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An Innovative Method of Storing Live Cocoons and its Impact on the Quality and Technological Indicators of Live Cocoons

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Abstract. This article presents the results of scientific research in the field of development of invasiv technology for storing live silkworm cocoons grown by re-feeding in the worm water of the Uzbek Researc Institute of Natural Fibers. As well as the results of research to determine the impact of innovative technolog for storing live cocoons on the qualitative and technological indicators of live cocoons. Determination qualitative and quantitative indicators live cocoons were produced with honey of a single unwinding on laboratory machine for single unwinding of cocoons of the LC system of the UzNIISHP system in th laboratory conditions of the accredited testing laboratory of UzNIINV. After each season of re-feeding, liv cocoons were unwound on the LC laboratory machine and the technological parameters of live cocoons we determined. Live cocoons removed from cocoons were stored on special refrigeration units at temperatures +2, +4 and +8 ° C and after 10, 20 and 30 days of storage, the technological parameters of live cocoons we determined.

Key words. Silkworm, live cocoons, primary processing, storage, low temperature, caliber, technolog cocooning, unwinding, raw silk.

Silkworm cocoons are a seasonal product and are produced in numerous wormholes in relatively small batches. For subsequent processing, they are concentrated in large batches at procurement points and in the bases of primary processing of cocoons (BPOK). To provide cocoon winding factories with raw materials for year-round work, it is necessary to protect the cocoon shells from damage by butterflies, i.e. it is necessary to preserve the cocoons, preventing the pupae from developing into butterflies. To do this, you need to either store the cocoons in conditions that exclude the process of turning pupae into butterflies (storage in the cold), or kill the pupae in cocoons. Currently, in industrial conditions, the most common method is pickling by simultaneous drying on cocoon dryers of various types. All operations related to the primary sorting, pickling and drying of cocoons are called the process of primary *processing of cocoons* [1]. There are many known methods of cocoon caricature, such as pestilence, suffocation (sealing), steam followed by drying, sunlight, vacuum, high-frequency currents (HDTV), radioactive radiation, hot air, cold (sublimation), etc. All of the above methods have not received widespread industrial application. Currently, the method of carcasing and drying cocoons with hot air is widely used. The drying process is to remove moisture from the raw material. In a living cocoon Moisture is in free, hygroscopic and bound states. A characteristic feature of a living cocoon is the uneven quantitative distribution of moisture in its constituent parts: the main part of the moisture is in a free state, the moisture contained in the shell is mainly in a hygroscopic and bound state. When drying cocoons, it is necessary to remove only the free moisture of the pupa, and it is not recommended to remove hygroscopic moisture in the amount of 7.0-10.0%, so as not to dehydrate the silk shell.

In a living cocoon, inequality is true at every single moment:

$$W_o < W_v < W_к \quad (1)$$

где: W_o – влажность оболочки коконов;

W_{in} is the humidity of the cocoon air gap;

W_{to} is the humidity of the pupa.

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A cocoon can be considered dried when the following equation is satisfied: $W_o = W_{in} = W_{to}$ (2)

To ensure the maximum yield of raw silk, it is necessary that the drying of the pupa is not accompanied and does not lead to dehydration of the shell, i.e. the following equality is satisfied:

$W_o = W_к = 0$ (3)

where: W_{to} is the current humidity of the cocoon shell;

W_o is the initial moisture content of the shell of the living cocoon before drying.

This is possible if all the moisture evaporated from the shell is completely compensated by the moisture it receives from the pupa, or if the cocoons are dried with air with sufficiently high humidity [2]. . These conditions should be taken into account when creating drying units for drying cocoons. After drying, the air-dry cocoons are stored packed in rhubarb bags, stacked in critical warehouses in stacks. For each stellage, 2 bags are laid in depth along the length, 12 bags along the length of the stellage, and up to 9 rows in height. Long-term storage of cocoons in such storage conditions significantly worsens the technological and quality indicators of cocoons. Therefore, in different years, different methods of storing cocoons were proposed, but these methods did not find industrial application.

Methods

Different methods are used to perform specific research tasks. The removal of live cocoons is carried out according to the methods of existing standards [3], the division of qualitative, technological and quantitative indicators is used by the method of single unwinding on laboratory machines LC [4], other qualitative indicators are determined according to the methods of current standards or otherregulations.

