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Research of the technology for obtaining top wool

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Abstract. The article addresses the development of a comprehensive technology of coarse and semi-coarse sheep wool high-level processing that ensures obtaining new kinds of wool product, underwool, various semi-finished products out of it. Research has been made of primary and high-level processing of impure semi and semi-coarse wool: wool sorting, washing, obtaining underwool from wool by dehairing coarse fibers using Oktir carding machinery made in Italy. Research was made at LLP "Wool primary processing factory – Taraz" in the Kazakhstan Republic.

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Keywords: wool, sheep wool, underwool, carding machines, natural fibers, fiber length

Introduction

Sheep wool is the main material of one of the most important industries, wool industry, in Kazakhstan. By its cold-resisting properties, wool is incomparable with any natural fiber [1]. Recycling coarse and semi-coarse sheep wool for manufacturing clothes is impossible, since resulting products are very coarse, the coarse fibers sticking on the surface cause skin irritation, and coarse dead hair is resistant to dye. As a result, these products are not sought-for, and thus, it becomes necessary to increase their competitiveness, which, along with the breeding methods, can be ensured by high-level processing. The most promising areas in processing coarse sheep wool should include obtaining the most valuable products from it in the form of underwool based on dehairing from coarse fibers [2,8].

Methods

Modern technology of sheep wool preparation and processing with removing coarse hairs is as follows [2]:

1. Wool gathering, washing and classifying.
2. Wool processing on dehairing machines.

Fiber fineness, length of wool [3] and comfort factor were measured using an OFDA 4000 [11,12] unit, underwool content was measured using the gravimetric method, quality of carded batting – by counting number of slugs. Yield on the basis on changeovers – by full weighing of the product and waste. [4]

The main part

Carding is the main technological changeover for dehairing coarse wool for the purpose of selecting underwool fibers in the textile industry. The main feature of this machine is a large number of needles in card fillet on numerous working parts that perform carding.

In French spinning for manufacturing top wool, the carding process [5] is used with 1 changeover. In order to increase level of cleaning coarse wool from dead, ordinary and transient fibers, we performed repeated double and triple carding on the same carding machine made by Oktir company.

Carding machine for carding wool, upon selecting optimal parameters, ensuring compliance with technological mode of raw materials preparation (correctshredding and scutching, emulsification and lagging, etc.) ensures sparing conditions for wool fibers [6].

Table 1. Yield of marketable products (underwool) after 3-fold coarse wool carding

Equipment and number of cardings	Weight of wool, kg	Yield			
		main part		waste	
		kg	%	kg	%
"Oktir" (1 run)	1895	1201	63.4	694	36.6
"Oktir" (2 run)	1201	867	72.2	334	27.8
"Oktir" (3 run)	867	750	86.5	117	13.5
Total	1895	750	39.6	1145	60.4

The Oktir carding machine has two drums with diameter 1600 mm that ensure its rather high efficiency of 80-100 kg/hour. When processed on a carding machine, the main part of wool is separated into the underwool product and the waste. By repeated carding of wool main part, the desired level of its clearing from undesired coarse fibers is achieved. The number of wool and its main part clearing operations in the Oktir carding machine was 3.

Yield of the product after 3 carding runs in the Oktir machine is 39.6%, whereas using reference technology, the yield was only 18.9%.

Analysis of the data in Table 1 also shows that with increasing the number of wool and its main part carding runs, the yield of underwool product consistently increases: from 63.4 to 72.2 and up to 86.5%.

With increasing the number of carding runs, content of underwool, compared to original wool, increases from 60.4% to 84.8, 86.3 and 85.3%, respectively, and the proportion of coarse fibers reduced from 39.6% to 15.24, 13.7, and 14.7% [8].

As it can be seen from Table 2, due to these qualitative changes in the morphological composition of the obtained products, its degree of fineness is improved, which is one of the most important technological features of wool products.

Table 2. Fineness and crimp of wool by coarse wool manufacturing processes in a carding machine

Kind of wool (raw material)	Fineness			Crimp, deg./mm
	M, microns	Cv, %	CF, %	
Original wool	30.94	40.80	60.44	46.50
Wool from bin	29.64	42.71	62.30	50.91
Product in the form of underwool obtained after				
1 fiber web	23.51	44.71	85.31	67.21
2 fiber webs	22.66	45.26	86.57	73.67
3 fiber webs	23.08	44.54	85.27	74.54

Thus, the average fineness of the obtained product in the form of underwool after 1, 2 and 3 wool cardings in the Oktir carding machine reduces relative to the original wool from 30.94 microns, respectively, down to 23.51, 22.66 and 23.08 microns, or down to 31.6, 36.5 and 34.1%. With that, wool thinning appears in original wool after wetting and laying into a bin, which may theoretically be due to a partial falling out of fibers in the process of wool shredding on picking and oil-padding lines.

Reducing the average fineness of the obtained product in the form of underwool in course of carding wool in a carding machine is mainly due to the decrease in the diameter of underwool fibers, as shown in Table 3.

So, if during fiber webs the average fineness of transitional, medium and fine ordinary hair changes insignificantly – from 37.01 to 37.67, from 62.80 to 60.77 and from 77.56 to 76.94 microns respectively, then by underwool fibers this change is significant - from 23.41 to 19.69 microns, or 18.9%. This in turn indicates during wool carding, that good wool goes to waste along with coarse and transitional fibers, as compared to coarsened underwool fibers.

