

# Utilization of Silk Waste and Standard Requirements for their Recycling

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**Received:** 2024, 15, Mar  
**Accepted:** 2025, 21, Apr  
**Published:** 2025, 10, May

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**Annotation:** This scientific paper analyzes the types of silk waste and the standards applied in their recycling process. Adhering to the standards for waste generated in sorting and silk reeling sections helps to improve product quality.

**Keywords:** los, gumbak, defective, ugly, spotted, soft, hole, unraveled, thin-shelled silk, kaznok, control skeins, seriplan reels.

The demand for silk fiber in the global market has been increasing significantly year by year. According to data from the International Silk Association Committee (ISAC), in recent years, more than 153,000 tons of raw silk have been produced worldwide [1]. On a global scale, special attention is being paid to the efficient utilization of raw silk, increasing the use of silk waste fibers as secondary raw materials, improving product quality, expanding product assortments, reducing production costs, and identifying and eliminating factors that negatively affect product quality at all stages of initial processing and reprocessing of silk waste fibers. From this perspective, improving the consumer properties of silk fiber and increasing the competitiveness of silk products in the global market is considered of great importance.

It is well known that in recent years, our country has ranked fourth in the world in silkworm cocoon production, following China (650,000 tons), India (280,000 tons), and Vietnam (50,000 tons), producing over 26,000 tons of silk annually [2]. The process of raising silkworms and obtaining high-quality cocoons is closely connected to the availability and quality of mulberry leaves, which serve as the main feed for silkworms [3]. Therefore, in order to ensure the production of high-quality and abundant silk cocoons in our Republic, a total of 50,193.3

hectares of mulberry plantations have been established. These plantations contain around 80.7 million mulberry saplings (Table 1).

**Table 1. Area of existing mulberry plantations and the amount of fresh cocoons produced during the 2023 silk season in our Republic**

№	Regions	Existing mulberry orchards		Quantity of produced live silkworms, t
		Orchards, h	Single-row mulberry trees, one thousand pieces	
1	Republic of Karakalpakstan	2541,0	3283,2	852,6
2	Andijan	4683,1	5397,6	3303,4
3	Bukhara	5222	13582	3099,71
4	Jizzakh	2192	2350	641,5
5	Kashkadarya	7303,1	3923,5	3082,1
6	Navoi	1444,5	2783	1007,9
7	Namangan	3048,2	6177,7	2727,2
8	Samarkand	8262	10413,5	2829,75
9	Surkhandarya	3434,2	7617,4	1552,7
10	Syrdarya	1551,5	1591,1	616,0
11	Tashkent	3053,7	5719,9	1641,44
12	Fergana	3297	13354,4	2714,94
13	Khorezm	4158	4540,5	2178,36
<b>Total</b>		50193,3	80733,8	26347,6

In our country, there are currently 28 silk-reeling enterprises for full processing of 26,347.6 tons of raw silk produced. In these silk-reeling enterprises, a total of 2,139 tons of raw silk is being processed, mainly in yarns with densities of 2.33 and 3.23 tex.

The existing silk-reeling enterprises in our country are mainly equipped with 80 series of automatic silk-reeling machines and 10 series of mechanical silk-reeling devices manufactured in China (FEIYU-2000 EX, FY-2000 EX, FY-2008, and KMS), South Korea (KSS-RS-100, KMS), Japan (NISSAN), and Uzbekistan (KSM-10, KS-10). The total number of hooks amounts to 32,550 (Table 2) [4].