Results And Discussion

In recent years, inthe Republic of Uzbekistan, repeated feeding of silkworms has been tested in industrial scales [5,6], which opens up additionalopportunities for storing live cocoons. The introduction of reusable feeding of silkworms on an industrial scale opens up prospects for year-round unwinding of live cocoons, which ensures the high quality of the raw silk produced. In some leading silk-processing countries, for example, in China, up to 10 times repeated feedings are produced. In our republic in Nauchno - The Research Institute of Sericulture (NIISH) and UzNIINV have been conducting research on re-feeding for several years. Based on many years of experience of re-feeding, UzNIINV has developed and tested a new method of storing live cocoons using refrigeration units. This method of storing cocoons makes it possible to unwind live cocoons for a long time. It is known thatthe quality indicators of raw silk from living cocoons are higher than raw silk from dry cocoons. At the institute, silkworm worms are fed up to 5 times according to the agricultural technology developed by the institute [7,8], starting in spring and ending in late autumn. Good results have been obtained in all feeding seasons . According to the developed technology, cocoons are stored in a refrigeration unit, while different storage modes have been studied, the effects of low temperature have been studied (from +2 to $+8^0$C) on the mass and silkinessof live cocoons. Storage of live cocoons in low positive temperatures in a sense inhibits the process of transformation of the pupa into butterflies, i.e. will increase the period of diapause of the cocoon pupa [9]. Under normal conditions, the process of diapause in silkworm cocoon pupaewill last up to 30-32 days from the beginning of curling of cocoons. If during this period does not produce the primary processing of live cocoons, the pupae turn into butterflies and destroy the shell of the cocoons, thereby turning varietal cocoons into defective ones. A new innovative method allows you to increase the shelf life of live cocoons to 6.0-6.5 months, which means that it is possible to organize year-round unwinding of live cocoons, thereby improving the quality of raw silk, reducing the specific consumption of cocoons. Table 1 presents the results of studies on the effect of low positive storage temperature of live cocoons in a refrigeration unit in terms of shelf life on the masses of live cocoons.

Table 1. Effects of low air temperature and shelf life on the masses of live cocoons when stored in a refrigeration unit

Cocoons	Начал-ная	Average weight of live cocoons by shelf life, g		
		After 10 days, it is	After 20 days, it is	After 30 days, it is

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	мас-са коко-нов г	stored.			stored.			stored.		
		Air temperature when storing cocoons in a refrigeration unit								
		+2°C	+4°C	+8°C	+2°C	+4°C	+8°C	+2°C	+4°C	+8°C
I выкормки	1,505	1,375	1,354	1,386	1,330	1,326	1,358	1,250	1,310	1,300
II выкормки	1,498	1,360	1,355	1,369	1,325	1,330	1,348	1,245	1,320	1,295
III выкормки	1,460	1,330	1,340	1,341	1,295	1,300	1,323	1,290	1,270	1,300
IV выкормки	1,500	1,362	1,360	1,330	1,341	1,321	1,310	1,320	1,300	1,285
V выкормки.	1,517	1,380	1,380	1,348	1,335	1,315	1,300	1,315	1,298	1,295

Analysis of the results of the studies given in Table. 1 shows that the storage of cocoons in special refrigeration units does not have a significant change in theMASSU of live cocons, which can be seen from the study diogramsshown in Fig.1. As can be seen from the data in Table. 1, with the best good results obtained when storing cocoons at an air temperature of + 4 ° C. If the initial average weight of live cocoons before storage was 1.505 g, then after 10 days it was 1.354 g, and after 20 days 1.326 g, after 30 days 1.310 g., i.e. shrinkage of live cocoons after 30 days of storage is 12.96%.

From the analysis of the results of the study, it can be concluded that those minor changes in the mass of cocoons are due to the coloring of the moisture of the pupa. This also proves that the storage of live cocoons in special refrigeration units will not have a negative impact on the environment and ecology [10].

Simultaneously with the determination of the mass of live cocoons after storing them in a special refrigeration unit, the silkiness of live cocoons was also determinedaccording to the current methods. To determine the silkiness of a batch of cocoons, a sample of 250 g is taken, first the total mass of the cocoons of the sample is measured, then all cocoons of the sample are cut off and the cocoon shells are announced with an accuracy of 0.1 g. After the announcement of the shells of the samples, the sh elkonost is determined Cocoons in % pabout the formula:

$$Ш = \frac{m_0}{m_k} 100 \qquad (4)$$

where: m_0*- mass of cocoon shell, g;* m_k *– weight of cocoons, g.*

Table 2 presents the results of studies to determine the silkiness of live cocoons, depending on the shelf life and air temperature when stored in a special refrigeration unit.

