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Finely Silky Silkworm Breeds (Bombyx Mori L.) as Components of New Industrial Hybrids

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Abstract
Natural silk is the most valuable textile raw material of animal origin. It is a product of the isolation of the silk-separating glands of the silkworm (Bombyx mori L.).
The quality of silk fabrics produced by the silk industry from natural silk, characterized by its strength, lightness, beauty, hygroscopicity, largely depends on the natural qualities of the silkworm.
The introduction of breeds with high economic and valuable indicators into production will lead to a significant improvement in the raw material base of Uzbekistan and, as a result, to an improvement in the quality of manufactured fabrics.
In order to improve the productive and textile characteristics of the selected breeds, it is necessary to carry out family feeding of the silkworm with strict selection at all stages of development, including selection by the granularity of the cocoon shell.
It is known that the granularity of the silk shell is correlated with a number of economically valuable signs of the silkworm. Therefore, cocoons with the largest number of tubercles per 1 cm2 of the shell were selected for the tribe.
Selection within three years by the grain size of the cocoon shell of the silkworm led to a thinning of the cocoon thread in Chinese-108 – up to 3800 units, in Ya-120 - up to 3900 units.

Keywords: silkworm, gren, caterpillar, cocoon, silk thread tonin, grain size, selection, line.

Introduction

The silkworm is one of the biological objects that is fed on a production scale only in a hybrid combination. Hybridization is carried out in order to use heterosis – a unique biological phenomenon. Silkworms have long sought to use heterosis, which is observed

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in a number of signs in hybrids.

The initiator of the silkworm breeding in the form of simple and complex hybrids is Academician B.L.Astaurov, he developed the basic principles of hybridization, methods of testing hybrids [1].

The creation of high-yielding hybrids of the silkworm were developed by leading silkworm breeders country: String bass V. A. [13], Safonova A. M. [12], Yakubov A. B. [17;], Larkina E. A.[11].

Quality problems silk thread worked: Trinh Ngoc LAN [15], Tagieva Z., [14], Pashkina T., [11] and others.

From their research, it becomes clear that the productivity and quality of the cocoon thread largely depend on the breed and conditions of keeping and feeding the caterpillars.

Meanwhile, the world collection of silkworm breeds has been created and maintained at the Scientific Research Institute of Sericulture (NIISH) since its organization (1927) [5].

The main indicators of the breeds subjected to ranking are taken from the Catalog "Genetic Fund of the world collection of the silkworm of Uzbekistan" [5].

After ranking, [7], i.e. determining the occupied places of collection breeds by the main biological and technological characteristics of silk thread and selecting the best breeds, it is necessary to carry out breeding work in order to improve their economically valuable properties, as indicated in their works by V.A. Strunnikov [13], B.U. Nasirillaev [8]. In order to improve the productive and textile characteristics of the selected breeds, it is necessary to carry out family feeding of the silkworm with strict selection at all stages of development, including selection by the granularity of the cocoon shell.

Nasirillaev B.U. studied this [9]. For example, cocoons with coarse grain are unwound worse and the resulting cocoon thread is characterized by low metric numbers. And, conversely, fine-grained cocoons, as a rule, are characterized by increased unwinding and thin cocoon thread. This was proved by S.S. Lezhenko [6] and U.N. Nasirillaev [8]. Consequently, the selection of breeding cocoons by the grain size of the shell in the selection and breeding processes will increase the technological features important for the silk industry.

In the scientific works of Nasirillaev B.U. [9], Eshkoraeva K.Sh. [16], the possibility of quantifying the granularity of cocoons by the number of tubercles per 1 sq.m. has been experimentally proved.the cm of the shell, calculated using a binocular magnifier MBS-9. The possibility of increasing the content of fine-grained cocoons in breeding populations by systematic individual selection is shown. High positive correlation coefficients between the number of tubercles per 1 cm2 of the shell and the unwinding of cocoons, the yield of raw silk, the length of the continuously unwound cocoon thread, the metric number of the thread indicate the need for the selection of cocoons by grain size at all stages of selection and breeding of the silkworm.

Such breeding work will lead to the improvement of the technological properties of mulberry that interest us, which in itself is already very valuable, and in the future will serve as the basis for the creation of new breeds and hybrids.

From the studies of Larkina E.A. [3], it is known that the hybridization of domestic large-window silkworm lines Line 48 and Line 51 with breeds of other geographical origin with

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a thin cocoon thread Japanese 66 and Chinese 108 leads to an improvement in the quality of the cocoon thread. This means that with a thoughtful selection of components, it is possible to create hybrids with cocoon thread properties that meet the requirements of world standards.

In our project, as component breeds for creating hybrids with high productivity and high-quality cocoon thread, breeds from the collection Chinese 108, Ya-120 are used, characterized by exceptionally fine silk thread, good viability of caterpillars and high silkiness of cocoons.

Materials and Methods

The purpose of this study is to develop silkworm lines with high productive and technological properties of cocoon thread, with their subsequent introduction into production as part of hybrids.

As a material for the study, the breeds contained in the world collection of the silkworm NIISH were used: I-120, K-108.