**Table 2. Silk production enterprises in Uzbekistan**

№	Name of the enterprise	Installed device or machine brand (country of manufacture and year)	Installed series and number of hooks		Type and quantity of products being produced	
			number of series	number of hooks	Raw silk, tex	tons
Republic of Karakalpakstan						
1	“Asian Silk” LLC (Vietnam)	FEIYU 2000 EX (China 2010 y.)	2	800	2,33 and 3,23	50
Andijan region						
2	“Harir Tola” OJSC	FEIYU 2000 EX (China 2010 y.)	1	400	2,33 and 3,23	25
3	“Royal Silk”	KCC-RS-100	4	1600	2,33 and	100

	OJSC	(South Korea, 2000 y.)			3,23	
4	“Sapfir Sanoat”	NISSAN (Japan 1982 y.)	3	90	Row silk	15
5	“Andijan Xonoy Silk” OJSC	FEIYU 2000 EX (China 2010 y.)	2	800	2,33 and 3,23	50
Bukhara region						
6	“Bukhara Brilliant Silk” QK	FY-2008 (China 2010 y.)	8	3200	2,33 and 3,23	150
7	“Romstar” QK	FEIYU 2000 EX (China 2010 y.)	4	1600	2,33 and 3,23	80
		KMS-10 (Uzbekistan 1986 y.)	2	240	2,33 and 3,23	20
8	“Silk Service” OJSC	KS-10 (Uzbekistan 2004 y.)	2	300	2,33 and 3,23	56
9	“Qumushkent Silk” OJSC	KMS (South Korea 2012 y.)	2	300	2,33 and 3,23	50
Jizzakh region						
10	“Bunsan Silk” QK	FEIYU 2000 EX (China 2010 y.)	3	1200	2,33 and 3,23	75
Kashkadarya region						
11	“Radian Silk” QK	FEIYU 2000 EX (China 2013 y.)	4	1600	2,33 and 3,23	120
Navoiy region						
12	“Richard Best Silk” OJSC	FEIYU 2000 EX (China 2012 y.)	2	800	2,33 and 3,23	50
13	“Xatirchi Pilla Xazinasi” XK	FEIYU 2000 EX (China 2012 y.)	1	400	2,33 and 3,23	25
Namangan region						
14	“Golden Silk” LLC	FEIYU 2000 EX (China 2009 y.)	4	1600	2,33 and 3,23	100
15	“Marjona Fayz-Fiber” OJSC	FY 2000 EX (China 2007 y.)	2	800	2,33 and 3,23	50
16	“Veregrov Silk” OJSC	FY 2008 (China 2013 y.)	3	1200	2,33 and 3,23	100
17	“Oydinkul Trade Service” XK	KMS-10 (Uzbekistan 1990 y.)	1	100	Row silk	7
		KS-10 (Uzbekistan 1992 y.)	1	160	Row silk	12
Samarkand region						
18	“Jiloi Malika” XK	KMS (China 2012 y.)	1	400	Row silk	25
19	“Kumush Fiber” XK	FEIYU 2000 EX (China 2012 y.)	1	400	2,33 and 3,23	25
20	“Elbek TRJ”	FEIYU 2000 EX (China 2013 y.)	1	400	2,33 and 3,23	25
Tashkent city						
21	“Great Turan Gold” OJSC	FY-2000 (China 2004 y.)	5	2000	2,33 and 3,23	150
22	“Silver Silk” QK	FEIYU 2000 EX (China 2006-2007 y.)	11	4400	2,33 and 3,23	275

Tashkent region						
2 3	“Ravnaq Silk” QK	FEIYU 2000 (China 2007 y.)	2	800	2,33 and 3,23	50
2 4	“Singapoor- Samarkand” QK	FEIYU 2000 EX (China 2007-2008 y.)	10	4000	2,33 and 3,23	250
Fergana region						
2 5	“Nurli Tong Silk” OJSC	FEIYU 2000 EX (China 2011 y.)	2	800	2,33 and 3,23	65
2 6	“Vodiy Mirjoni” XF	KMS-10 (Uzbekistan 2001 y.)	1	160	Row silk	14
Surkhandarya region						
2 7	“Inter Silk Pro” QK	FEIYU 2000 EX (China 2012 y.)	2	800	2,33 and 3,23	50
Khorezm region						
2 8	“Khorezm Fiber” OJSC	FY-2000 (China 2008 y.)	3	1200	2,33 and 3,23	75

