak silkworm.

There is no doubt that the productivity of oak silkworm in intensive cultivation on racks in human-controlled environmental conditions will increase, but at the same time it will require to understand how to pay-back for using new technological approaches.

To evaluate the possibility of industrial cultivation of oak silkworm new researches are needed to be conducted with taking into account all the technological and economical costs (especially at the stages of preparing forage and cocoon processing). It is also very important to evaluate the competitiveness of products made from oak silkworm silk on domestic and foreign markets.

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ABOUT SCIENTIFIC-PRACTICAL IMPORTANCE OF BEING CULTIVATED IN PROGRESSIVE LANDSCAPE SURVEYS OF MULBERRIES THAT INTENDED TO USE IN SERICULTURE

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ABSTRACT: As it is shown in the countries like China, India, Japan that sericulture developed well, there are special plantations of high sort mulberry trees and making this type of mulberry tree gardens is one of the norms that adopted in sericulture economy. The development of this sector still fell behind in Azerbaijan and CIS countries. It is impossible to get qualitative silk from the leaves of mulberry trees that having different types, maybe being infected with diseases, and growing in random places-roadsides, yards and so on. Nowadays the time has run out to use the leaves of mulberry trees that are among the cucurbitaceous, native bushes and trees being infected with different fungal trees. Lately, decreasing type and biomass amount of fitoncidal and bactericidal property of plants in the area of Sheki-Zagalata economical region prove that, in past times the risk of being infected of trees increase. That is why, cultivation of mulberry trees intended to use in sericulture only in progressive landscape surveys and protecting of pine and juniper trees with forests that their surveys have high fitoncidal from each side are considered expedient.

Keywords: fungal diseases, progressive landscape surveys, plants with fitoncidal and bactericidal, pine and juniper forests.

During long years it hasn't been used special plantations for development of sericulture economy in other past USSR countries like Azerbaijan. For the best condition tree rows and forest strips consisting mulberry trees have been made for the reason of protecting cotton fields from the wind as in Uzbekistan (3). In Azerbaijan, especially in the area of Sheki-Zagatala economical region sporadic mulberry tree gardens have existed. But, because of its locating surround of planting and vegetable garden areas, it caused being infected with the disease by means of agrocultures-tomato, cucumber, potato, cabbage, watermelon, bean and so on. which are potential carriers of different fungal diseases. In many cases, in roadsides, sometimes in courtyards it is used mulberry trees which are happened occasionally and differed one another for species diversity. When it is used for feeding of silkworms it arouses suspicion getting qualitative silk product. Whereas this problem has been solved in certain amount in China, Japan, India those are famous in sericulture. In these countries it has been paid attention making special plantations consisting of mulberry tree sorts tested in practice.

Lately, as a result of researches and monitoring in low mountainous, foothills and Kura-Ayrichay valley of Sheki-Zagatala region in "Landscape" department of ANAS, SRSC it was known that, amount of tree, bush and grass plants those have phytoncide and bactericidal characteristics decreases gradually. This fact confirms that, it may adopt reducing fitoncidal and bactericidal plant types for both quality and sort quantity and biomass which protecting them from disease. Increasing of quantity and scale of viral, bacterial and fungal diseases like powdery mildew, brown spottiness of leaves, microphylla frizzy, bacterios, uproar mushroom, gum, rotten roots, and so on. is related with the above argument.

Recently, the scale of regressive processes observing in local natural and anthropogenic landscape structure strengthened much more. In the root of regressive processes stand different reasons-increasing toxic matters in air, water and soil with the influence of industrial processes, land degradation, desertification and invasion processes in semidesert areas. As a result, it is observed rising fungal, bacterial and viral diseases in existing biogenesis (1,2).

1) One of them is invasion processes. When it is organized transferring different plant types by people and not to meet its opponent in this area, it takes place developing fast without feeling any danger. This resettlement and migration associated with mass non-periodic and

anthropogenic activities are usually observed with mass energy and transferring matters. In contrast to the simple migration, invasion migrants may destroy vegetation in the new settlement area and shatter normal life style. It should take into account that, after the Azerbaijan Republic gained independence in 1991, serious anthropogenic and invasion changes have taken place in agrobiosis of the area as a result of leading reforms (destroying collective and state farms and privatization of lands) in his agriculture sector. So, mulberry and mulberry bush gardens which used in sericulture shattered, instead of them plantation of different cucurbitaceous and fruit trees were made.

2) The main features of semideserts are being without plant cover and departing areas having separate plants with bare lands, advantage of exhalation from rainfall (3-6 times) and being loose of river tracery. Nowadays in Azerbaijan dry subtropical semidesert landscape has a great place which is prone to desertification and biomass of valuable xerophytes herb plants and declining species diversity. Most parts of Kur-Araz lowland, Jeyranchol, Samur-Davachi, Araz plains, Gobustan, Absheron peninsula and Ajinohur plateau in the area of Sheki-Zagatala economical region belong to semidesert landscape. These semideserts was used as natural pasture during many times. Among these herb plants there are many valuable xerophytes, absinth, ephedra, thyme, alhagi, rue, astragalus, medick, ferula, halocnemum strobilaceum, echinacea and so on.

   If we take into consideration symbiotic relations among the herbs, we consider expedient protecting high-sorted mulberry trees plantation with forest lines consisting phytoncidal pine and juniper tree sorts. We must noted that, in dry subtropical areas pine and juniper tree sorts create natural surveys in Jeyranchol area. Central lowland and Ajinohur area of Sheki-Zagatala economical region using the help of these trees may consider promising. For the foothills and low mountainous areas of Sheki-Zagatala economical region it is possible to make healthy phytocoenosis with using Crimean pine which is characterictic for Sheki Pine forest and local foothill juniper sorts.

3) In last decades the degradation of the lands of Kura-Ayrichay valley belonging to mild climate zone is observed (Fig. 1). Here, it must be noted decreasing of soil fertility as a result of human farm action or arided natural factors. In degradation of lands shattering lands with physical-hydrophysical changes, decreasing of chemical-mineral matters amount, derivative arthritis, contamination with xenobiotics besides becoming worse of its structures gradually, decreasing of humus amount, destroying land structure are characteristic. Decreasing soil fertility related with the weakening of species diversity of plants, changing quantity and ratio of soil microorganisms as a biological factor.

   Mulberry silkworms which are sensitive to the cleanness of environment are considered the most accurate indicators of the pollution of environment. Diseases in mulberry tree and its leaves causes arising several problems (perishing grain, different disease cases in caterpillars) in cocoon worms. That’s why, we consider expedient growing up mulberry trees in possibly progressive landscape surveys and showing attention to biogeochemical characteristics of these surveys.

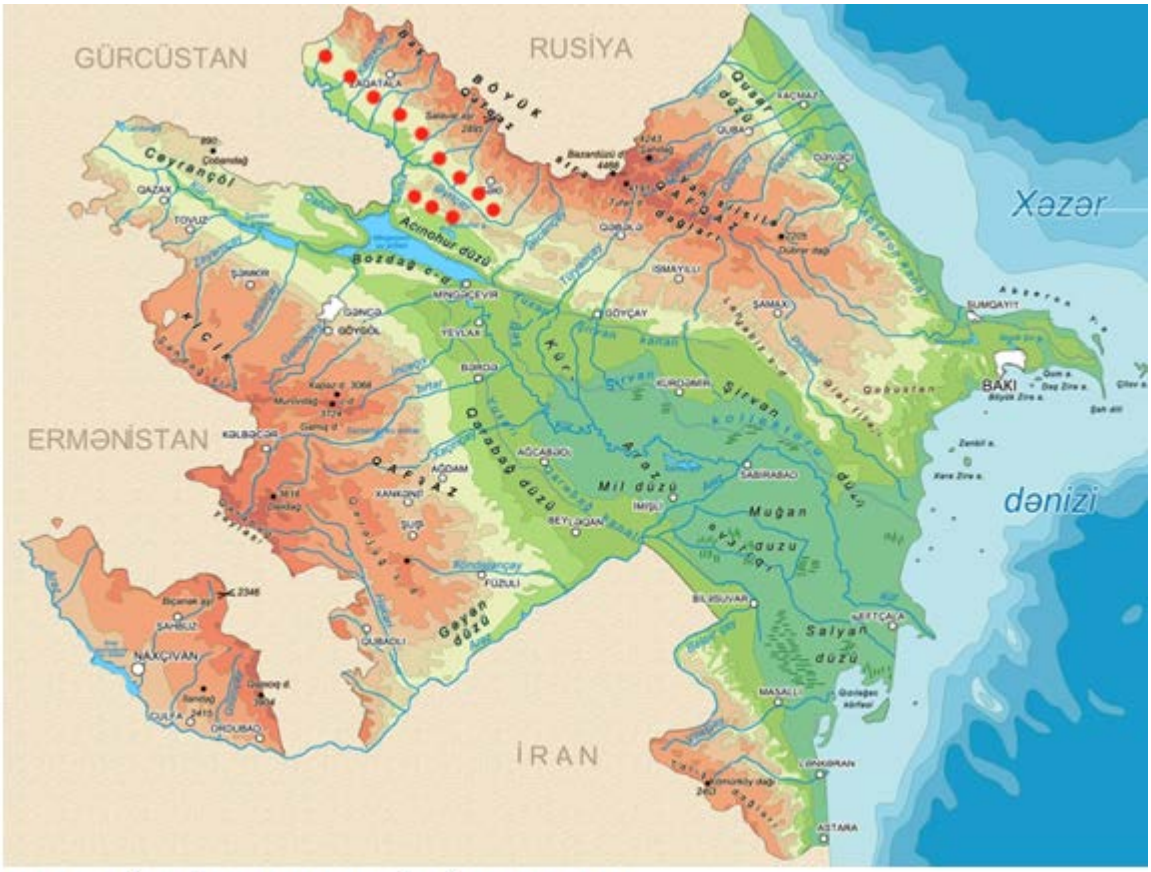

Fig. 1. Red circles: Progressive landscape surveys

Among biogeochemical characteristics of Sheki-Zagatala regions unique ecogeographical environment has formed related with the action of biofil elements group (5). Lately, regressive biogeochemical environment type judges which is characteristic with high background of carbon and sulfur oxides in Azerbaijan as most countries of the world. In such ecological condition, especially increasing amount of sulfur in soil and water, having toxic character of several heavy metals- U, Te, Hg, Ir, Os, Bi, Ba, Sr, As and so on. in usual background amount (4). Vice versa, chemical elements like K, Fe, Co, Zn, Mo, J and others which are useful in biological processes have little importance in regressive biogeochemical environment. Only in normal or progressive landscape complex, development of lively organism these elements have great role in the synthesis of proteins and enzymes and in carbohydrate metabolism.

When making special mulberry trees plantations, we must try its progressive dynamics-development take place without changing appearance of landscape and biological productivity. Gradual increase of plant mass, useful mushrooms, microorganisms, insects, birds and animals or decreasing harmful plant and insects are observed with the thickness of land, fertility and development of structure. For this optimization of existing landscape structure, actions system directed to rise its productivity, floristic and faunistic richness and appearance aesthetics must been realized. Long-term perspective of economy development and taking measure for attaining the most rational ecological balance in protecting life condition of people and biological diversity were considered ahead problems.

Today it needs to take into consideration the aftereffect of global warming process that is actual for the Earth in morphological structure of landscape zones of Azerbaijan. In connection with the approaching global warming process the probability of drying mountain lakes in Azerbaijan and Caucasia is overwhelming. Strengthening of drinkable water stock reduction process may result water scarcity after 70-80 years. That’s why while making

special plantations of mulberry trees, using low mulberry bushes which have great biomass and applying luckily in sericulture economy of China seems very actual.

For the researches of 2016 leading by the employees of "Landscape" department there are convenient opportunities in making special surveys consisting of mulberry trees and bushes for development of sericulture in the following landscape types in Sheki-Zagatala economical-geographical region:

1. Forest-steppe and intrazonal landscape of moderately fragmented intermountain plains of Kura-Ayrichay valley. 2. Dry-steppe landscape of moderate and severe fragmented foothills and low mountainous. 3. Semidesert landscape of severe and moderate fragmented low mountainous.

   In the following landscape structures belonging to these three landscape zones noted above: a) in degraded alluvial meadow lands of river valleys landscape surveys of meadow, meadow-marshy and bushes, b) in convex, pointed, and delta plains, in gray meadow and riparian forests forest-bush and bushes natural landscape facial and surveys, c) meadow-bush facial and surveys of undulating, slightly sloping plain in meadow and forest lands, d) meadow-bush facial and surveys of undulating sloping, weak fragmented meadow in alluvial meadow lands, e) liana alder, wing nut forest surveys meadow-forest lands of sloping undulating meadow—it would be expedient to form special plantations consisting of mulberry bushes and feed silkworms in barns inside these plantations.

RESULT:

1. After the Azerbaijan Republic gained independence in 1991, serious anthropogenic and invasion changes have taken place in agrobiosis of the area as a result of leading reforms (destroying collective and state farms and privatization of lands) in his agriculture sector and as a result, mulberry and tokhmachar gardens which used in sericulture shattered, instead of them plantation of different cucurbitaceous and fruit trees were made.
2. In the root of regressive processes observing in local natural and anthropogenic landscape structure stand different reasons- changing the measure of morphological elements of landscape, desertification and invasion processes in semidesert areas, land degradation.
3. These regressive processes impact negatively to the quantity and quality indicators of silkworm and cocoon. As a result, it is observed rising fungal, bacterial and viral diseases in mulberry tree and bushes that it causes arising several problems (perishing grain, different disease cases in caterpillars) in cocoon worms.
4. We consider expedient growing mulberry trees in possibly progressive landscape surveys which are intended to use in sericulture and making protective forest line consisting phytoncidal trees. For this purpose, we consider acceptable to use pine and juniper tree in the areas having subtropical climate condition and for the foothills and low mountainous areas of Sheki-Zagatala economical region Crimean pine and local foothill juniper sorts which are characterictic for Sheki Pine forest.
5. In connection with the approaching global warming process for strengthening of drinkable water stock reduction process these areas may result water scarcity after 70-80 years. That's why it would be useful to feed silkworms in itinerant barns in the plantations consisting special sort mulberry trees. In this renovation process we consider promising using low mulberry bushes which have great biomass and applying luckily in sericulture economy of China in protection of progressive landscape complex.