The Chinese 108 breed was brought from China: gren - light gray, greenish; caterpillars-white without masks and half-moons, cocoons-white, rounded without interception, fine-grained.

The Ya-120 breed was obtained from Japan: gren-light gray, caterpillars-white milk, cocoons-oval, elongated, white, fine-grained.

The Chinese breed 108 and Ya-120 are distinguished by a thin cocoon thread (metric number 5002 and 4500, respectively) [5; pp.4-66].

Incubation and feeding of caterpillars of all lines and breeds was carried out in full accordance with the method of experimental feeding approved for white-window breeds [10; p.3-20],. In accordance with the same methodology, all data obtained as a result of storage and incubation of grain, feeding of caterpillars, papillonage of butterflies, weighing of cocoons were collected and statistically processed.

When feeding all the breeds and lines used in the project, the method of selection by motor activity was also used [2; pp.51-54]. According to the method of selection for motor activity when working with breeds, the most mobile individuals are selected for feeding at the moment of the caterpillars' revival, and the most mobile and active males are selected at the moment of the butterflies' cocoons.

According to the "Basic methodological provisions of breeding work with the silkworm" [10; p.3-20] in the process of breeding new lines with improved silk thread quality, samples of cocoons of each family were analyzed according to the grain size of the silk shells.

For breeding lines from selected breeds, 10-12 families with fine grain cocoons are left for the tribe. The cocoons are numbered, then a paper template with an opening of 1 cm2 is applied to each cocoon. Using a magnifying glass, the number of tubercles per 1 cm2 of the shell is calculated. According to the indicators of 10 cocoons (5 ♀ and 5 ♂), the average number of tubercles per 1 cm2 of the cocoon of the family is determined. Those families that have the largest number of tubercles are selected for the tribe. Crosses are carried out between selected families.

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Results

According to the totality of economically valuable characteristics, the Ya-120 and Chinese 108 breeds were selected for work.

The reproductive indicators of the studied breeds are shown in Table 1.

Table I - Reproductive indicators and egg vivacity of the studied breeds by year.

№№	Breeds	Years	The number of normal eggs, pcs		Weight of normal eggs, mg		Weight of the 1st egg, mg		Egg Revival, %	
			$\overline{X} \pm S_{\overline{x}}$	C_v	$\overline{X} \pm S_{\overline{x}}$	C_v	$\overline{X} \pm S_{\overline{x}}$	C_v	$\overline{X} \pm S_{\overline{x}}$	C_v
1	Ya-120	2021	574±8,7	10,0	288±4,7	15,2	0,502±0,003	5,0	96,0±0,4	2,0
		2022	616±10,9	9,4	300±7,0	10,1	0,486±0,005	6,0	94,6±0,5	2,8
		2023	679±9,1	7,2	358±5,0	8,7	0,527±0,004	4,0	96,3±0,3	1,5
2	K-108	2021	529±6,7	16,7	276±4,0	2,4	0,522±0,003	4,3	96,1±0,3	2,0
		2022	663±8,4	8,6	367±6,2	17,0	0,562±0,004	6,6	96,0±0,4	2,6
		2023	655±7,3	6,5	340±5,0	10,1	0,519±0,003	5,0	96,2±0,3	19
	Ip-1 (к)	Ср.	620±6,7	8,0	330±5,7	12,8	0,516±0,003	7,8	95,0±0,4	2,0

Table 1 shows that the reproductive indicators of the breeds were different in different years. In general, there is a tendency to increase the main characteristics of the grain.

The Ya-120 breed demonstrates an increase in the number of normal eggs in the clutch from year to year. A slight decrease in the number of grains in the K-108 breed in 2023 can be explained by minor seasonal fluctuations in the conditions of detention.

It can be argued that selective selection based on reproductive characteristics for 3 years led to a noticeable increase in the size of the clutch of the studied breeds. For example, the number of eggs in clutches Ya-120 increased from 574 pieces to 679 pieces, Chinese-108 - 0.529 to 655 pieces (Table.1), the mass of normal eggs in the clutch increased in Ya-120 from 288 to 358 g, in K-108, 276 to 340 g, (Table 1).

The livability of eggs of the studied breeds, although slightly changed over the years, however, remained at a high level - from 96.3% to 97.5% (Table 1). The immutability of such an indicator as the revival of the gren indicates the genetic stability of the breeds according to this characteristic.

During 2021, 2022, 2023, 18-20 families of each breed with the highest percentage of gren revival and the maximum number of eggs in the clutch were selected for feeding.

Biological indicators of breeding lines of the studied breeds by year are given in Table 2.