Table 2. Effects of low air temperature and shelf life on the silkiness of live cocoons when stored in a special refrigeration unit

Cocoons	Initial shelfof cocoons, %	Average silkiness of live cocoons by shelf life, %								
		After 10 days, it is stored.			After 20 days, it is stored.			After 30 days, it is stored.		
		Air temperature during storage in the refrigeration unit								
		+2°C	+4°C	+8°C	+2°C	+4°C	+8°C	+2°C	+4°C	+8°C
I выкормки	21,90	22,95	23,50	22,80	23,25	23,75	23,05	23,65	23,95	23,32
II выкормки	21,05	22,60	22,95	22,10	22,85	23,15	22,40	23,05	23,55	22,85
III выкормки	20,80	22,20	22,75	22,30	22,45	22,90	22,55	22,65	23,05	22,80
IV выкормки	21,25	22,70	23,10	22,50	22,90	23,30	22,70	23,20	23,55	23,05
V выкормки.	21,30	22,80	23,35	22,75	23,05	23,55	23,00	23,25	23,75	23,20

Analysis of the research results given in Table 2 shows that with an increase in the shelf life of live cocoons at low temperatures, the silkiness of cocoons also increases. For example, the silkiness of live cocoons after 10 days of storage at an air temperature of + 4 ° C increased by 7%, then after 30 days of storage it increased by 9% compared to the initial silkiness of cocoons. The main reason for this is that during the storage of cocoons, the mass of the pupa decreases due to shrinkage, i.e. the mass of cocoons decreases. It is known that the silkiness of cocoons is determined by the detachment of the mass of the cocoon shell to the mass of cocoons. From the data given in Table No. 2, it can be seen that the silkiness of cocoons mainly increases in the first 10 days of storage, since in this storage interval there is an intensive decrease in the mass of cocoons. These conclusions are confirmed by the diograms of the dependence of the

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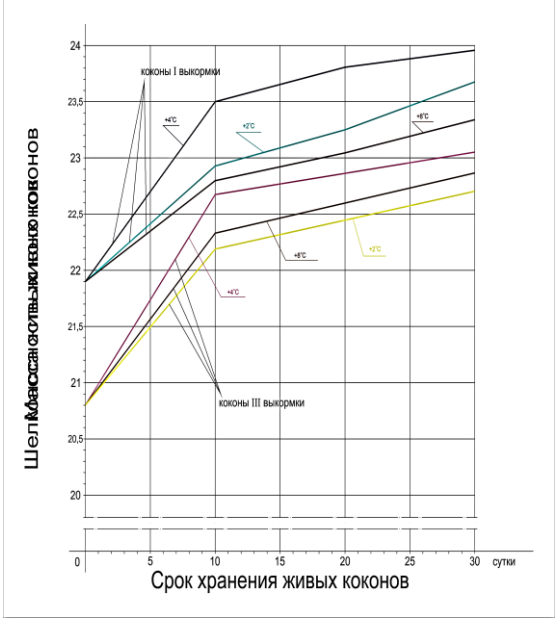
silkiness of living cocoons on the shelf life and air temperature when stored in special refrigeration units, shown in Fig.2.



Rice. 1. A gram ofchanges in the mass of live cocoons depending on the period and temperature of storage (for example, cocoons I and III of re-feeding)

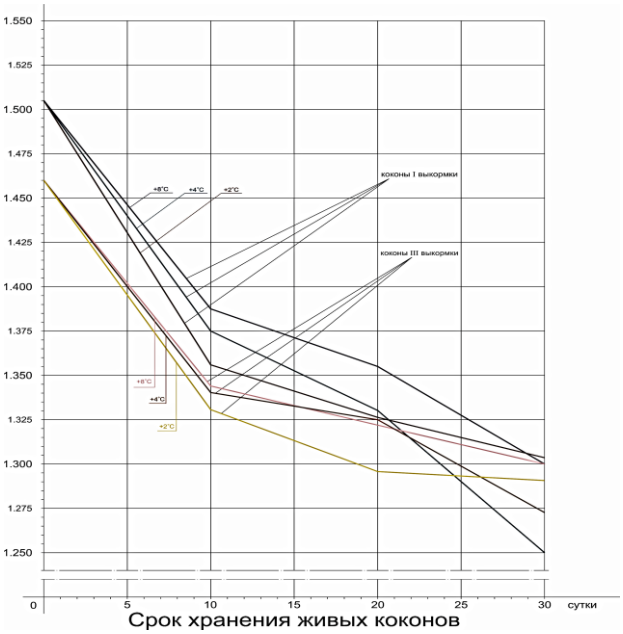


Fig.2. Diagram of the dependence of the silkiness of living cocoons on the shelf life and air temperature when storing them in special refrigeration units (for example, cocoons I and III of re-feeding)

At the testing laboratory, in addition to the silkiness and weight of cocoons, the following indicators are determined: thickness, power, density, porosity, friability, rigidity, air permeability, absorbency, capillarity of the cocoon shell. These indicators are determined either by measurement on special devices, or by calculation [4].