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The affection of Altozid SR-10 similar to juvenile hormone to several biological indicator and fertility of mulberry silkworm in the feeding seasons

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ABSTRACT: According to the researches it has been defined that when we include altozid SR-10 drug to the organismof mulberry silkworm in spring feeding coccon productivity increase 45,45%, weight of silk shell 60,0%, silkness of wet cocoon 10,0%, life ability of worms 8,88% and in comparison to oversight coccon productivity from 1gr worm 45,57%, it has been 28,57; 49,64; 16,65; 16,59; 28,57; 47,36; 58,14; 7,29; 8,80; 47,25% in summer and autumn feeding seasons.

Application of altozid SR-10 drug in sericulture allows earning 5-6 thousand manat additional income from 1kg of cocoon seed.

Keywords: altozid SR-10, coccon, silk shell, sericulture, productivity, feeding seasons

Indexes	Season of feeding					
	In spring		İn summer		In autumn	
	Exper-ience	Moni-toring	Exper-ience	Moni-toring	Exper-ience	Moni-toring
Viability of caterpillars, %	98,0	90,0	97,0	91,0	98,0	90,0
Mass of a silk envelope, *mg*	3,20	2,20	2,70	2,10	2,80	1,90
Mass of a silk envelope, *mg*	800	500	630	421	680	430
Silk-screening of silkworm cocoons, %	25,0	22,72	23,33	20,0	24,28	22,63
Harvest of cocoons with 1 *g* of caterpillars, *kg*	6,74	4,63	5,40	4,20	5,89	4,0
Duration of the fifth age, *working day*	11	9	11	9	11	9

EFFECTS OF MULBERRY (*MORUS ALBA*) FRUIT CONSUMPTION ON LIPID PROFILES, ANTIOXIDANT, AND INFLAMMATION STATUS IN HYPERCHOLESTEROLEMIC SUBJECTS

Suthira Ponjaruen[1/] Wiroje Kaewruang[1/] Patcharanee Pavadhgul[2/] Anchalee Sirikanchanarod[2/] Tipanee Senawong[1/] Akkarach Bumrungpert[2/] Bavornnat Naprapasak[1/] Pimrumphai Wongwai[1/] Jeeranun Basungnoen[1/] Anan Suwannarat[1/] Weena Pongpattananon[1/]

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ABSTRACT: Cardiovascular disease (CVD) is a non-communicable disease, but it is an important public health problem worldwide. In mulberry fruit, there is plentiful of nutrients and phytochemicals; especially, anthocyanin that can reduce a risk of CVD development. However, there is no research have been studied in human. This study; therefore, emphasizes on an effect of freeze-dried mulberry fruit consumption on lipid profiles, antioxidation and anti-inflammation of adult human that has Dyslipidemic.

The study was an experimental controlled trial (randomized controlled trial) that consist of 58 adult human with Dyslipidemic subjects, age range between 30 and 60 years old. Thirty subjects (experimental group) were consumed freeze-dried mulberry fruits, which contain 325 mg of anthocyanin, and the remains (control group) were not consumed.

The results showed that the total cholesterol and LDL-C in Dyslipidemic subjects who consumed freeze-dried mulberry were significantly reduced ($p \leq 0.001$). However, the consumption of freeze-dried mulberry fruit did not effect on triglycerides, HDL-C and anti-inflammation; while, the anti-oxidation in the experimental group was significantly increased ($p \leq 0.001$) after the experiment.

The mulberry fruit consumption can reduce total cholesterol, LDL-C and increase anti-oxidative activity. Therefore, mulberry fruit may be an alternative choice for regulating the lipid level in Dyslipidemic adults, and then can decrease the risk of CVD.

Keywords: Mulberry Fruit, Anthocyanins, Lipid Profiles, Antioxidation Hypercholesterolemic sabject

INTRODUCTION: Cardiovascular disease (CVD) is a non-communicable disease, but it is an important public health problem worldwide which most is found in developing countries, around 80 percent (World Health Organization, 2014). In Thailand, there is found that the cardiovascular disease is related to dietary habits and it is the top cause of death. High cholesterol in the blood is an important risk factor for atherosclerosis that leads to various diseases such as coronary heart disease and stroke in the future.

There are some epidemiological studies have shown a relationship between a reduction of cardiovascular disease and nutrients and phytochemicals found in fruits and vegetables with (Gan *et al*., 2015). The World Health Organization has recommended that adequate consumption of fruits and vegetables (5 standard portions per day or about 400 grams per day) can prevent chronic disease including cardiovascular disease, hypertension, diabetes, and cancer. However, it is found that 80 percent of the populations of Thailand consume fewer fruits and vegetables than the recommended dose (Akepalakorn, 2011). Food consumption controlling is the first method used to treat and to prevent the cardiovascular disease. Berries fruits are important as the source of vitamins, minerals, fiber and phytochemical compounds such as anthocyanin (Kaewruang *et al*., 2011). Freeze-dried mulberries are contained higher polyphenols anthocyanins and quercetin than fresh mulberries about 5-10 times (Pansuwan *et al*., 2008). They can reduce blood cholesterol, inflammation, and antioxidant (Zafra-Stone *et al*., 2007). Some paper reported that fiber consumption 10 grams per day could reduce the risk of death from cardiovascular about 17 percent (Streppel *et al*., 2008) and consumption anthocyanin 0.2 mg per day in postmenopausal women found to associate with decreasing rates of death from cardiovascular disease was statistically significant (Mink *et al*., 2007).

Mulberry has widely cultivated crops in the north and the northeast of Thailand. Ripe mulberry fruits are dark red to purple-black. They are richer in antioxidants than vitamin C and E twice. Antioxidants can reduce the damage of oxidants and reduce cholesterol in the blood (Castañeda-Ovando *et al*., 2009). Some experiments, in both in vitro and animal, were found that mulberry can reduce an accumulation of fat inhibits the oxidation reaction of LDL cholesterol and enhance the function of enzymes that are antioxidants (Liu et al., 2008, Ou *et al*., 2011).

Fresh mulberry fruits are easily bruised after harvesting and can be kept for only a short time. Therefore, in this experiment, freeze-dried mulberry fruits were used because it still has antioxidants and high nutritional value that similar to in fresh mulberry fruits and could extend for longer storage. However, results of some former studies showed that mulberry affected on blood lipid levels was limited just in vitro and animal studies only, while there was no studied in a human before on the effects of mulberry consumption on the changing of lipid levels antioxidants and inflammation in the blood. In this regard, we really concern the benefit of mulberry fruit consumption on human health. Hence this project was also established.

MATERIALS AND METHODS:

1. Study design

This study was an experimentally controlled trial (randomized controlled trial) which comprised 60 Dyslipidemic subjects (30-60 years old). The subjects were divided into two groups which each group consisted of 30 subjects. (Mulberry fruit consumption and non-mulberry fruit consumption) The first group was consumed freeze-dried mulberry which contained 45 grams per day for 6 weeks. The second group did not consumption the mulberry fruit. In order to follow the research compliance all data collection obtained by telephone and meeting every 2, 4, 6 weeks to the sample subjects. All the subjects must be avoided or must not consumption the food and the drink which were rich in anthocyanin such as fruit juices and berries, wine grapes, purple cabbage, etc. for 7 days preceding and during the six-week trial. The participants were recorded their diets and activities 3 days; for example, the first time, the participants chose 2 days within weekdays (Monday - Friday) for their recording. The second time, the participants chose 1 day within weekend days (Saturday or Sunday), and the last, all participants were recording the data on the last day of the 6th week of the study. The experimental group and the control group were received a physical examination by measuring and recording the weight, height, waist girth, blood pressure, lipid levels (triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol), antioxidant (ORAC, FRAP) and indicators of inflammation (hsCRP).

2. Sample

Participants of this experiment were 60 subjects that including both males and females who was age between 30 and 60 years old, had hypercholesterolemia, fasting TC $\geq$ 200 mg/ dL and LDL-C $\geq$130 mg/dL and had no cardiovascular disease, diabetes, kidney disease, liver cancer and work thyroid disorders, had no supplement/ hormone supplements, and did not smoke or drink alcohol. All participants had to singe a permitting document as a volunteer of the experiment. This project was approved by the Human Research Ethics Committee of the faculty of Public Health, Mahidol University.

Before the experiment, all subjects were taken blood tests such as lipid profiles, an indicator of inflammation and antioxidant level. They were fasting 12 hours before blood collection from a vein in the crook of the arm by nurses who had expert experiences.

(1) The subjects were randomly divided into two groups: an experimental group and a control group. Each group consist of 30 subjects; however, at the final of the experiment, there were 2 subjects in the control group were withdraw, so the subjects have remained just 28 people only in that group.

All participants in the experimental group were received 45 g freeze-dried mulberry per day (320 mg anthocyanins).
All participants in the control group were not received mulberry fruits.

(2) During the trial, all subjects were allowed to maintain their usual diet, physical activities, and lifestyle patterns, and abstained vitamins or supplements of any kind.

(3) Freeze-dried mulberry was prepared for the experimental group for every 2 weeks. In addition, weighting and counseling of problems or side effects of the subjects in the experimental group were taken every 2 weeks.

(4) All subjects were had blood tested at the end of the 6-week trial. They were fasting for 12 hours before the blood test.

(5) The results of blood tests before and after treatment were statistically analyzed to compare the effects of dietary freeze-dried mulberry on lipid profiles antioxidants and inflammation.

3. Freeze-dried mulberry fruits

In this experiment, freeze-dried fruits of Chiang Mai variety mulberry were used. They contain 45 grams of phytochemical compounds such as polyphenols 482.40 ± 1.68 mg, anthocyanin 326.25 ± 1.43 mg, and quercetin 0.62 ± 1.95 mg.

4. Analysis of food consumption

All subjects were recorded their dietary consumption 3 days of the 0, 3rd, and 6th week of the experiment. Two days were chosen the days within the weekdays (Monday - Friday) and one day was chosen a day within weekend days (Saturday or Sunday). For food consumption analysis, the unit was used in gram. The INMUCAL software was used for data analysis.

5. Data Analysis

The data; for example, the difference of lipid profiles, antioxidant resistant, an indicator of inflammation, and anthropometrics of the mulberry group and control groups was compared using independent samples t-test. In addition, the differences of the average lipid profiles, antioxidant resistant, and an indicator of inflammation in the blood of the experimental group at before and after freeze-dried mulberry consumption were statistically analyzed using paired samples t – test. The One-way ANOVA analysis was used for food consumption assessment. All statistical analysis was processed on SPSS 18.0 software and set up the difference of statistically significant at a confidence level of 99.99% ($p \leq 0.001$).

DURATION AND LOCATION:

Duration March 2014 – September 2015
Location The Queen Sirikit Department of Sericulture
Faculty of Public Health, Mahidol University

RESULTS AND DISCUSSION:

1. THE RESULTS OF ANTHROPOMETRICS AND DIETARY NUTRIENT INTAKES

The samples that meet the criteria of the selection - out and join a research project -were 58 persons. The common characteristics of the selected persons such as gender, age, income, educational level, dietary habits, and exercises were no significant difference between the two groups. As well as, the anthropometrics, for example, weight, body mass index, percentage body fat, percentage abdominal fat, waist circumference and blood pressure between mulberry group and control group in both before and after the mulberry group was no difference (Table 1). A group who consumed mulberry fruits was obtained fiber higher than the control group with the statistically significant at the end of the study (Table 2). During the first week of the study, there were 7 subjects has adverse effects; for example, bloating, discomfort and distension by freeze-dried mulberry consumption. It may be because of the increasing of intake fiber from mulberry. However, the side effects are minimal. They did not need a special treatment.