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Table II. Biological indicators and coefficients of variation of the studied breeds by year

№№ пп	Breeds	Years	Viability of caterpillars, %		Cocoon weight, g		Shell weight, mg		Silkiness, %	
			$\overline{X} \pm S_{\overline{x}}$	C_v	$\overline{X} \pm S_{\overline{x}}$	C_v	$\overline{X} \pm S_{\overline{x}}$	C_v	$\overline{X} \pm S_{\overline{x}}$	C_v
1	Ya-120	2021	77,6±2,1	9,6	1,67±0,02	5,1	416±4,9	4,8	21,8±0,2	5,0
		2022	91,7±1,1	5,3	1,87±0,03	6,2	450±6,4	6,5	24,1±0,2	4,7
		2023	92,2±1,0	4,7	1,52±0,62	5,0	346±5,2	5,0	22,6±0,2	3,8
2	K-108	2021	91,3±1,0	5,0	1,67±0,02	6,2	405±6,1	7,5	24,3±0,2	3,6
		2022	92,4±1,8	9,8	1,96±0,02	5,5	445±6,2	6,9	22,7±0,2	3,5
		2023	93,2±1,1	7,9	1,68±0,02	5,3	382±5,2	6,0	22,7±0,2	3,1
	Ip-1 (к)	Ср.	89,0±1,2	7,9	1,80±0,02	5,9	405±6,1	6,2	22,5±0,2	3,0

As can be seen from Table 2, the viability of caterpillars of all breeds of the project for 3 years of research was quite high - 77.6-93.2% and changed little over the years. The spread of the coefficients of variation - 4.7-9.8 indicates the dependence of this feature on external influences and once again indicates the need to strictly observe the agrothermal regime of feeding.

In 2023, due to the announcement of quarantine regarding the coronavirus pandemic, feeding was started 1 month later than usual. In this regard, the quality of the feed was reduced, which inevitably affected the biological indicators of the breeds. The mass of the cocoon and the mass of the shell of the studied rocks in 2023 were lower than in previous years and lower than in the control. For example, the mass of the cocoon in Ya-120-1.52g, in Chinese-108-1.67g, the mass of the shell in Ya-120-346mg, in K-108-405mg.

During the feeding, 10-12 families with the best indicators of caterpillar viability and cocoon silkiness were selected from 18-20 families of each breed. From each selected family, 30-40 cocoons with the correct shape and fine grain were visually selected. All selected cocoons were individually weighed. Cocoons with the best silkiness were left for the tribe.

In just 3 years of research, 2,970 cocoons were individually analyzed. Of these, 1,850 cocoons were allowed to produce breeding grain, i.e. 62.3%. This intensity of selection led to an improvement in the productive indicators of the studied breeds.

To study the textile properties of the studied rocks, a technological analysis of their cocoon threads was carried out. The data is shown in Table 3.

Attention is drawn to the fact that the rocks reacted to the selection by the granularity of the cocoon shell by thinning the cocoon thread. For example, the metric number in K-108 has grown from 3205 units to 3933 units, in the breed I-120 from 3247 units to 4016 units.

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Table III. Technological properties of the cocoon thread of the studied rocks by year

№№	Name of the material	Years	Weight of the 1st dry cocoon g	Output of silk products, %	Metric thread number, m	DNRKN, m	Total length of the thread, m
11	K-108	2021	0,750	49,60	3205	1191	1191
		2022	0,856	45,09	3289	1166	1166
		2023	0,728	49,34	3933	992	992
22	Ya-120	2021	0,681	51,06	4016	1383	1383
		2022	0,933	45,00	3597	704	1454
		2023	0,574	49,35	3846	1021	1108
3	Ip-1 (к)		0,700	48,06	3350	1000	1000

All 3 years of research, as can be seen from Table 4, families with the largest number of tubercles per 1 cm2 (Ya-120 - from 110 to 120, K-108 - from 113 to 120) were used to breed fine-shelled lines of rocks Ya-120 and K-108. The selection of the finest-grained cocoons for breeding crosses made the cocoon thread of the Ya-120 and K-108 breeds thinner (Tables 3).

Table 4 shows the intensity of selection by the number of tubercles per 1 cm2 in the rocks Ya-120, K-108 for 3 years.

Table IV. The number of tubercles per 1 cm2 in the nurtured and breeding families of the K-108 and Y-120 breeds by years.

№№	Breeds	Years	Number of families and repetitions, pcs			Number of tubercles per 1 cm2, pcs.		
			total	selected	selection	in the feeding. families	in selected. families	S
11	Я-120	2021	23	14	60,9	78	110	32
		2022	25	14	70,0	80	111	31
		2023	23	12	52,2	86	120	34
22 2	K-108	2021	27	14	51,9	98	113	15
		2022	27	14	58,3	98	113	15
		2023	25	13	25.0	100	120	20

Ya-120 and K-108 have a large number of tubercles per 1 cm2 than the cocoons of the zoned breed Ipakchi 1 (control) and, consequently, a thinner thread.

Conclusion

Selection within three years by the grain size of the cocoon shell of the silkworm led to a thinning of the cocoon thread in Chinese-108 – up to 3800 units, in Ya-120 - up to 3900 units.

The combination of traditional selective selection and selection by motor activity led to an increase in the number of eggs laid in Ya-120 – from 574 to 679, in Chinese-108 - from 529 to 655, to an improvement in the viability of caterpillars in Ya-120 - from 77.6% to 92.2%, in Chinese-108 - from 82.9% to 91.3%.

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The finely silky breeds Ya-120 and Chinese-108 can be used to create industrial silkworm hybrids of different directions.

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