In addition, thelaboratory machines for single unwinding of the LC of the UzNIISHP system by the method of single unwinding determined the technological parameters of live cocoons according to the seasons of re-feeding, depending on the storage temperature of the cocoons. Table 3 shows the results of tests of technological indicators of live cocoons grown by re-feeding in the spring, summer and autumn seasons of feeding by single unwinding.

Tablitz 3. Technological indicators of live cocoons grown byre-feeding in the spring, summer and autumn feeding seasons.

Tempera of the Tour	Mass of cocoons, *G*	Shelko nostno st ,%	Linear distance, *tex*	The length is continuously-times. to horse thread *m*	The total length of the cocoon thread, *m*	Floss %	Cocoon string. Sdira %	Obol. odonki, %	Total silk prod., %	Roman Witch, %	Specific consumption cocoon., *kg/kg*
Live cocoons grown in the first spring feeding from the gren hybrid Ipakchi 2											
+2°C	1,378	23,65	0,275	835,0	965,0	19,75	2,05	1,75	23,55	1,76	5,05
+4°C	1,372	23,95	0,260	875,0	950,0	23,2	1,95	1,55	26,7	1,50	4,30

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						5			5		
+8°C	1,375	23,32	0,255	825,0	960,0	20,80	2,15	1,85	24,80	1,78	4,80
Live cocoons grown in I I spring feeding from the Ipakchi 2 hybrid											
+2°C	1,365	23,05	0,270	825,0	960,0	19,45	2,00	1,70	23,15	1,50	5,14
+4°C	1,360	23,55	0,265	860,0	945,0	23,05	1,70	1,60	26,35	1,46	4,34
+8°C	1,357	22,85	0,275	820,0	965,0	21,10	2,05	1,55	24,60	1,67	4,74
Live cocoons grown in III summerfeeding from the Ipakchi 2 hybrid											
+2°C	1,350	22,65	0,275	775,0	910,0	18,34	1,70	1,50	21,54	1,64	5,45
+4°C	1,340	23,05	0,265	825,0	925,0	18,51	1,35	1,25	21,11	1,30	5,40
+8°C	1,355	22,80	0,270	785,0	950,0	17,69	1,40	1,30	20,39	1,70	5,65
Live cocoons grown in the IV autumn feeding from the gren hybrid Ipakchi 2											
+2°C	1,367	23,20	0,270	820,0	965,0	18,55	2,05	1,70	22,85	1,45	5,39
+4°C	1,360	23,55	0,265	845,0,	965,0	19,08	1,75	1,45	22,28	1,30	5,24
+8°C	1,355	23,05	0,280	785,0	955,0	18,42	1,95	1,65	22,02	1,50	5,43
Live cocoons grown in the V autumn feeding from the gren hybrid Ipakchi 2											
+2°C	1,385	23,25	0,270	835,0	965,0	19,05	2,05	1,75	22,85	1,60	5,25
+4°C	1,370	23,75	0,260	865,0	950,0	20,40	1,95	1,45	24,15	1,25	4,90
+8°C	1,365	23,20	0,265	815,0	960,0	18,24	2,10	1,80	22,14	1,54	5,48

Analysis of the data given in Table 3 shows that the best results were obtained in the cocoons of the spring and autumn feeding seasons. The worstindicators were obtained in the summer feeding season, since in the summer the weather is very hot, the humidity is minimal and it is very difficult to maintain the temperature and humidity conditions for feeding silkworms. As can be seen from the data in Table 3, the best results were obtained when storing live cocoons at + 4 ° C, so the storage of live cocoons at a temperature of + 4 ° C is considered optimal. As you know, the qualitative and quantitative indicators of raw silk produced from live cocoons are much higher than raw silk produced from dry cocoons. Therefore, the organization of year-round unwinding of live cocoons is a very promising problem of the cocoon-winding industry.

Conclusion

1. In many countries of silkworm cocoon producers, cocoons are grown by re-feeding. In some countries, up to 10 re-feedings are made. Inrecent years, 4 feedings per year have been carried out in the Zbekistan region.
2. The Uzbek Research Institute of Natural Fibers has created a technology for storing live cocoons using refrigeration units at low positive air temperatures. The created technology was tested in the production conditions of the institute , during which optimal storage parameters were developed.

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3. When storing live cocoons, it is recommended to maintain the ambient temperature in refrigeration units within + 4 ° C, which provides the best technological performance of live cocoons during cocooning.
4. The created technology for storing live cocoons and introducing it into production allows year-round unwinding of live cocoons at cocoon-winding enterprises, which ensures high quality of raw silk and reduces the specific consumption of cocoons
5. The created technology for storing live cocoons in refrigeration units and organizing year-round unwinding of live cocoons makes it possible to reduce the most labor-intensive process of natural silk production - the process of primary processing of cocoons. At the same time, a large number of production areas are freed up, the consumption of electricity, heat, etc., is reduced several times.

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