Table 1. Anthropometrics at baseline (week 0) and the end of study (week 6) in the mulberry and control group[a,b]

Variables	Group	*p* - value

		Mulberry	Control	
Body weight (kg)	week 0	58.67 ± 11.19	62.38 ± 15.67	0.301
	week 6	58.60 ± 11.05	62.72 ± 15.48	0.246
BMI (kg/m^2)	week 0	23.87 ± 3.87	24.80 ± 5.41	0.454
	week 6	24.02 ± 3.86	24.92 ± 5.32	0.464
%body fat	week 0	32.44 ± 5.28	31.34 ± 6.14	0.471
	week 6	32.34 ± 5.44	31.09 ± 6.81	0.563
% visceral fat	week 0	7.17 ± 4.04	7.99 ± 5.93	0.621
	week 6	6.93 ± 3.92	8.00 ± 5.55	0.433
Waist circumference (cm)	week 0	81.67 ± 9.87	82.98 ± 12.90	0.667
	week 6	83.22 ± 9.55	85.00 ± 12.06	0.534
Systolic blood	week 0	118.17 ± 15.18	119.00 ± 16.82	0.844
pressure (mmHg)	week 6	115.77 ± 13.40	116.96 ± 14.55	0.745
Diastolic	week 0	77.37 ± 9.31	76.93 ± 10.62	0.868
blood presseure (mmHg)	week 6	74.23 ± 10.44	73.79 ± 10.03	0.869

[a] Data are shown as mean ± SD

[b] There were no significant differences between the two groups at baseline in any variable by the independent-sample *t* test

Table 2. Dietary nutrient intakes of the subjects at baseline, week 3, week6 of study in the mulberry group[a,b]

Variables	Group	Week 0	Week 3	Week 6	*p* – value[b]
Energy	Mulberry	1,265.0 ± 279.1	1,194.7 ± 302.0	1,163.7 ± 295.7	0.393
(kcal/d)	Control	1,243.9 ± 288.6	1,209.7 ± 256.4	1,183.3 ± 230.9	0.702
Carbohydrate	Mulberry	188.0 ± 47.8	175.8 ± 47.0	170.1 ± 41.8	0.305
(g/d)	Control	189.0 ± 49.1	181.9 ± 53.0	171.2 ± 44.2	0.422
(% of energy)	Mulberry	59.2 ± 8.2	58.8 ± 7.3	59.1 ± 8.3	0.974
	Control	58.9 ± 7.4	59.0 ± 8.2	57.7 ± 8.2	0.796
Protein (g/d)	Mulberry	43.1 ± 14.2	41.5 ± 12.7	44.1 ± 17.5	0.793
	Control	43.1 ± 12.2	41.9 ± 10.5	41.7 ± 11.8	0.890
(% of energy)	Mulberry	13.7 ± 2.6	14.1 ± 2.3	14.7 ± 2.9	0.315
	Control	14.0 ± 3.1	14.0 ± 2.9	14.8 ± 4.1	0.650
Fat (g/d)	Mulberry	38.1 ± 13.3	37.0 ± 14.1	35.4 ± 15.2	0.771
	Control	36.5 ± 13.0	37.8 ± 12.3	37.2 ± 10.8	0.966
(% of energy)	Mulberry	26.6 ± 6.6	28.0 ± 9.0	26.2 ± 6.8	0.614
	Control	25.5 ± 6.0	27.2 ± 6.3	28.1 ± 6.1	0.317
Cholesterol	Mulberry	202.4 ± 100.2	199.4 ± 118.8	195.0 ± 118.8	0.968
(g/d)	Control	203.1 ± 94.3	201.6 ± 87.7	195.9 ± 92.8	0.957
Fiber	Mulberry	10.7 ± 6.9	19.4 ± 5.9	18.4 ± 4.3	< 0.001*
(g/d)	Control	8.0 ± 4.9	8.3 ± 3.7	7.7 ± 3.8	0.865

[a] Data are shown as mean ± SD

[b] Significant differences, *p*-value< 0.001assesed by one-way ANOVAs

2. THE EFFECTS OF FREEZE-DRIED MULBERRY CONSUMPTION ON LIPID PROFILES, ANTIOXIDANTS, AND INFLAMMATION IN THE BLOOD

2.1. The effects of freeze-dried mulberry consumption on lipid profiles.

This study found that the consumption of freeze-dried mulberry which containing anthocyanin 325 milligrams for six weeks could significantly reduce the TC (total cholesterol) 3.73% and LDL-C 6.53%. However, there was no effect on TAG and HDL-C (Table 3). It was similar to the two previous studies. Qin *et a*l. (2009) reported that dyslipidemic subjects who consumed the purified anthocyanins derived from bilberry and black currant of for 8 weeks could statistically significant decrease the LDL-C around 13.6% and increased the HDL-C around 13.7%. Zhu *et*

al. (2013) also revealed that it could reduce the LDL-C around 10.4% and increase the HDL-C around 14% in adults with hypercholesterolemia after the 6 -month consumption; however, it was no significant changes in the level of TAG and TC. Furthermore, Basu *et al*. (2010) found the similar results of freeze-dried strawberries which contain 320 mg anthocyanins consumption. On the other hand, Curtis *et al* (2009) found that elderberry which contained 500 mg consumption for 12 weeks of healthy postmenopausal women were no significant changes in biomarkers of inflammatory and blood lipid profiles

Interestingly, there were several reports showed the mechanisms of cholesterol decreasing affected from mulberry consumption as following:

1) It blocked the uptake of cholesterol into Caco-2 cells. (about 25% inhibition) (Duangjai *et al*., 2011)
2) It inhibited of cholesterol ester transfer protein (CETP) activity. (Qin *et al*., 2009)
3) It suppressed cellular lipid accumulation through activating AMPK pathway.
4) It retained the lipogenic enzyme
5) It enhanced the gene expression of LDL receptor.
6) It stimulated fatty acid oxidation. (Ou *et al*., 2011, Zhu et al., 2013, Liu *et al*., 2009)

Ozguven *et al* (2013) reported that the 100 grams freeze-dried mulberries provided approximately 24.3 grams fiber. Hypocholesterolaemic action, at least partly, found in the study may have been due to the increase in dietary fiber intake from baseline about 10 grams per day during the 6 weeks of the study and the results were synchronize with the experiment of Casto *et al* (De Castro *et al*., 2006) who found that intake fiber 10 grams for a period of 7 years reducing TC 12.5 milligrams per deciliter including the association of the United States has recommended intake 14 grams fiber/1000 kcal of food can reduce blood lipid profiles and reduce the risk of cardiovascular disease (Marlett *et al*., 2002).Therefore, the interaction of anthocyanin and mulberry fiber will reduce theTC and HDL-C in hypercholesterolemic.

At the beginning of the study, all Lipid profiles such as triglycerides, TC, LDL-C, and HDL-C of the two groups were no difference. At the end of the study (week 6), however, the TC and LDL-C were statistical significantly decreased, but triglyceride and HDL-C were not significantly statistically in the mulberry consumption group, while the TC was statistically significant increased, but triglycerides, LDL-C and HDL-Cl were no statistical significant in control group. Furthermore, the level of TC, LDL-C HDL-C of the group who was consumed mulberry for six weeks were statistical significance decreased by 3.73% and 6.53%, respectively, while triglyceride levels and HDL cholesterol were no statistically significant.

Table 3. Changes of lipid profiles at baseline (week 0) and the end of study (week 6) in the mulberry and control group[a,b,c]

Lipid profiles (mg/dL)	Group	Week 0	Week 6	Mean change	Percent change
TC ***	Mulberry	235.07 ± 28.10	225.83 ± 24.26	- 9.23 ± 10.75	- 3.73 ± 3.99
	Control	237.26 ± 32.72	244.70 ± 33.12	7.44 ± 12.13	3.33 ± 5.07
LDL-C***	Mulberry	167.47 ± 29.32	156.07 ± 24.70	- 11.40 ± 12.04	- 6.53 ± 5.93
	Control	166.59 ± 34.02	166.48 ± 32.64	- 0.11 ± 8.77	0.15 ± 4.90
HDL-C	Mulberry	61.13 ± 12.59	62.57 ± 13.66	1.43 ± 4.96	2.40 ± 8.60
	Control	65.39 ± 15.86	66.14 ± 15.96	0.75 ± 7.33	2.11 ± 11.28
TAG	Mulberry	117.03 ± 41.21	109.28 ± 43.65	- 7.76 ± 30.69	- 3.90 ± 28.64
	Control	100.50 ± 31.97	97.31 ± 30.74	- 3.19 ± 25.40	- 0.42 ± 25.81

[a]TC: total cholesterol, LDL-C: low density lipoprotein cholesterol, HDL-C: high density lipoprotein cholesterol TAG: triacylglycerol

[b] Data are shown as mean ± SD

[c] The mean change was calculated as value at wk6 – value at baseline

[d] The percent change was calculated as (value at wk6 – value at baseline) Value at baseline

** Significant differences, p-value < 0.001 by Independent-sample t test

2.2. The effects of freeze-dried mulberry consumption on Antioxidant and Inflammation status.

In mulberry consumption group, the antioxidant resistant value, that was analyzed by ORAC method, was significantly increased to 55.16 μM / ml after the six weeks consumption, while the antioxidants of a control group were decreased from 49.34 μM / ml to 47.25 μM / ml. In addition, the results from FRAP method was similar (Table 4).

It is noticeable, in mulberry consumption group, the antioxidant, both ORAC, and FRAP, in blood was significantly increased when compared between at pre- and post-experiment.

There was consistent with a report of Mazza and Maffucci (2002) which studied the effects of consumption freeze-dried and found that blueberry could increase antioxidant in the blood. It is probably due to anthocyanin in mulberry directly affected by a mechanism of the free radicals get rid of. It also has the effect of the promoting and increasing the activities of the antioxidant (superoxide dismutase: SOD, glutathione peroxidase: GSH-Px). In addition, there were some studies found that the consumption of strawberries can increase antioxidants in the blood (Cao *et al*., 1998), and after one hour of the 300 ml red wine in volume consumption, an antioxidant in the blood was up to 18% because of the subjects received anthocyanin which is an antioxidant from strawberry and red wine. (Whitehead *et al*.,1995).

Table 4. Changes of antioxidant and inflammation at baseline (week 0) and the end of study (week 6) in the mulberry and control group[a,b,c]

	Group	Week0	Week 6	Mean change	Percent change
Antioxidant	Mulberry	50.49 ± 8.89	55.16 ± 8.92	4.70 ± 4.88	10.27 ± 11.36
ORAC * [TE (μM) / ml (g)]	Control	49.34 ± 11.91	47.25 ± 10.37	-2.09 ± 4.45	-3.16 ± 10.37
FRAP* [TE (μM) / ml (g)]	Mulberry	15.45 ± 2.33	17.06 ± 2.11	1.61± 1.58	11.39 ± 11.42
	Control	14.31 ± 2.18	14.06 ± 1.65	-0.25 ± 1.97	-0.09 ± 15.65
Inflammation hsCRP (mg/L)	Mulberry	1.75 ± 1.87	1.59 ± 1.84	-0.15± 0.77	-6.6 ± 37.49
	Control	2.30 ± 1.87	2.08 ± 1.76	-0.22 ± 0.87	-4.64 ± 34.69

[a] ORAC: Oxygen radical absorbance capacity, FRAP: ferric reducing ability of plasma, hsCRP: High sensitivity C-reactive protein

[b] Data are shown as mean ± SD

[c] The mean change was calculated as value at wk6 – value at baseline

[d] The percent change was calculated as (value at wk6 – value at baseline) Value at baseline

** Significant differences, p-value <0.001 by Independent-sample t test

CONCLUSION

The consumption of 45 grams freeze-dried mulberry (325 mg anthocyanin, ~ 160 g fresh mulberry) per day for 6 weeks could reduce the TC (total cholesterol) 3.7% and LDL-C (Low-density lipoprotein cholesterol) 6.53% at p<0.001, but there was no changed in HDL-C (High-density lipoprotein), and increased in anti-oxidants. Mulberry is a natural source of antioxidants and good alternative food for lipid profiles control to normal levels and a great way to boost the fiber content in dietary intake. The hypercholesterolemia subjects could reduce lipid medications which; therefore, decrease the expenses and side effects.

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BASIC CHEMICAL COMPOSITIONS AND ANTIOXIDANT ACTIVITIES OF THAI SILKWORM AND SILKWORM PUPA

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ABSTRACT: Silkworm pupa has normally obtained as a by-product during cocoon production. Some of their antioxidant activities were studied, but not cover all Thai silkworm varieties which have been promoted by The Queen Sirikit Department of Sericulture. Therefore, this research aimed to study on the basic chemical compositions and antioxidant activities of Thai silkworm and silkworm pupa**.** The experimental design was 7×2×2 Factorial in Completely Randomized Design. Three main factors were studied which were 7 silkworm varieties (Nangnoi Srisaket-1, Samrong, Nangtui×Nangsew, Nangnoi Srisaket-1×Samrong, Ubon Ratchathani 60-35, Luang Surin and J108xNanglai), 2 stages of silkworm (mature silkworm and silkworm pupa) and sex (male and female). It was found that all silkworm varieties had similar basic chemical compositions without significant differentiation *($p \geq 0.05$)* which were moisture (77.13-78.93%), protein (56.11-61.71%), fat (11.02-19.11%), ash (4.19-6.73%) and carbohydrate include fiber (18.49-23.86%) respectively. However, it showed that silkworm pupa had higher fat and carbohydrate include fiber content than silkworm with having significant differentiation *($p \leq 0.05$).* In addition, male pupa had fat content more than female pupa but female pupa had protein and carbohydrate include fiber content more than male pupa. Antioxidant activities analysis had been evaluated by using 3 methods; DPPH, TEAC, and TRAP assays). It can be seen that Nangnoi Srisaket-1 and Luang Surin silkworm varieties had significantly *($p \leq 0.05$)* highest of antioxidant activities, while silkworm pupa showed higher antioxidant activities than mature silkworm in each variety. Furthermore, both male and female gave the same level of antioxidant activities with having no significantly differentiation.

Keywords : Silkworm, Silkworm pupa, Chemical composition, Antioxidant activities

INTRODUCTION

Insects have played a very important role as a source of food in the history of human nutrition, especially in developing countries (Bodenheimer, 1951). Insects (on dry weight basis) have very high crude protein content and insect proteins have been reported to be a good sources of essential amino acids, equivalent or even superior to soy protein (Frinke, deFoliart, & Benevenga, 1989).The consumption of insect has been documented in Japan, Thailand, Africa, Latin America, Australia, Mexico and other parts of the developing world where the represent a cheap source of good quality protein (deFoliart, 1999; Misuhashin, 1997). One of high potential insect for food is silkworm pupa (*Bombyx mori* L.). It is the main by product of the silk reeling industry, is used to feed animals directly for a long time. Meanwhile, it is treated as nutrient food owing to its high protein content and functional gradients. Annually, there are a large numbers of silkworm pupae by-product but only a small quantity of silkworm pupae are utilized as human food. Other parts of silkworm pupa are discarded in open place due to their pollution, besides loss of nutrients (Yang *et al*. 2013). Their were reported that in silkworm pupa has some food

nutrients including antioxidants. Antioxidants play an important role as health protecting factor. Scientific evidence suggests that antioxidants reduce the risk for chronic diseases including cancer and heart disease. Primary sources of naturally occurring antioxidants are whole grains, fruits and vegetables. Plant sourced antioxidants like vitamin C, vitamin E, carotenes, phenolic acids etc. have been recognized as having the potential to reduce disease risk (Tailor and Goyal, 2014). Most of the antioxidant compounds in a typical diet are derived from plant sources and belong to various classes of compounds with a wide variety of physical and chemical properties (Sravani and Paarakh, 2012).