Analysis of the data presented in the above tables shows that, on average, more than 10–12 kg of fresh cocoons are consumed to produce 1 kg of raw silk in our country. In particular, in 2022–2023, the dry cocoon yield coefficient from fresh cocoons was 2.87 kg, which is higher than the standard agrotechnical norm of 2.72 kg. On average, 1,000–1,100 tons of silk fiber waste of 11 types are generated annually in silk-reeling enterprises (Table 3). Of these, 7 types are suitable for spinning into silk yarn, cotton-silk, and wool-silk blended yarns due to their physical-chemical and physical-mechanical properties [5]. The remaining 4 types are not suitable for producing silk or blended yarns using the current production technologies, but are widely used in the production of artificial and synthetic fibers, nonwoven materials and fabrics, silk wadding, paper, surfactants, thermal insulation materials, and other nanotechnology products [6].

Currently, even in countries with a well-developed silk industry, great attention is paid to the production of valuable goods from silk fiber waste, primarily yarn made of pure silk or a mixture of natural and synthetic fibers. These waste fibers are efficiently used as low-cost natural resources to produce various high-value products. Silk fiber waste is also used to make filters for purifying water from motor and vegetable oils, films for biomedical and other applications, membranes for imparting the properties of natural silk to carbon fibers, and other similar products (Table 3).

**Table 3. Some characteristics of silk fiber waste**

Type of silk fiber waste	Descriptions and specific properties			
	Linear density (mg/tex)	Breaking strength (cN)	Elongation at break (%)	Sericin content (%)
Cocoon floss	375-385	6-7	13-14	35-38
String	360-376	7-9	13-15	25-27
Tangled silk	355-370	7-9	14-16	25-27
Silk fragments	233-323	7-9	16-18	20-22
Reeling scraps	233-323	7-9	16-18	20-22
Test bobbins	233-323	7-9	16-18	20-22
1st-grade waste	265-302	5-6	11-13	18-20
Fiber cut from rollers	302-342	7-9	13-15	25-27
Seed cocoons	250-380	6-7	12-15	25-30
Double cocoons	260-400	6-7	13-15	25-30
Unreelable cocoons	232-305	5-6	11-14	25-27

Analysis of the data in Table 3 shows that the characteristics and properties of silk fiber waste are quite similar. Therefore, they can be processed under the same conditions. However, it is necessary to improve the initial treatment technologies and prepare the fibers for spinning. Because for spinning yarn from silk fiber waste, the material must meet technological requirements, especially regarding the residual sericin, oils, waxy substances, and soap content. However, the incoming raw materials (waste) to spinning enterprises often have significantly higher sericin and oil content. Annually, more than 1,000–1,100 tons of 11 types of silk fiber waste are generated in silk-reeling enterprises (Table 3). Of these, 7 types are suitable for spinning due to their physical-chemical and mechanical properties [9]. The remaining 4 types are not compatible with current production equipment and are thus used for manufacturing artificial and synthetic fibers, nonwoven fabrics, silk wadding, paper, surfactants, insulation materials, and other nanotech products [10].

In the sericulture sector and silk-reeling enterprises, a large volume of defective cocoons and silk fiber waste is generated. These waste materials are highly valuable in the national economy because, for every kilogram of raw silk produced, about one kilogram of various waste is also generated. Defective cocoons and silk waste are considered valuable raw materials in spun silk production. Meanwhile, pupae are used as feed for animals and fish, as they contain about 50% protein and 27% fat.

Silk-reeling waste is categorized by its origin: from sorting sections, reeling sections, and quality control units. Waste from the sorting section includes cotton-like floss, defective cocoons, highly stained cocoons, large-sized or smooth-surfaced cocoons, and those with deformities such as hollow, thin-shelled, or double cocoons. Waste from the reeling section includes cocoon floss, reeling residues, unreelable cocoons, silk fragments, and pupae. The quality control unit produces waste such as silk fragments, sample bobbins, and seriplan packages.