There are more than 100 of silkworm varieties in Thailand. According to The Queen Sirikit Sericulture Department, Thailand's practices, there are 3 types; Thai native, Improved Thai and Foreign. Thai native silkworm have shuttle yellow cocoon and 250-300 meter length yarn per cocoon. The Improved silkworm have classified in to 3 groups, Improved Thai native, Thai Hybrid and Hybrid varieties. Improved Thai native silkworm were bred between Thai native and Thai native varieties which have yellow cocoons as Thai native one. Thai Hybrid varieties are provided by breeding between Thai polyvoltine and Thai bivoltine silkworm. They have yellow cocoon and 600-800 meter length yarn per cocoon. Hybrid group are bred between Thai bivoltine silkworm and foreign bivoltine silkworm varieties. They have white or yellow cocoon, about 1,000 meter length yarn per cocoon. The last type is foreign variety (bivoltine into bivoltine) which is imported from other countries. This type had white oval cocoon (The Office of Sericulture Research and Development, 2015).

Nowadays in Thailand, there are little information of basic chemical compositions and antioxidants activities in silkworm and silkworm pupa. It also lacks of some knowledge about bioactive compounds in silkworm and silkworm pupa. Therefore, this study has undertaken to determine some important silkworm varieties for basic chemical composition and antioxidant activities. From this study, high potential of silkworm varieties which had healthy bioactive compounds would be reported. This knowledge would be the background information to created value-added and supplemented food products which would bring great benefit to sericulture in Thailand.

MATERIALS AND METHODS

2.1 Preparation of samples

All of silkworms were rearing at The Queen Sirikit Sericulture Center, Chiangmai province and The Queen Sirikit Sericulture Center, Nakorn Rachsrima province. The silkworm and silkworm pupa were separate sex and kept in the incubator at -18 ^{o}C. All samples were dissolved and grounded to powder for analyzed.

2.2 Chemical analysis

Basic chemical composition by AOAC (2000) moisture, protein, ash and carbohydrate were assayed by the AOAC (2000) :

- Moisture analysis by hot air oven
- Protein content was determined by Semi-Kjedhl method
- Fat content was determined by Sohxlet extract method
- Ash was determined by dry-ashing at 550 ^{o}C
- Carbohydrate include fiber

2.3 Antioxidant activities assay

Five grams of random sample were mix with 50 ml of 75% ethanol, shook at room temperature for 1 hour, centrifuged at 300 rpm for 2 minutes and filtrated with No 4. filter paper (Meetali *et al.*,2014). The fluid extracts were found out antioxidant activities in 3 methods:

1.) DPPH radical scavenging activity assays

Fluid extract samples were reacted with 0.3 % DPPH solution at dark condition and then measured the absorbance at 517 nm using a UV-visible spectrophotometer. (Orhan *et al.*, 2013).

2.) Trolox equivalents antioxidant capacity (TEAC assay)

Prepared solution of ABTS, by mixed 7mM ABTS and 140 mM potassium persulphate in ratio 5 ml. and 80 ul respectively. The mixture was shaken vigorously and allowed to dark room for 12-16 hour. Diluted solution of ABST by *phosphate buffer* (pH 7.0) in ratio 1 ml and 89 ml respectively. There for add the mixture 40 ul with ABTS solution 4 ml., incubated for 6 minute at room temperature to protect from light and measure the absorbance 734 nm using a UV-visible spectrophotometer (Moreira *et al*., 2001).

3). Total radical trapping antioxidant parameter (TRAP assay)

Prepared by using AAPH reagent mixed with 2 mM AAPH {2,2'Azinobis(2-methyl-propannimidamide)} and 75 uM ABTS in 50 mM acetate buffer (pH 4.3).The mixture incubated at temperature 45 ^{o}C for 60 minutes. Then, pipate the AAPH reagent 2600 ul mixed with the sample 600 ul for 15 minutes and the absorbance of the resulting solution was read at 734 nm using a UV-visible spectrophotometer(Moreira *et al*., 2001).

2.4 Analytical statistic

The experimental design was 7×2×2 Factorial in Completely Randomized Design. Three main factors were studied as follow : 1) 7 silkworm varieties (Nangnoi Srisaket-1, Samrong, Nangtui × Nangsew, Nangnoi Srisaket-1×Samrong, Ubon Ratchathani 60-35, Luang Surin and J108xNanglai), 2) 2 stages of silkworm (mature silkworm and silkworm pupa) and 3) 2 sexes (male and female)**.** Proximately results were statistical analysis by ANOVA to compared analysis of variance by Duncan's New Multiple Range Test (DNMRT) at the level 95 percent statistical confidence.

RESULTS AND DISCUSSION

1. Chemical composition

1.1. Single factor (silkworm variety , silkworm stage and silkworm sex)

Considering to the variety the result showed that all silkworm variety had similar basic chemical compositions without significant differentiation *($p \geq 0.05$)* which were 77.13-78.93% moisture, 56.11-61.71% protein, 11.02-19.11% fat, 4.19-6.73% ash and 18.49-23.86% carbohydrate include fiber. Considering to the stage it was found that silkworm had higher protein content more than silkworm pupa with significant differentiation (*$p \leq 0.05$*). There were 67.65% and 51.34 % protein content in silkworm and silkworm pupa respectively. But silkworm pupa had higher fat and carbohydrate include fiber than silkworm with significant differentiation (*$p \leq 0.05$*).There were 26.43% and 19.40 % fat and carbohydrate include fiber in silkworm pupa respectively. Similar results were found by Longvah *et al*. (2011). To determine the silkworm and silkworm pupa sex it was showed that female had higher protein and carbohydrate include fiber than male, but male had higher fat than female with significant differentiation (*$p \leq 0.05$*).(Table 1) Similar results have been reported by Sukritanon *et al*. (2003).

Table 1. Basic chemical composition of single factor of Thai silkworm and silkworm pupa .

Factor	component				
	moisture (% wb)	protein (% db)	fat (% db)	ash (% db)	carbohydrate (% db)
variety	**ns**	**ns**	**ns**	**ns**	**ns**
Nangnoi	**78.93 ± 3.27**	**59.18 ± 11.21**	**20.77 ± 9.89**	**5.13 ± 2.25**	**15.46 ± 13.12**
Srisaket-1					**15.65 ± 11.24**
Samrong	**77.41 ± 2.13**	**59.77 ± 14.45**	**23.86 ± 6.56**	**4.19 ± 1.98**	**11.02 ± 11.54**
Nangtui					**16.92 ± 7.36**
×Nangsew	**78.36 ± 1.43**	**61.71 ± 12.15**	**23.27 ± 9.44**	**4.44 ± 2.06**	
Nangnoi					
Srisaket1	**77.16 ± 1.65**	**56.11 ± 10.52**	**22.04 ± 7.31**	**4.92 ± 1.69**	**15.40 ± 13.70**
×Samrong					**19.11 ± 10.69**
Ubon					**16.36 ± 9.14**
Ratchathani 60-35	**77.55 ± 0.74**	**65.41 ± 15.48**	**18.49 ± 9.49**	**6.73 ± 2.92**	

Luang Surin	**77.13 ± 2.65**	**58.16 ± 11.24**	**21.72 ± 9.55**	**5.45 ± 2.44**	
J108xNanglai	**78.28 ± 1.90**	**56.14 ± 12.17**	**21.46 ± 7.87**	**6.20 ± 2.32**	
stage	**ns**			**ns**	
silkworm	**77.64 ± 2.27**	**67.65 ± 10.21[a]**	**16.88 ± 5.75[b]**	**5.21 ± 1.03**	**12.00 ± 5.23[b]**
silkworm pupa	**78.01 ± 1.93**	**51.34 ± 11.25[b]**	**26.43 ± 6.23[a]**	**5.37 ± 2.41**	**19.40 ± 6.49[a]**
sex	**ns**			**ns**	
male	**77.74 ± 1.56**	**57.08 ± 10.81[b]**	**24.89 ± 5.28[a]**	**5.25 ± 1.18**	
female	**77.91 ± 2.31**	**61.91 ± 12.45[a]**	**18.42 ± 5.16[b]**	**5.33 ± 2.57**	**14.15 ± 5.19[b]** **17.26 ± 6.03[a]**

Remark : Mean comparison along the column by DNMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

1.2 Two factors between silkworm variety and silkworm stage

In this study it was found that silk varieties and silk stage had similar moisture content without significant differentiation *(p≥0.05)* which were 76.51-79.11 % but Luang Surin, Nangtui ×Nangsew and Nangnoi Srisaket-1 silkworm varieties had higher protein content more than the others. There were 72.12, 70.62 and 69.32% protein in Luang Surin, Nangtui ×Nangsew and Nangnoi Srisaket-1varieties respectively. In addition, Luang Surin silkworm pupa, Luang Surin and Nangnoi Srisaket-1 silkworm varieties had higher fat more than the others, which were 30.30, 27.99 and 27.55 % respectively. The data showed that Ubon Ratchathani 60-35, J108xNanglai and Luang Surin silkworm varieties had higher ash than the others. There were 8.10, 6.61 and 5.98% respectively. For carbohydrate include fiber content it was shown that Samrong, Ubon Ratchathani 60-35 and Nangnoi Srisaket-1 silkworm pupa varieties had higher than the others, which were 23.99, 21.21 and 19.91% respectively (Table 2). This result was similar to previous report of Zhou and Han, (2006) which protein, fat and ash have been 71.90, 20.10 and 4.10% respectively.

Table 2. Interaction of silkworm variety and silkworm stage on their basic chemical composition.

variety	stage	component				
		moisture (%wb) [ns]	protein (%db)	fat (%db)	ash (%db)	carbohydrate (%db)
Nangnoi Srisaket-1	**silkworm**	**78.91 ± 4.60**	**69.32 ± 7.09[a]**	**26.55 ±11.44[ab]**	**4.43 ±2.76[ab]**	**15.30 ± 16.89[ab]**
	silkworm pupa	**78.95 ± 1.95**	**65.58 ± 10.58[abc]**	**27.55 ±4.27[a]**	**5.83 ±1.72[ab]**	**15.63 ± 10.79[ab]**
Samrong	**silkworm**	**76.72 ± 2.09**	**52.78 ± 8.48[bcde]**	**20.17 ±6.78[abc]**	**3.20 ±1.97[b]**	**7.32 ± 5.86[ab]**
	silkworm pupa	**78.08 ± 2.24**	**50.23 ± 13.92[cde]**	**14.98 ±2.88[bc]**	**5.17 ±1.64[ab]**	**23.99 ± 8.69[a]**
Nangtui ×Nangsew	**silkworm**	**77.60 ± 0.57**	**70.62 ± 7.94[a]**	**21.03 ±11.13[abc]**	**4.69 ±2.16[ab]**	**5.02 ± 6.87[b]**
	silkworm	**79.11 ±**	**52.79 ±**	**25.50**	**4.18**	**17.02 ±**

	pupa	**1.71**	**8.35 ^{bcde}**	**±8.41 ^{ab}**	**±2.26 ^{b}**	**12.95 ^{ab}**
Nangnoi Srisaket-1 ×Samrong	**silkworm**	**77.45 ± 1.64**	**62.62 ± 8.97 ^{abcd}**	**19.42 ±4.84 ^{abc}**	**4.03 ±1.80 ^{b}**	**13.94 ± 5.27 ^{ab}**
	silkworm pupa	**76.86 ± 1.85**	**49.61± 8.06 ^{de}**	**24.67 ±9.11 ^{abc}**	**5.82 ±1.13 ^{ab}**	**19.91 ± 8.66 ^{ab}**
Ubon Ratchathani 60-35	**silkworm**	**77.67 ± 0.21**	**49.34 ± 5.87^{de}**	**14.55 ±2.87 ^{bc}**	**8.10 ±3.65 ^{a}**	**9.59 ± 7.60 ^{ab}**
	silkworm pupa	**77.43 ± 1.10**	**58.10 ±16.60^{abcde}**	**22.44 ±12.66^{abc}**	**5.35 ±1.25 ^{ab}**	**21.21 ±17.04 ^{ab}**
Luang Surin	**silkworm**	**76.51 ± 2.49**	**72.71± 11.90^{a}**	**27.99 ±5.41 ^{a}**	**5.98 ±2.62 ^{ab}**	**18.92 ± 14.24 ^{ab}**
	silkworm pupa	**77.75 ± 3.03**	**66.98 ± 7.29^{ab}**	**30.30 ±3.39 ^{a}**	**4.92 ±2.50 ^{ab}**	**19.31 ± 7.99 ^{ab}**
J108xNanglai	**silkworm**	**78.66 ± 2.24**	**65.73 ± 7.11^{abc}**	**14.94 ±1.28 ^{bc}**	**6.61 ±3.38 ^{ab}**	**13.64 ± 9.34 ^{ab}**
	silkworm pupa	**77.91± 1.73**	**46.54 ± 7.04^{e}**	**13.14 ±2.26 ^{c}**	**5.80 ±0.85 ^{ab}**	**19.08 ± 9.39 ^{ab}**

Remark : Mean comparison along the column by DNMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

1.3 Two factors between silkworm variety and silkworm sex

Considering to interaction chemical composition between silkworm varieties and silkworm sexes had similar moisture and protein content without significant differentiation *(p≥0.05)* which were 76.96 - 79.23 and 53.18 - 73.04% respectively. Male Nangtui ×Nangsew variety had highest fat content which was 28.70%.Therefore, female Ubon Ratchathani 60-35 variety had highest ash, which was 8.51 % and female Luang Surin variety had highest carbohydrate include fiber which it tended to different from the other group with statistical different (Table 3).

1.4 Two factors between silkworm stage and silkworm sex

Considering to interaction chemical composition between silk stage and silk sex had were similar moisture and ash without significant differentiation *(p≥0.05)* which were 77.49 -78.34, 5.01-5.49% respectively. Female silkworm had highest protein which was 68.29% .In addition, male silkworm pupa had highest fat which was 30.95% and female silkworm pupa had highest carbohydrate include fiber include fiber which was 20.29% (Table 4).

Table 3. Interaction of silkworm variety and silkworm sex on their basic chemical compositions**.**

variety	**sex**	**component**				
		moisture ^{ns} (%wb)	**protein (%db)**	**fat (%db)**	**ash (%db)**	**Carbohydrate (%db)**
Nangnoi Srisaket-1	**male**	**79.23±4.87**	**60.63±14.86**	**23.18 ±12.26^{ab}**	**5.96 ±2.23 ^{ab}**	**11.30 ±13.13 ^{ab}**
	female	**78.64±1.00**	**57.73±8.18**	**18.35 ±7.90 ^{ab}**	**4.31 ±2.24 ^{b}**	**19.62 ±13.53 ^{ab}**
Samrong	**male**	**77.46±2.53**	**56.70±15.86**	**27.21±5.30 ^{a}**	**4.73 ±1.60 ^{b}**	**18.30 ±13.95 ^{ab}**
	female	**77.35±2.04**	**62.85±14.50**	**20.51±6.25**	**3.64**	**13.01 ±9.05 ^{ab}**

				ab	±2.41 b	
Nangtui ×Nangsew	**male**	**78.26±1.62**	**61.30±13.95**	**28.70 ±10.37 a**	**4.51 ±2.79 b**	**6.34 ±10.73 b**
	female	**78.45±1.45**	**62.11±12.23**	**17.83 ±4.64 ab**	**4.36 ±1.45 b**	**15.71 ±11.72 ab**
Nangnoi Srisaket-1 ×Samrong	**male**	**76.18±1.01**	**53.18±13.51**	**25.62 ±8.62 ab**	**4.50 ±2.32b**	**16.69 ±7.02 ab**
	female	**78.13±1.67**	**59.04±7.28**	**18.46 ±4.04 ab**	**5.34 ±0.88ab**	**17.16 ±8.78 ab**
Ubon Ratchathani 60-35	**male**	**77.23±0.94**	**57.77±19.96**	**24.04 ±11.31ab**	**4.94 ±0.89ab**	**14.03 ±15.05 ab**
	female	**77.87±0.36**	**73.04±2.35**	**12.95 ±0.42 b**	**8.51 ±3.26a**	**16.77 ±14.38 ab**
Luang Surin	**male**	**77.29±2.37**	**58.13±15.24**	**23.19 ±10.31 ab**	**6.44 ±2.78ab**	**12.24 ±6.83 ab**
	female	**76.96±3.27**	**58.19±7.91**	**20.25 ±10.04 ab**	**4.45 ±1.87b**	**25.99 ±9.70 a**
J108xNanglai	**male**	**78.56±2.06**	**51.87±11.55**	**22.30 ±8.51ab**	**5.68 ±0.65ab**	**20.14 ±6.05 ab**
	female	**78.01±1.98**	**60.40±12.80**	**20.62 ±8.38 ab**	**6.72 ±3.38ab**	**12.58 ±10.97 ab**

Remark : Mean comparison along the column by DNMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

Table 4. Interaction of silkworm stage and silkworm sex on their basic chemical compositions.

stage	**sex**	**component**				
		moisture ns (%wb)	**protein (%db)**	**fat (%db)**	**ash (%db)**	**carbohydrate (%db)**
silkworm						
	male	**77.80±2.78**	**67.01 ±10.08 a**	**23.18 ±12.26ab**	**5.01±2.23**	**9.78 ±8.68 b**
	female	**77.49±1.69**	**68.29 ±6.83 a**	**18.35 ±7.90 ab**	**5.43±3.51**	**14.24 ±9.52 ab**
silkworm pupa						
	male	**77.68±2.10**	**47.16 ±9.02 c**	**27.21±5.30 a**	**5.49±1.69**	**18.51 ±10.88 a**
	female	**78.34±1.77**	**55.53 ±9.01 b**	**20.51±6.25 ab**	**5.24±1.47**	**20.29 ±11.65 a**

Remark : Mean comparison along the column by DMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

1.5 Three factors between silkworm variety, silkworm stage and silkworm sex

Considering to interaction chemical composition between silkworm variety, silkworm stage and silkworm sex had similar moisture and protein content without significant differentiation *($p \geq 0.05$)* which was 76.17-79.68%.Therefore, female silkworm pupa Nangnoi Srisaket-1variety had highest protein which was 74.80%. Female silkworm pupa Ubon

Ratchathani 60-35 variety had highest fat content which was 31.93%. Meanwhile, Jintasataporn *et al.* (2001) have been report that there were 54.63 and 28.14 % protein and fat in Eri silkworm. Besides, this study was showed that female silkworm Ubon Ratchathani 60-35 variety had highest ash which was 10.87% and female silkworm pupa Luang Surin variety had highest carbohydrate include fiber which was 29.92% (Table 5).

Table 5. Interaction of silkworm variety, silkworm stage and silkworm sex on their basic chemical compositions.

variety	stage	sex	component				
			moisture ^{ns} (%wb)	protein (%db)	fat (%db)	ash (%db)	carbohydrate (%db)
NangnoiSrisaket-1	silkworm	male	79.62 ± 7.74	70.64 ±11.63 ^{abc}	14.94 ±2.06 ^{de}	6.11 ±2.46 ^{ab}	10.41 ±14.71 ^{ab}
		female	78.21 ± 1.28	61.38 ± 2.63 ^{abcde}	15.03 ±4.55 ^{de}	2.76 ±2.34 ^{b}	12.20 ±17.25 ^{ab}
	silkworm pupa	male	78.83 ± 3.28	69.78 ± 16.08 ^{abcd}	31.46 ±5.24 ^{a}	5.80 ±2.97 ^{ab}	28.64 ±7.42 ^{a}
		female	79.07 ± 0.79	74.80 ± 4.48 ^{a}	21.67±11.07^{a} ^{bcde}	5.86 ±0.12 ^{ab}	18.40 ±22.79 ^{ab}
Samrong	silkworm	male	76.37 ± 3.50	51.48 ± 8.29 ^{abcde}	24.83 ±7.06 ^{abcde}	3.37 ±0.28 ^{b}	7.7 ±10.07 ^{b}
		female	77.08 ± 0.57	54.08 ± 11.84 ^{abcde}	15.50 ±1.00 ^{cde}	3.03 ±3.38 ^{b}	6.68 ±0.11 ^{ab}
	silkworm pupa	male	78.55 ± 1.51	63.84 ±3.29 ^{abcde}	29.58±3.46 ^{abcd}	6.10 ±0.33 ^{ab}	20.85 ±4.84 ^{ab}
		female	77.62 ± 3.44	49.57 ±23.25 ^{cde}	25.52±5.11 ^{abcde}	4.25 ±2.14 ^{b}	19.34 ±9.23 ^{ab}
Nangtui ×Nangsew	silkworm	male	77.89 ± 0.70	50.90 ±6.26 ^{bcde}	26.36±15.83^{a} ^{bcde}	4.71 ±3.28 ^{b}	18.03 ±0.00 ^{ab}
		female	77.31 ± 0.37	70.61 ±7.33 ^{abc}	15.71 ±2.79 ^{cde}	3.65 ±1.84 ^{b}	10.04 ± 6.38 ^{ab}
	silkworm pupa	male	78.63 ± 2.62	51.97 ±10.03 ^{abcde}	31.05 ±7.11 ^{abc}	4.31 ±3.54 ^{b}	12.67 ±13.59 ^{ab}
		female	79.60 ± 0.95	53.61 ±10.30 ^{abcde}	19.96 ±6.22 ^{abcde}	5.07 ±0.93 ^{b}	21.37 ±15.58 ^{ab}

Nangnoi Srisaket-1× Samrong	**silkworm**	**male**	**76.19 ± 0.44**	**62.28 ±14.11 abcde**	**19.79 ±7.70 abcde**	**2.86 ±1.99 b**	**15.07 ±8.41 ab**
		female	**78.71 ± 1.25**	**62.96 ±6.46 abcde**	**19.05 ±3.23 abcde**	**5.20 ±0.49 b**	**12.81 ±2.73 ab**
	silkworm pupa	**male**	**76.17 ± 1.70**	**44.08 ±4.10 e**	**31.43 ±13.23 ab**	**6.15 ±1.18 ab**	**18.31 ±8.16 ab**
		female	**77.55 ± 2.35**	**55.13 ±7.50 abcde**	**17.88 ±6.10 abcde**	**5.49 ±1.42 ab**	**21.51 ±12.17 ab**
Ubon Ratchathani 60-35	**silkworm**	**male**	**77.51 ± 0.20**	**70.94 ±20.10 abc**	**16.16 ±3.73 bcde**	**5.34 ±1.24 b**	**9.13 ±12.91 b**
		female	**77.82 ± 0.0**	**44.60 ±9.86 e**	**12.94 ±0.64 e**	**10.87±2.81 a**	**10.06 ±2.35 ab**
	silkworm pupa	**male**	**76.94 ± 1.51**	**50.77 ±7.09 abcde**	**31.93 ±10.99 a**	**4.54 ±0.44 b**	**23.49 ±20.84 a**
		female	**77.93 ± 0.62**	**71.60 ±0.30 ab**	**12.95 ±0.34 e**	**6.16 ±1.36 ab**	**7.93 ±3.70 b**
Luang Surin	**silkworm**	**male**	**77.36 ± 1.03**	**70.19 ±9.19 abc**	**29.38 ±4.12 abcd**	**7.33 ±3.64 ab**	**16.55 ±7.21 ab**
		female	**75.66 ± 3.83**	**63.77 ±5.81 abcde**	**26.60 ±7.95 abcde**	**4.63 ±0.26 b**	**18.93 ±20.14 ab**
	silkworm pupa	**male**	**77.23 ± 3.98**	**70.04 ±8.37 abc**	**31.82 ±4.25 a**	**5.56 ±2.62 ab**	**22.07 ±10.44 ab**
		female	**78.27 ± 3.27**	**74.48 ±2.87 ab**	**28.78 ±2.70 abcd**	**4.27 ±3.21 b**	**29.92 ±10.55 a**
J108xNanglai	**silkworm**	**male**	**79.68 ± 1.85**	**46.08 ±5.58 de**	**15.23 ±0.10 de**	**5.35 ±0.76 b**	**17.99 ±3.66 ab**
		female	**77.64 ± 2.74**	**52.61 ±5.44 abcde**	**14.65 ±2.14 de**	**7.86 ±5.23 ab**	**9.30 ±13.15 ab**
	silkworm pupa	**male**	**77.44 ± 2.08**	**61.43 ±2.80 abcde**	**14.57 ±1.85 de**	**6.01 ±0.49 ab**	**22.30 ±8.82 ab**
		female	**78.37 ± 1.64**	**42.31 ±5.19 e**	**11.72 ±1.93 e**	**5.59 ±1.32 ab**	**15.87 ±12.04 ab**

Remark : Mean comparison along the column by DNMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

2. ANTIOXIDANT ACTIVITIES OF THAI SILKWORM

2.1 Single factor (silkworm variety, silkworm stage and silkworm sex)

Considering to the each factor, it was found that Luang Surin and Nangnoi Srisaket-1 variety have highest antioxidant activities than the others. It was similar to the results by Supanida *et al.* (2000).The result showed that Nangnoi Srisaket-1 pupa oil had higher antioxidant activities than Samrong pupa oil. Therefore, silkworm pupa had higher antioxidant activities than silkworm with significant differentiation ($p \leq 0.05$). Usub *et al.* (2008) had been reported that silkworm pupa had high antioxidant activities which can reduced cholesterol in human blood and both of sex were not significant differentiation $(p \geq 0.05)$ (Table 6).

Table 6. Antioxidant activities of single factor of Thai silkworm and silkworm pupa.

factor	antioxidant activities (mg/ml garlic acid)		
	DDPH assay	**TEAC assay**	**TRAP assay**
variety			
Nangnoi Srisaket-1	**0.505 ± 0.09 ^{ab}**	**0.694 ± 0.05 ^{ab}**	**0.543 ± 0.12 ^{ab}**
Samrong	**0.423 ± 0.26 ^{b}**	**0.609 ± 0.12 ^{b}**	**0.325 ± 0.11 ^{c}**
Nangtui ×Nangsew	**0.409 ± 0.12 ^{b}**	**0.651 ± 0.08 ^{ab}**	**0.343 ± 0.07 ^{c}**
NangnoiSrisaket-1×Samrong	**0.484 ± 0.14 ^{ab}**	**0.630 ± 0.11 ^{ab}**	**0.399 ± 0.06 ^{bc}**
Ubon Ratchathani 60-35	**0.544 ± 0.15 ^{ab}**	**0.643 ± 0.08 ^{ab}**	**0.417 ± 0.29 ^{bc}**
Luang Surin	**0.641 ± 0.20 ^{a}**	**0.728 ± 0.11 ^{a}**	**0.576 ± 0.08 ^{a}**
J108xNanglai	**0.371 ± 0.05 ^{b}**	**0.651± 0.07 ^{ab}**	**0.350 ± 0.14 ^{b}**
stage			
silkworm	**0.360 ^{b} ± 0.14**	**0.610 ^{b} ± 0.056**	**0.380 ^{b} ± 0.064**
silkworm pupa	**0.590 ^{a} ± 0.05**	**0.700 ^{a} ± 0.024**	**0.460 ^{a} ± 0.119**
sex		**ns.**	**ns.**
male	**0.460 ^{b} ± 0.48**	**0.640 ± 0.06**	**0.430 ± 0.16**
female	**0.490 ^{a} ± 0.24**	**0.660 ± 0.12**	**0.400 ± 0.05**

Remark : Mean comparison along the column by DMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

2.2 Two factors between silkworm variety and silkworm stage

Considering to factors between silkworm variety and silkworm stage, the result showed that Luang Surin silkworm pupa variety had highest antioxidants activities by DPPH and TEAC assay which were 0.808 and 0.755mg/ml garlic acid respectively. In addition, by TRAP assay, it was found that Nangnoi Srisaket-1silkworm had antioxidants activities which was 0.631mg/ml garlic acid with significant differentiation ($p \leq 0.05$).That was tended to be different from the other group (Table 7).