**Main part.** Reprocessing the waste generated in sorting sections requires adherence to several standards. Cotton-like floss accounts for 0.3–0.5% of the dry cocoon mass and contains various impurities, including up to 40% sericin. After processing, it is divided into two grades and pressed into bales. The first grade includes clean, uniform-colored floss with no more than 1% impurities. The second grade includes manually or mechanically cleaned floss with mixed colors and up to 3% plant impurities. Sorted floss is pressed into bales not exceeding 40 kg. The yield of defective and double cocoons varies (subject to change) depending on sorting practices.

Name	Value
Double cocoons	1-2
Deformed shape	0,2-0,4
Soft cocoons	1,5-3,0
Spotted (surface spots)	1-2
Internal spots	0,5-1,0
Partially reeled	0,5-1,0
Thin-shelled	0,3-0,6
Pierced	0,1-0,2
Other defective cocoons	0,9-1,8
<b>Total:</b>	<b>6-12</b>

In the cocoon reeling workshop, the cocoon waste (reeling waste) may contain no more than 1% of unusable cocoons, tangled cocoons, and double cocoons in relation to the total waste mass, and no more than 0.5% of condensed knots. The average mass of the initial section of the thread extracted from the cocoon waste must not exceed 1.1 g.

The cocoon waste from automatic reeling appears in two forms:

➤ **Waste wound around the RK machine wheel.** This type is cut off every 1.5–2 hours

during operation, straightened, tied together with a thread, and collected into bundles. This waste may contain up to 2% of unusable cocoons, unreelable cocoons, and double cocoons in relation to the waste mass.

- **Knot-shaped waste.** This is manually loosened and sent to the waste processing section. It may contain up to 2% of unusable cocoons and double cocoons. The moisture content of cocoon waste is around 200%.

In the waste processing section, cocoon waste is washed and squeezed in a centrifuge, cleaned from foreign impurities, dried, sorted by color, and packed into bales. Double cocoons are categorized as either normal (round or oval) or deformed. The normal type is preferable for reeling silk with a linear density of 5 deniers or more, while the deformed type is more suitable for spun silk production.

**Conclusion.** Processing waste in the cocoon industry not only brings economic benefits but also holds great ecological importance. Through recycling, valuable products can be derived from waste, thus reducing environmental pollution. Each type of waste has specific processing requirements. For example, cotton-like waste must go through special cleaning processes to reduce impurities. This type contains sericin, and it can be divided into two grades: the first grade with fewer impurities, and the second grade with more plant-based contaminants. Defective cocoons include double cocoons, deformed, pierced, thin-shelled, or spotted cocoons. Each requires individual cleaning and sorting procedures. Double cocoons, when unusable for reeling, may be processed into feed for animals and fish due to their high protein and fat content. For this purpose, proper feed standards must be followed. In conclusion, adhering to standard requirements for waste recycling in cocoon production enterprises ensures efficient utilization of materials. Proper processing of waste from sorting and reeling departments increases production efficiency and enables the creation of useful products. Understanding the composition of cocoon waste and the specific processing requirements at each stage plays a key role in quality control and improves both environmental and economic performance of production.

## Reference

1. Silk Road Chamber of international committee Zhangjiajie, China From the Secretariat of the ISAC. Cooperation@srcic.com, December 17, 2021
2. G'ulomov A.E., Xabibullaev D.A., Azamatov U.N., Zaripov B.Z. Respublika da mavjud ipakchilik korxonalari va ularda ishlab chiqarilayotgan mahsulotlarning tahlili // J.To'qimachilik muammolari. №1. 2017. –S.35–42.
3. Raximov A. Yu., Sulaymonov Sh. A., Raximov A. A. Ishlab chiqarilgan sun'iy g'umbakdan tut ipak qurti pillasini o'rash jarayonida foydalanish //Jurnal ilmiy nashrlar aspirantlar va doktorantlar uchun. – 2015. – №. 4. – S. 160–161.
4. Alisher R. et al. Study of the Influence of Silkworm Feeding Conditions on the Quality of Cocoons and Properties of the Cocoon Shell //Engineering. – 2019. – T. 11. – №. 11. – C. 755.
5. Raximov A. Yu., Abduraxmonov A. A., Sulaymonov Sh. A. Vata-sdira dan foydalanish holatini o'rganish va kokon xomashyosi sifatini oshirish yo'llari // Jurnal ilmiy nashrlar aspirantlar va doktorantlar uchun. – 2015. – №. 4. – S. 152–157.
6. Abdumanabovich, Sulaymonov Sharifjon, Sativaldiyev Aziz Kaxramanovich, and Sulaymonov Sharifjon. "Theoretical Fundamentals of Cocoon Ball Moistening and its Modification with Surface Active Substances." Design Engineering (2021): 10636-10647.
7. Sulaymonov Sh. A. Tabiiy ipakdagi yuqori armirlovchi kimyoviy komponentlarni o'rganish orqali kimyoviy preparatlar yordamida pillani saqlash usullari // Academic Research in Educational Sciences. – 2021. – T. 2. – №. 12. – S. 407–413.