Table 7. Interaction between silkworm variety and silkworm stages on their antioxidant activity.

variety	stage	antioxidant activities (mg/ml garlic acid)		
		DDPH assay	**TEAC assay**	**TRAP assay**
Nangnoi Srisaket-1	**silkworm**	**0.453 ± 0.02 ^{defg}**	**0.735 ± 0.03 ^{a}**	**0.631 ± 0.12 ^{a}**

	silkworm pupa	0.558 ± 0.11 bcd	0.653 ± 0.03 abcd	0.455 ± 0.02 abcd
Samrong	silkworm	0.180 ± 0.03 i	0.503 ± 0.06 e	0.220 ± 0.04 f
	silkworm pupa	0.665 ± 0.02 b	0.715 ± 0.03 a	0.430 ± 0.01 bcd
Nangtui ×Nangsew	silkworm	0.305 ± 0.05 h	0.588 ± 0.04 cde	0.377 ± 0.07 cdef
	silkworm pupa	0.513 ± 0.02 cde	0.715 ± 0.05 a	0.309 ± 0.07 def
Nangnoi Srisaket-1×Samrong	silkworm	0.378 ± 0.06 fgh	0.550 ± 0.08 de	0.380 ± 0.07 cdef
	silkworm pupa	0.590 ± 0.11 bc	0.710 ± 0.07 a	0.417 ± 0.05 cde
Ubon Ratchathani 60-35	silkworm	0.445 ± 0.09 defg	0.600 ± 0.07 bcde	0.235 ± 0.09 f
	silkworm pupa	0.643 ± 0.14 b	0.685 ± 0.06 abc	0.600 ± 0.31 ab
Luang Surin	silkworm	0.475 ± 0.13 cdef	0.700 ± 0.15 ab	0.596 ± 0.03 ab
	silkworm pupa	0.808 ± 0.06 a	0.755 ± 0.05 a	0.555 ± 0.11 abc
J108xNanglai	silkworm	0.338 ± 0.04 gh	0.595 ± 0.05 cde	0.243 ± 0.10 ef
	silkworm pupa	0.405 ± 0.03 efgh	0.708 ± 0.04 a	0.458 ± 0.08 abcd

Remark : Mean comparison along the column by DMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

2.3 Two factors between silkworm variety and silkworm sex

From this study, it was found that male Luang Surin variety had highest antioxidant activity by DPPH and TEAC assay, which were 0.678 and 0.770 mg/ml garlic acid respectively, but TRAP assay, the result found that female Luang Surin variety had highest antioxidant activity which was 0.639 mg/ml garlic acid. (Table 8)

Table 8. Interaction between silkworm variety and silkworm sex on their antioxidant activity.

variety	sex	antioxidant activities (mg/ml garlic acid)		
		DDPH assay	TEAC assay	TRAP assay
Nangnoi Srisaket-1	male	0.458 ± 0.03 abc	0.683 ± 0.06 ab	0.604 ± 0.15 ab
	female	0.553 ± 0.11 abc	0.705 ± 0.04 ab	0.482 ± 0.06 abcde
Samrong	male	0.423 ± 0.28 abc	0.578 ± 0.14 b	0.311 ± 0.04 def
	female	0.423 ± 0.0.28 abc	0.640 ± 0.11 ab	0.340 ± 0.11 def
Nangtui ×Nangsew	male	0.393 ± 0.13 bc	0.675 ± 0.06 ab	0.283 ± 0.04 ef
	female	0.425 ± 0.11 abc	0.628 ± 0.10 ab	0.403 ± 0.04 bcdef
Nangnoi Srisaket-1 ×Samrong	male	0.525 ± 0.18 abc	0.578 ± 0.10 b	0.407 ± 0.04 bcdef
	female	0.443 ± 0.09 abc	0.683 ± 0.10 ab	0.390 ± 0.08 cdef
Ubon Ratchathani 60-35	male	0.445 ± 0.10 abc	0.610 ± 0.09 b	0.591 ± 0.33 abc

	female	**0.633 ± 0.15 ^{ab}**	**0.675 ± 0.06 ^{ab}**	**0.244 ± 0.10 ^{f}**
Luang Surin	**male**	**0.678 ± 0.11 ^{a}**	**0.770 ± 0.07 ^{a}**	**0.512 ± 0.06 ^{abcd}**
	female	**0.605 ± 0.28 ^{abc}**	**0.685 ± 0.13 ^{ab}**	**0.639 ± 0.01 ^{a}**
J108xNanglai	**male**	**0.345 ± 0.05 ^{c}**	**0.643 ± 0.10 ^{ab}**	**0.343 ± 0.21 ^{def}**
	female	**0.398 ± 0.04 ^{bc}**	**0.660 ± 0.05 ^{ab}**	**0.358 ± 0.04 ^{def}**

Remark : Mean comparison along the column by DMRT test, the different letter had statistical significant different (($p \leq 0.05$).

ns = non-significant in statistical different.

2.4 Two factors between silkworm stage and silkworm sex

Considering to factor between silkworm stage and silkworm sex.The result showed that both of sexes had highest antioxidant activity with significant differentiation ($p \leq 0.05$) by DPPH and TEAC assay (Table 9). In addition, it had 0.378- 0.484 mg/ml garlic acid antioxidant activity without significant differentiation *($p>0.05$)* by TRAP assay.

Table 9. Interaction between silkworm stages and silk sex on their antioxidant activity.

stage	**sex**	**Antioxidant activities (mg/ml garlic acid)**		
		DDPH assay	**TEAC assay**	**TRAP assay ns.**
silkworm	**male**	**0.368 ± 0.13 ^{b}**	**0.604 ±0.13 ^{b}**	**0.388 ± 0.20**
	female	**0.367 ± 0.10 ^{b}**	**0.616 ± 0.07 ^{b}**	**0.378 ± 0.16**
silkworm pupa	**male**	**0.568 ± 0.13 ^{a}**	**0.691 ± 0.05 ^{a}**	**0.484 ± 0.19**
	female	**0.626 ± 0.14 ^{a}**	**0.720 ± 0.05 ^{a}**	**0.437 ± 0.10**

Remark : Mean comparison along the column by DMRT test, the different letter had statistical significant different ($p \leq 0.05$).

ns = non-significant in statistical different.

2.5 Three factors between silkworm variety, silkworm stage and silkworm sex

Considering to factor between silkworm variety, silkworm stage and silkworm sex.The result showed that male and female Luang Surin silkworm pupa variety had highest antioxidant activity than the others with significant differentiation ($p \leq 0.05$) by DPPH assay, which were 0.770 mg/ml garlic acid and 0.845 mg/ml garlic acid respectively. While, female Nangnoi Srisaket-1 silkworm pupa had 0.760 mg/ml garlic acid. Furthermore, it was found that both sex of Luang Surin silkworm pupa variety had highest antioxidant activity than the others with significant differentiation ($p \leq 0.05$) which were 0.820 and 0.790 mg/ml garlic acid respectively, by TEAC assay. Nangnoi Srisaket-1 female silkworm pupa had 0.765 mg/ml garlic acid. Whereas, determination by TRAP assay, the result showed that Luang Surin female silkworm pupa had highest antioxidant activity with significant differentiation ($p \leq 0.05$) which was 0.873 mg/ml garlic acid. Nangnoi Srisaket-1 male silkworm pupa and Luang Surin male silkworm pupa antioxidant activities were 0.735 and 0.653 mg/ml garlic acid respectively. (Table. 10)

It could be seen that Nangnoi Srisaket-1 and Luang Surin varieties had highest antioxidant activities, while silkworm pupa showed higher antioxidant activities than mature silkworm in each variety. Furthermore, both male and female gave the same level of antioxidant activities with having no significant differentiation.

Table 10. Interaction between silkworm variety silkworm stage and silkworm sex on their antioxidant activities.

variety	**stage**	**sex**	**Antioxidant activities (mg/ml garlic acid)**		
			DDPH assay	**TEAC assay**	**TRAP assay ns.**

NangnoiSrisaket-1	**silkworm**	**male**	**0.445 ± 0.02 efg**	**0.730 ± 0.01 abcde**	**0.473 ± 0.01 e**
		female	**0.460 ± 0.01 efg**	**0.700 ± 0.08 bcdef**	**0.527 ± 0.05 d**
	pupa	**male**	**0.665 ± 0.02 bc**	**0.735 ± 0.01 abcd**	**0.735 ± 0.01 b**
		female	**0.760 ± 0.01 ab**	**0.765 ± 0.03 abc**	**0.437 ± 0.01 ef**
Samrong	**silkworm**	**male**	**0.470 ± 0.04 ef**	**0.630 ± 0.01 defghij**	**0.194 ± 0.04 l**
		female	**0.645 ± 0.03 c**	**0.675 ± 0.01 cdefg**	**0.246 ± 0.00 k**
	pupa	**male**	**0.180 ± 0.04 i**	**0.455 ± 0.01 l**	**0.427 ± 0.02 efg**
		female	**0.180 ± 0.01 i**	**0.550 ± 0.06 jklm**	**0.433 ± 0.01 ef**
Nangtui ×Nangsew	**silkworm**	**male**	**0.285 ± 0.08 h**	**0.700 ± 0.04 bdef**	**0.317 ± 0.01 j**
		female	**0.325 ± 0.01 h**	**0.730 ± 0.01 abcde**	**0.437 ± 0.00 ef**
	pupa	**male**	**0.500 ± 0.03 de**	**0.620 ± 0.01 efghij**	**0.248 ± 0.01 k**
		female	**0.525 ± 0.02 de**	**0.555 ± 0.03 ijkl**	**0.369 ± 0.02 hi**
NangnoiSrisaket1× Samrong	**silkworm**	**male**	**0.380 ± 0.09 feh**	**0.500 ± 0.08 kl**	**0.433 ± 0.02 ef**
		female	**0.375 ± 0.06 fgh**	**0.600 ± 0.03 fghijk**	**0.327 ± 0.03 ij**
	pupa	**male**	**0.670 ± 0.08 bc**	**0.655 ± 0.03 cdefghi**	**0.381 ± 0.04 gh**
		female	**0.510 ± 0.03 de**	**0.735 ± 0.05 abcd**	**0.453 ± 0.02 e**
Ubon Ratchathani 60-35	**silkworm**	**male**	**0.385 ± 0.09 fgh**	**0.540 ± 0.01 jkl**	**0.310 ± 0.04 j**
		female	**0.375 ± 0.06 fgh**	**0.660 ± 0.04 cdefghi**	**0.160 ± 0.02 l**
	pupa	**male**	**0.670 ± 0.08 bc**	**0.680 ± 0.07 bcdefg**	**0.327 ± 0.01 ij**
		female	**0.510 ± 0.03 de**	**0.690 ± 0.09 bcdef**	**0.567 ± 0.01 d**
Luang Surin	**silkworm**	**male**	**0.585 ± 0.01 cd**	**0.720 ± 0.06 abcde**	**0.625 ± 0.01 c**
		female	**0.365 ± 0.08 fgh**	**0.580 ± 0.06 ghilk**	**0.457 ± 0.01 e**
	pupa	**male**	**0.770 ± 0.01 a**	**0.820 ± 0.06 a**	**0.653 ± 0.01 c**
		female	**0.845 ± 0.06 a**	**0.790 ± 0.01 ab**	**0.873 ± 0.01 a**
J108xNanglai	**silkworm**	**male**	**0.315 ± 0.06 h**	**0.560 ± 0.04 hijkl**	**0.158 ± 0.02 l**
		female	**0.360 ± 0.00 gh**	**0.630 ± 0.04 defghij**	**0.327 ± 0.03 ij**

pupa	**male**	**0.375 ± 0.01** **fgh**	**0.725 ± 0.05** **abcde**	**0.527 ± 0.01** **d**
	female	**0.435 ± 0.01** **efg**	**0.690 ± 0.03** **bcdef**	**0.389 ± 0.02** **fgh**

Remark : Mean comparison along the column by DMRT test, the different letter had statistical significant different (($p \leq 0.05$).

ns = non-significant in statistical different.

CONCLUSION

From this study it could be concluded that all Thai silkworm varieties, 2 silkworm stages and 2 silkworm sexes had similar basic chemical compositions without significant differentiation but the silkworm had higher protein than silkworm pupa. However, silkworm pupa had higher fat and carbohydrate include fiber than silkworm. Nangnoi Srisaket-1 and Luang Surin variety had highest antioxidant activities. Silkworm pupa had higher antioxidant activities than silkworm. Both sexes of silkworm pupa had similar antioxidant activities. Therefore, the high potential of silkworm pupa for further healthy products were both male and female of Luang Surin and Nangnoi Srisaket-1 varieties.

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EFFECT OF THAI SILKWORM PUPA EXTRACT ON ACTIVATION OF VASODILATION

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ABSTRACT: This research was aimed to study on the activation and mechanism of vasodilation of Thai silkworm pupa extract obtained from two different solvent layers. Both male and female pupae of two silkworm varieties as Nangnoi Srisaket-1 and Luang Surin were studied. Silkworm pupa was extracted using ethanol and water, then each sample was evaporated, dried by freeze dryer and crushed into small powder. Silkworm pupa powder was analysed for Cytotoxicity on blood vessels cell using MTT {3- (4,5-dimethylthiazol-2-yl)-2,5-diphenyl-tetrazolium} bromide assay. It was found that maximum concentration of Nangnoi Srisaket-1 and Luang Surin extracted powder samples from ethanol layer which 90% of cells could survive were at 60 and 410 µg/ml respectively, while extracted powder from water layer were at 2200 and 125 µg/ml respectively. Ability of extracted powder on blood vessel cells to produce nitric oxide comparing to standard solution, Sildenafil (Viagra®), using Griess's method of extracted powder from ethanol layer from Nangnoi Srisaket-1 and Luang Surin were high activity which were 101.57% and 102.55% respectively, while extracted powder from water layer had lower activity which were 80.83% and 79.23%, respectively. In addition, mechanism of nitric oxide production in blood vessels by extracted powder from both layers comparing to standard solution had also been studied. Endothelial nitric oxide synthase (eNOS) mechanism was positive effect on health by controlling blood circulation. Extracted powder of Nangnoi Srisaket-1 from ethanol and water layers had stimulated eNOS gene expression for 2.7 and 2.6 times respectively, related to β-Actin which were slightly lower than standard solution (3.1times), while extract from both layers of Luang Surin had lower level. Another mechanism was inducible nitric oxide synthase (iNOS) mechanism which was negative effect on health by causing inflammation of cells. Extracted powder from ethanol and water layers had stimulated iNOS gene expression for 1.1 and 1.2 times respectively, related to β-Actin which were higher than standard solution (0.65 time),

while extract from both layers of Luang Surin were at least 4 times higher than standard solution. In summary, extract of Nangnoi Srisaket-1 pupa from ethanol layer was the most effective on activation of vasodilation which also provided beneficial effect on health and had high potential to produce as a functional food.

Keywords : Silkworm pupa , Nitric oxide , Sildenafil, Vasodilation

INTRODUCTION

Silkworm pupa is rich in nutrients such as protein, amino acids, lipids, vitamins and many types of minerals, for example, potassium, sodium, calcium and magnesium (Sukritanon *et al.*, 2003). In addition, it also contains bioactivity compounds, for instance, antioxidant activity compound which can protects nerve cells from toxic of beta amyloid and glutamate (Meetali *et al.*, 2014), compound which enhances learning skill and protects memory loss from Alzheimer's disease and reduce risk of brain damage due to stroke (Kaewruang, 2011 and Kongpa *et al.*, 2012). Researchers reported that silkworm pupa can reduce Erectile dysfunction induced by alcohol and increase activity of nitric oxide synthase which produces nitric oxide. Nitric oxide can effect on vasodilation which cause penile erection and also reduce atherosclerotic plaque (Ahn *et al*., 2008). Machanism of nitric oxide production of artery vessel can divide into 2 types. Firstly, endothelial nitric oxide synthase (eNOS), which is a unique mechanism only found in blood vessel cell wall, provides positive effect on health and involves in nitric oxide production related to penile erection. Another mechanism is inducible nitric oxide synthase (iNOS) which have negative effect on health involving in nitric oxide production inflammation of blood vessel. As a result, extract which could benefit to recover erectile dysfunction should significantly increase in gene expression of eNOS and insignificantly increase in gene expression of iNOS.

At present, there are few researches on activation and mechanism of vasodilation. Previous study on chemical composition and antioxidant activity of silkworm and silkworm pupa has shown that both sexes of Nangnoi Srisaket-1 and Luang Surin silkworm pupae had high antioxidant activity. Therefore, this research focuses on activation and mechanism of vasodilation of those two silkworm pupa varieties.

MATERIALS AND METHODS

Materials

1. Both sexes of Nangnoi Srisaket-1 and Luang Surin silkworm pupae after spinning cocoon 6 days
2. 3- (4, 5-dimethylthiazol-2-yl) – 2, 5-diphenyl-tetrazolium bromide (MTT) solution
3. Dimethyl sulfoxide (DMSO)
4. Sildenafil (Viagra®) standard solution
5. 80 % ethanol
6. Distilled water
7. Cells (Ea.hy 926)
8. RNA NeucleoSpin® RNA II Kit
9. cDNA RevertAid™ First Strand cDNA synthesis kit
10. ABI Fast 7500 System
11. UV-VIS Spectrophotometer
12. Grinder
13. Centrifuge
14. Rotary evaporator
15. Freeze dryer

Methods

1. Preparation of silkworm pupa extract

Both male and female silkworm pupae, Nangnoi Srisaket-1 and Luang Surin varieties obtained from Queen Sirikit Sericulture Centre, Chiang Mai province which had been stored at -18° C were thawed at room temperature. This method has been applied from Maaike *et al*. (2009). Ethanol and water were used as solvents for silkworm pupa extraction. First, 80% ethanol was mixed at ratio 1:2 by weight. The mixture was blended and centrifuged at 3000 rpm.

for 5 minutes. Residue from the first extraction was extracted again, totally 3 times. Liquid from ethanol layer was kept for further process. Then, solvent had changed to distilled water and repeat process again as ethanol. Liquid from ethanol and distilled water layer was dehydrated by rotary evaporator, dried by freeze dryer and grinded as powder.

2. Cytotoxicity test on blood vessel cells

MTT {3-(4,5-dimethylthiazol-2-yl) -2, 5- diphenyl-tetrazolium bromide} assay was used to test cytotoxicity of blood vessel cells by measuring 90% of viable cells. Two species silkworm extracted powder from both layers were prepared as solution at 0.3-5,000 µg/ml by 2-fold dilution, then added into microwell plate which contained of red blood cells at the concentration at $1x10^4$ (Ea.hy 926). The plate was incubated at 37° C for 24 hours. Culture media was removed from the plate, then MTT reagent was added and the plate was incubated at 37° C for 4 hours. *Dimethyl sulfoxide* (DMSO) was added to activate the reaction of colour production. The solution was measured the absorbance at 540 nm (OD_{540}) which will be further calculated for percentage of viable cell according to below equation (Buapool *et al.*, 2013). The most concentration of extract from each layer that can provide 90% of red blood cell was selected.

$$\% \text{ cell viability} = \frac{OD\,(sample) - OD\,(control)}{OD\,(Max) - OD\,(control)} \times 100$$

3. Ability of silkworm pupa extract on activation of nitric oxide production

Griess's Method was used for evaluation of ability of silkworm pupa extract on activation of nitric oxide production. Solution was dropped into concentration at $5x10^5$ cell/vial and added the extract (Ea.hy 926). Then the plate was incubated at 37°C for 24 hours and mixed with Griess reagent until the colour changed. The solution was measured the absorbance at 540 nm (OD_{540}) (Nims *et al.*, 1996) and calculated as percentage of the amount of nitrite by comparing to standard graph of nitrite from standard solution, Sildenafil (Viagra®).

4. Study on mechanism of nitric oxide production in artery vessel cell wall

Quantitative real-time polymerase chain reaction (qRT-PCR) was used for quantity analysis of mechanism of nitric oxide production whether extract that added to cell could increase gene (Ea.hy 926). Nitric Oxide Synthase has two patterns which are endothelial nitric oxide synthase (eNOS) and Inducible nitric oxide synthase (iNOS). Cell concentration at $2x10^5$ was cultured in 6-well plate until reaching 80% confluence of cells. Adding culture medium which had no growth factor into microwell plate, incubated for at least 12 hours and added the studied cell. Concentration of standard substrate for toxic testing compared with standard solution (Sildenafil) 25 micromolar. After adding testing substance for 24 hours, cell would be digested for RNA extraction by RNA

NeucleoSpin® RNA II Kit. When concentration of RNA had been calculated, cDNA was synthesized from RNA by cDNA RevertAid^{TM} First Strand cDNA synthesis kit. Then cDNA was mixed with primer that specified to eNOS and iNOS using β-Actin as controller gene. The process was continued using ABI Fast 7500 and calculate by $2^{-\Delta CT}$. Extract that could benefit on erectile dysfunction should have high impact on gene expression of eNOS and less impact on gene expression of iNOS.

Finally, selected the extract from layer, which had potential activation of vasodilation in term of positive effect on health.

Duration	October 2014 – September 2015
Location	Queen Sirikit Sericulture Centre (Chiang Mai)
	Faculty of Agro-Industry, Chiang Mai University
	Faculty of Medicine, Chiang Mai University

RESULTS AND DISCUSSION

1. Productivity of silkworm pupa extract from ethanol and distilled water layer

Silkworm pupae extract of two varieties from ethanol and distilled water layer were dried and ground, then evaluated the productivity. There was not significantly different between productivity from ethanol layer of Nangnoi Srisaket-1 and Luang Surin varieties ($p \leq 0.05$), 2.80%

and 2.48% respectively. According to table 1, distilled water layer of Nangnoi Srisaket-1 varieties had significantly higher than Luang Surin varieties which were 7.26% and 5.30% respectively ($p \leq 0.05$).

Table 1. Production yield of extracted powder from 2 varieties of silkworm pupae

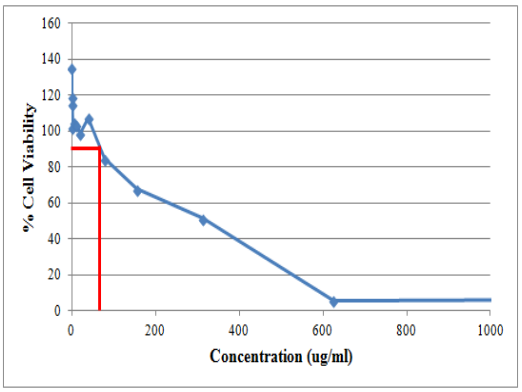
Solvent	Silkworm pupa extract yield (%)	
	Nangnoi Srisaket-1	Luang Surin
Ethanol $^{ns.}$	2.80 ±0.11	2.48 ±0.18
Water	7.26^{a} ±0.14	5.30^{b} ±0.09

Remark: **Means** followed by the same letters are not significantly different at $p \leq 0.05$ with t-test
ns: non-significant

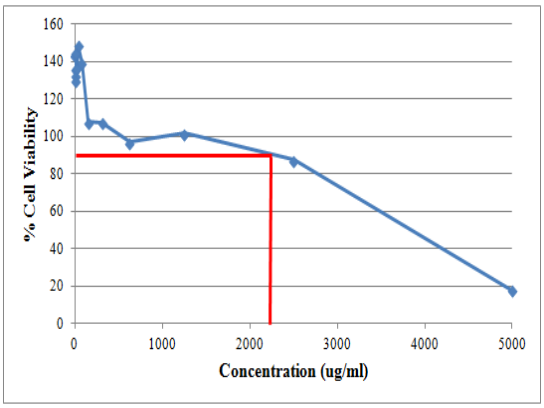
2. Cytotoxicity test on artery wall cells

The result showed that silkworm pupa extract from ethanol layer concentrated at 60 µg/ml and 410 µg/ml of Nangnoi Srisaket-1 and Luang Surin varieties were the maximum concentrations that cells still be survived at 90%. Another layer from distilled water, the maximum concentrations were at 2200 µg/ml and 125 µg/ml, respectively (Fig.1).

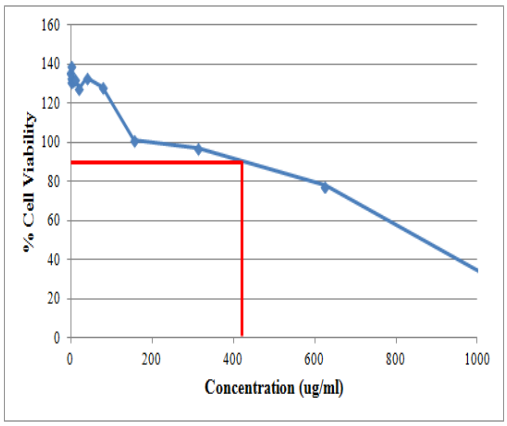
A. Nangnoi Srisaket-1 (ethanol layer)



B. Nangnoi Srisaket-1 (water layer)



C. Luang Surin (ethanol layer)



D. Luang Surin (water layer)

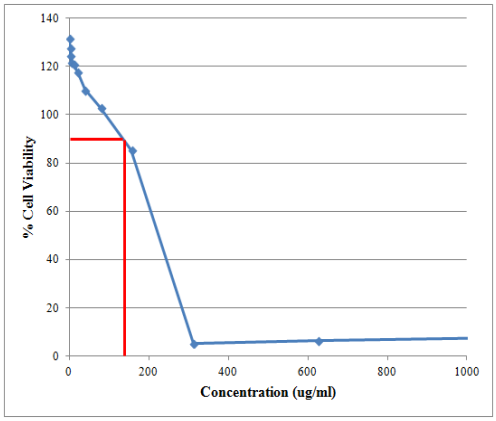


Figure 1: Effect of silkworm pupa extract by ethanol and water to cell viability (at 90%)

3. Ability of silkworm pupa extract to activation of nitric oxide production

Extract obtained from ethanol layer of Luang Surin varieties had the highest ability to activate nitric oxide production at 102.55%. The second is the extract from ethanol layer of Nangnoi Srisaket-1 varieties at 101.57%. The extract of both silkworm pupa varieties from water layer had similar level which were 80.83% and 79.30% (Table 2). According to the ability to activate nitric oxide production by mucuna, it can induce 82.40% of standard solution (Duangnin *et al*., 2015). It could be seen that extract from ethanol layer of both varieties had less activation to produce nitric oxide than standard solution or sildenafil which has been widely used in medical area.

Table 2. Activation of nitric oxide production by silkworm pupa extract compared to standard solution

Varieties	Layer	Concentration of extract (µg/ml)	Concentration of nitric oxide (µg/ml)	Nitric oxide compared to Sildenafil, (%)
Nangnoi Srisaket-1	Ethanol	60	2.083	101.57±6.06
	Distilled water	2200	1.793	80.83 ±7.18
Luang Surin	Ethanol	410	2.083	102.55 ±6.92
	Distilled water	125	1.752	79.30 ±3.83
Standard solution (Sildenafil)			2.041	100.00

4. Machanism of activation nitric oxide production

There were 2 mechanisms of activation nitric oxide production, eNOS (endothelial nitric oxide synthase) and iNOS (Inducible nitric oxide synthase). For eNOS mechanism, Standard solution(Sildenafil) could induce gene expression higher than control for 3.1 times related to β-Actin (Table 3). Extract of Nangnoi Srisaket-1 silkworm pupae from both layers could produce nitric oxide which were 2.7 and 2.6 times related to β-Actin. Luang Surin had lower activation than Nangnoi Srisaket-1 which were 1.8 and 2.2 times related to β-Actin, recpectively. For iNOS mechanism, Sildenafil could induce gene expression to be 0.65 time related to β-Actin. Extract of Nangnoi Srisaket-1 from ethanol and water layer were higher than standard solution which were 1.1 and 1.2 times related to β-Actin, respectively. Luang Surin species had at least 4 times higher than standard solution which were 3.4 and 2.6 times related to β-Actin, respectively (Table 3).