8. Sulaymonov Sh. Sanoat chiqindilaridan olingan sirt faol moddalarni pillakashlik korxonalariga qo'llash // Academic Research in Educational Sciences. – 2021. – T. 2. – №. 10. – S. 894–900.
9. Raximov A. Yu., Raximov A. A., Sulaymonov Sh. A. Metody ochistki othoda shelkovodstva vaty-sdira. Methods for cleaning waste of silk weaving // Ilmiy konferensiya. – 2020. – S. 135.
10. Raximov A. A. va boshq. Klassifikatsiya, xarakteristikasi va xossalari tabiiy ipak chiqindilari // Vestnik nauki i obrazovaniya. – 2020. – №. 5-1 (83). – S. 16–20.
11. Muhammadovich H. M. et al. The Influence of Harmful Substances on the Pigments of Leaves of Decorative Trees // Annual Research & Review in Biology. – 2019. – C. 1-5.
12. Sulaymonov Sh., Muminov U., Jamoldinov S. X. Izucheniye sostoyaniya ispol'zovaniya vati-sdira i puti povysheniya kachestva kokonnogo syr'ya // Universum: texnik fanlar. – 2019. – №. 7 (64). – S. 17–20.
13. Raximov A. Yu., Sulaymonov Sh. A., Raximov A. A. Vliyaniye usloviy vykormki tutovogo shelkopryada na kachestvo kokonov // Jurnal nauchnykh publikatsiy aspirantov i doktorantov. – 2015. – №. 4. – S. 158–159.
14. Sulaymonov, S. & Kholboeva, S. (2023). oeko-tex® standard 100 textile product safety management system role in product quality assessment according to requirements. International Bulletin of Applied Science and Technology, 3(5), 352–360.
15. Raximov A. Yu., Raximov A. A., Sulaymanov Sh. A. Metody ochistki otkhodov shelkovodstva vati-sdira // Sbornik nauchnykh trudov Mezhdunarodnoy nauchnoy konferentsii, posvyashchennoy 110-letiyu so dnya rozhdeniya professora AG Sevost'yanova. – 2020. – S. 135–137.
16. Sulaymonov S. Ultrasonic cleaning technologi for law temperature cocoon brush to obtain quality raw silk from surfactant modified cocoons //Scientific and technical journal machine building. – 2022.
17. Ismoilova, S. B. (2016). "Ipak ishlab chiqarishda sifat nazorati va texnologik jarayonlarni standartlashtirish." Toshkent Davlat Texnika Universiteti Nashri.
18. Boqiev, A. T. (2017). "Ipakchilikda texnik standartlarni qo'llash va ipak sifatini oshirish." Ipakchilik Ilmiy Tadqiqotlari Jurnali, 34(1), 18-28.
19. Mamadaliyev, R. Y. (2020). "Ipak tolasini ishlab chiqarishning ilmiy asoslari va standartlar muhimligi." O'zbekiston Milliy Universiteti Nashri, 15(3), 43.
20. Qodirov, M. R. (2018). "O'zbekistonda ipak qurti yetishtirish va ipak tolasini ishlab chiqarishda standartlashtirish masalalari." O'zbekiston Qishloq Xo'jaligi Ilmiy Jurnali.