Mechanism of nitric oxide production, in term of eNOS, means that having high level of eNOS could benefit to health due to controlling the circulation of blood system. For iNOS, it needs low level because high level can activate the immune system which can cause inflammation of muscle (Todaa *et al*., 2005).

Extract of Nangnoi Srisaket-1 silkworm pupa from both layers had more ability to activate vasodilation than Luang Surin species and also produced nitric oxide which was advantage to health. Consequently, Nangnoi Srisaket-1 silkworm pupa had potential to utilize as dietary supplementary products.

Table 3. Mechanism of activation nitric oxide production by silkworm pupa extract

Species	Layer	Concentration (µg/ml)	eNOS (Related to β-Actin)	iNOS (Related to β-Actin)
Nangnoi Srisaket-1	Ethanol	60	2.7	1.1
	Distilled water	2200	2.6	1.2
Luang Surin	Ethanol	410	1.8	3.4
	Distilled water	125	2.2	2.6
Standard solution (Sildenafil)			3.1	0.65

CONCLUSION

Both varieties of silkworm pupae, Nangnoi Srisaket-1 and Luang Surin, which were extracted bioactivity compounds by ethanol, had half productivity compared to extract by distilled water. The extract in form of powder by ethanol of both varieties provided positive activation on nitric oxide production more than standard solution (Sildenafil), while extracted powder from distilled water layer provided lower activation. Mechanism of vasodilation of extract from both layers of Nangnoi Srisaket-1 could activate nitric oxide production which

benefits to health similar to Sildenafil. Therefore, the finding indicated that both sexes of Nangnoi Srisaket-1 silkworm pupae had potential to utilize as dietary supplementary food products.

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THE NORTH-WEST REGION OF AZERBAIJAN SERICULTURE INDUSTRY DEVELOPMENT CONCEPTION

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Abstract: Azerbaijan's north-western region has a unique place and role of the silk. The country is located on the "Great Silk Way" – it is caused the formation and development of this industry especially in Sheki, and encouraged the development of trade and economic relations with other countries.

The formation of economic relations of Azerbaijan as an independent state, the basic principles of market economy taking interstate economic relations, land privatization, new approaches to solving the issues related to the development of sericulture became necessary. However, the objective and subjective reasons, it did not have the desired level of attention to this area. As a result, a significant decline occurred in this area. ~ 5921 tons of cocoons produced in 1982, when the figure to 57 tons in 2000, while in 2014 it dropped to ~ 10 tons in Azerbaijan. Sheki Silk factory (Sheki Silk Company) did not give the result of the measures taken to restore the activity and now this factory experiencing a period of stagnation.

The concept is important in economic terms, gave an opportunity for the mass of people to work, national and international experience in the cultural art of silk and new advanced technologies through the use of innovative approaches based on the development of sericulture.

Keywords: objectives of conception, silk industry and human resources, modernization of silk industry, international cooperation, implementation of conception

INTRODUCTION

The north-western region of Azerbaijan is located in the favourable geographical position, 6 districts incorporate in this region, and share 15 percent of the country's economy. It is characterized as an agricultural region, the country's main agricultural and livestock products manufacturer, developing a wide range of production of fruit, vegetable, tea, honey, tobacco, sericulture, poultry, grains.

There are natural and biological resources in the region for the developing of these areas - reserves of fertile and productive soil, groundwater and surface water resources, forests and plant reserves.

Azerbaijan's north-western region has a unique place and role of the silk. The country is located on the "Great Silk Way" – it is caused the formation and development of this industry especially in Sheki, and encouraged the development of trade and economic relations with other countries.

At the beginning, the entrepreneurs have engaged silkworm breeding in private factories and workshops in Sheki (Nukha), but it was limited work. Later this precious Sheki silk products reputation spread in the country and abroad, the demand for these products started to rise. The silk industry has its highest stage of development in XVIII-XIX centuries in Sheki and 9-10 thousand tons of fresh cocoons were produced every year during the same period. Silk products were exported mainly to Russia, and European countries. In particular, Sheki silk products distinguished by their quality, highly valued in foreign markets.

The first Silk Factory has been built in 1829, in Nukha (Sheki) and since 1830 was produced silk fabric. During the Soviet period, Sheki-Zagatala region plays an important role in socio-economic and cultural life and taking into account the development of the silk industry, the Silk Factory was established in Sheki which its capacity was in third in the former Soviet Union. The factory was a manufacturer of silk products and produced the qualitative production. The production of silk products have distinguished qualitative, and exported to all republics and most

regions of the USSR.

Sericulture production has began to develop in 60-70-years of XX century and produced~ 7800 tons of fresh cocoons in Azerbaijan.

The formation of economic relations of Azerbaijan as an independent state, the basic principles of market economy taking interstate economic relations, land privatization, new approaches to solving the issues related to the development of sericulture became necessary. However, the object-tive and subjective reasons, it did not have the desired level of attention to this area. As a result, a significant decline occurred in this area. ~ 5921 tons of cocoons produced in 1982, when the figure to 57 tons in 2000, while in 2014 it dropped to ~ 10 tons in Azerbaijan. Sheki Silk factory (Sheki Silk Company) did not give the result of the measures taken to restore the activity and now this factory experiencing a period of stagnation.

The concept is important in economic terms, gave an opportunity for the mass of people to work, national and international experience in the cultural art of silk and new advanced technologies through the use of innovative approaches based on the development of sericulture.

2 . THE MAIN OBJECTIVES OF CONCEPTION

2.1. The main objectives of the conception are the following:

2.1.1. Sheki Regional Scientific Center of the National Academy of Sciences has the status of a legal entity engaged in the cultivation of mulberry silkworm seed the creation of modern place kumxana (barn for silkworm breeding);

2.1.2. The adoption of long-term state program for the development of sericulture in the country;

2.1.3. To equip the mulberry silkworm seed-producing plants with the most modern equipment, and provide high-quality seeds of the species;

2.1.4. To make use of different kinds of achieved and patented high yielding mulberry silkworm silk getting from Ganja Regional Scientific Center and the Sheki Regional Scientific Center Institute for this purpose;

2.1.5. To organize the mulberry plantations in order to use of qualitative and high-yielding varieties of forage;

2.1.6. Giving subsidies to farmers and entrepreneurs that engaged in this area, low-interest, long-term loans, tax breaks and other incentives;

2.1.7. Cocoon production and silk industry in the acquisition and application of modern techniques and technology used in the maintenance and support of the state;

2.1.8. To manage basing on modern technologies, communication systems and the creation of kumxanas;

2.1.9. The organization of the relevant professions, training of staff on silk;

2.1.10. Measures for the protection of the internal market;

2.1.11. Directing the relevant research institutions and organizations, Institutions of National Academy of Sciences in the field of sericulture technology research and application of research results;

2.1.12. To study the international practices and results and expansion of innovation in line with application of silk;

2.1.13. To meet the international standards of competitive, high-quality assistance and to monitor the organization of silk production, controlling this area and expand the scope of scientific research;

2.1.14. Product cocoon production was five (5) thousand tons, 10 thousand tons a year in the future and to take measures to meet the demand for raw materials cocoon silk industry;

2.1.15. Silkworm mulberry cultivation and cocoon by applying artificial stimulation of the production of the product, and creation "Agropark" s in republic.

3. DEVELOPMENT OF SILK INDUSTRY AND HUMAN RESOURSES

Presented conception of the North-Western region of Azerbaijan makes efficient use of natural and biological resources, mulberry silkworm cultivation through modern farming

methods and technologies, cocoon and silk production based on innovative technologies, given the importance of human resources, identifies the following trends:

3.1. Preparation of professionals highly skilled in the use of intensive methods for the creation and cultivation of mulberry trees;

3.2. Preparation of professionals for being ready creative activity to control agro-technical care of mulberry gardens, pest and disease;

3.3. Preparation of creative thinking specialists of silkworm seed area;

3.4.Preparation of professionals for identifying mulberry silkworm diseases and the medicines used against them and carry out the activities of instructions;

3.5. Preparation of specialists of mulberry silkworm incubation and growth of the agro technical service;

3.6. Preparation of specialists for using artificial feed on mulberry silkworm and feeding instructions;

3.7. Preparation of competent professionals in the field of sex selection and application of modern equipment and sorting cocoon, calibration;

3.8. Preparation of competent professionals in the field of opening of the cocoon stalk, determine its technological performance;

3.9. Preparation of competent professionals in the field of various products of silk thread, including Sheki, "Brand" of woman head coverings "kelegayi" and other production;

3.10. Organizing the educational and awareness among the people for the developing of the silk industry in the country.

4. MODERNIZATION OF SILK INDUSTRY

4.1. The following measures must be implemented for the modernization of the silk industry:

4.1.1. Use of modern methods and technologies in the area of silk growing, organizing silkworm breeding through the use of artificial feeding of mulberry;

4.1.2. To ensure production of high-quality seeds for cultivation with the use of modern equipment production;

4.1.3. Creating of modern kumxanas for Mulberry silkworm breeding, production intensification, the removal of the partial use of hand labor;

4.1.4. Collection of Cocoon production, sorting, silk thread, using the handle to open the process of improving the quality of modern equipment;

4.1.5. Organizing high-quality, competitive, market demand, in line with international standards of silk production.

5. INTERNATIONAL COOPERATION

5.1. Given the importance of international cooperation, the following measures should be taken to facilitate the exchange of experiences:

5.1.1. Using artificial fodder and make use of local lines and species applying mulberry silkworm breeding species from abroad and advanced technologies currently available in the silk world;

5.1.2. Ensuring to get the exchange experiences of the Sheki Regional Scientific Center (SRSC) silkworm breeding specialists from specialization courses abroad;

5.1.3. Bringing the feed and mulberry silkworm breeds from the outside to SRSC for researching in the Department of Sericulture;

5.1.4. To study he ability of species introduced, the use of artificial feeding of all ages during the process, to watch the feeding process to evaluate all the positive and negative mark the end product, determine the cocoon’s technical, biological and technological parameters;

5.1.5. Preparing of the appropriate methodology and recommendations for artificial feeding silkworm cultivation. To investigate the composition of the artificial feed;

5.1.6. Selection work towards Species have been introduced to the local line and a new line between the sexes more productive and resistant to local conditions and species.

6. IMPLEMENTATION OF THIS CONCEPTION

6.1. The main condition for the effective implementation of the concept is the creation of a mechanism that can provide the cost-effective performance.

6.2. In addition to the implementation of the concept of state bodies, local self-governing bodies, farmers and entrepreneurs, stipulates that local people involved in this process, along with the provision of the state budget to attract foreign and local investors, involves the use of alternative financing mechanisms

6.3. The following are key measures of production diversification of funding sources:

6.3.1. Invertarisation of state budget funds allocated to this area, analysis, evaluation, as well as the costs and types of targeted use of funds allocated by the state orders a wider application and strengthening of control.

6.3.2. Alternative sources of finance (budget funds and other funding sources not prohibited by law)

6.4. Concept implementation is carried out by the National Academy of Sciences and the Ministry of Agriculture, Ministry of Industry and Economy of the Azerbaijan Republic.

The ministries carries out and take control of getting artificial feed and acquisition of modern equipment and organizing production in the Republic of Azerbaijan.

BACSA 8th Executive committee meeting proposals:

Dr. Maria Ichim, Romania: BACSA should focus its activities in promotion of organic sericulture, which has a bright future.

Dr Yusif Shukurlu, Azerbaijan:

1. Before organizing each international meeting BACSA should contact the official state authorities in the hosting country respective, like Ministry of agriculture or so.
2. Its already time to create a scientific journal of moriculture, sericulture and cocoon processing, all together. Among the BACSA members there are many scientists, technical staff etc. This capacity gives the opportunity to establish a serious editorial board, editor in chief and responsible body. The title of this journal could be "Moriculture and sericulture". The journal should have the necessary chapters like physic-chemical, biological, technological, entomological and other chapters respective. The papers should be edited accordingly and the publishing must be paid by the authors or their institutions.

Prof. Dr. Sanginjon Salimdjonov, Tajikistan: After each BACSA international conference and Executive committee meeting a declaration should be accepted in order the national coordinators will further be able to inform their governments about the necessary measures in sericulture development.

Prof. Dr. Elgudja Shapakidze, Georgia:

1. BACSA should stress its activities especially in sericulture revival and development in the Ex – Soviet union countries, because the sericulture in those countries, especially in Georgia is in a deep crisis in nowadays.
2. In the next BACSA conferences programmes, the problems of innovative technologies and technical means adoption in the whole sericulture value chain, starting from mulberry, through silkworm rearing and up to silk reeling may be included.
3. A possible organizing of the next BACSA conference in 2019 in Georgia may be very beneficial for the sericulture development in this country.
4. In the sericulture revival and development the silk quality is of a crucial importance, thus the adoption of modern technologies and silkworm and mulberry genetical improvement will play a vital role in this process.

Dr. Vasilii Bogoslovskii, Russia: Proposed enhancement of BACSA sericulture promotional role by sending official letters to each member country government about the sericulture importance and need for development. Establishment by BACSA an international scientific journal in sericulture with its possible further inclusion in the international databases (Web of Science, Scopus etc.).

Prof. Jiping Liu, China: Now is already time to re-consider the sericulture products, especially silk clothing so that to become more fashionable and attractive for the customers, especially the young generation.