Table 3. Fineness of certain types of wool by raw wool manufacturing processes on a carding machine

Kind of wool (raw material)	Average, microns	Including by types of fibers							
		underwool		intermediate hair		thin hair		medium hair	
		M, microns	Cv, %	M, microns	Cv, %	M, microns	Cv, %	M, microns	Cv, %
Original wool	30.94	23.41	19.6	37.01	14.6	62.80	9.6	77.56	1.0
Wool from bin	29.64	22.0	21.9	38.61	14.8	61.94	10.0	77.55	1.9
Product in the form of underwool obtained after									
1 fiber web	23.51	19.99	18.9	39.48	15.2	61.60	9.9	77.6	1.7
2 fiber webs	22.66	19.48	24.9	37.98	16.4	61.76	7.4	78.06	1.6
3 fiber webs	23.08	19.69	24.7	37.67	15.8	60.77	10.6	76.94	1.2

An important indicator of the quality of woolen product intended for the yarn manufacturing is length. Products with fiber length less than 45-50 mm are not suitable for obtaining top wool and, subsequently, worsted spinning yarn, and can only be used for woolen spinning [3].

Underwool products obtained in the process of coarse wool carding in a carding machine were subjected only to a slight shortening, as shown in Figure 1.

Thus, if the length of underwool fibers in a braid of original wool was in the range of 7 cm, then after 1, 2 and 3 cardings it decreased slightly – by 0.5-1 and 1-1.5 cm respectively. As a result, the length of underwool fibers in the raw wool after third carding is 5 cm and more, which makes it possible to use it for top wool production and yarn using worsted spinning system.

Describing the change in the length of wool fibers in the process of carding, it should also be noted that a similar behavior, i.e., slight shortening, is manifested in coarse types of fibers as well – from 15 to 12-13 cm (Figure 2).

This is due to the fact that in a carding machine intended for processing wool fibers of animal origin, beating-off coarse fibers with strike force of work tools is made without their considerable cutting [7].

Wool waste produced during wool processing is mainly represented by coarse fibers and partially shortened underwool, and garblings contained in it.

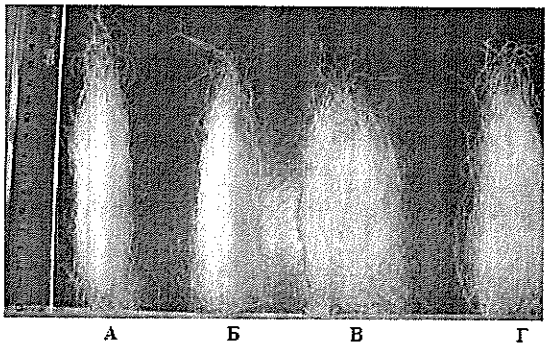
Specific weight of garblings in the waste after the 1st carding was 2.1%, after the 2nd carding – 6.1%, however, after the 3rd carding it was not detected, which fact indicates that it fell out during the first two cardings.

By garblings composition, difference was detected both with regard to the numbers of wool cardings and with regards to the three drums of the carding machine.

А Б В Г

Figure 1 – Underwool fibers in initial coarse wool and in the main part of the product obtained:

А – original wool, processed product in the form of underwool, В – after the 1st carding in the carding machine: С – after the 2nd carding, D - after the 3rd carding.



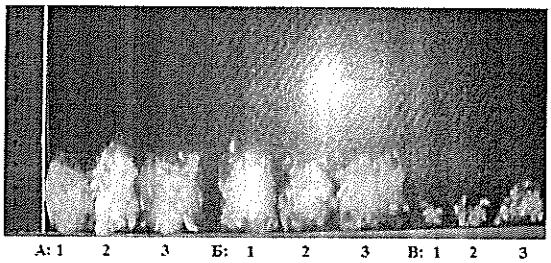
А Б В Г

Figure 2 – Coarse fibers in initial wool and in the main part of the product obtained:

А – original wool, processed product in the form of underwool, В – after the 1st carding in carding machine: С – after the 2nd carding, D - after the 3rd carding.

Thus, in the context of the number of cardings, the biggest quantity of underwool characterized the waste after the third carding – 20.0% versus 15.3% and 10.7% in the waste after the 1st and the 2nd wool cardings. This indicates further inexpedience of the 4th wool carding, because of theoretical manifestations of increased falling out of fine fibers with coarse fibers.

In the context of drums of working tools of the Oktir carding machine [10], the best wool cleaning occurs in the 2nd main drum and results in content of coarse fibers in the waste after the 1st carding in amount of 97.7%, after the 2nd carding – 91,3%, after the 3rd carding – 97.6% vs. 83.3%, 78.7%, and 68.5% in 1st, 66.7%, 79.6% and 73.8% in the second drum, respectively. As a result, in the waste from this drum, the content of underwool is just within 1.1-2.4%.



А: 1 2 3 Б: 1 2 3 В: 1 2 3

Figure 3 – Underwool fibers in the waste from wool processing:

А – from the 1st drum: 1 – 1st carding, 2 – second carding, 3 – 3rd carding;

А – from the 2nd drum: 1 – 1st carding, 2 – second carding, 3 – 3rd carding;

А – from the 3rd drum: 1 – 1st carding, 2 – second carding, 3 – 3rd carding;

Content of underwool fibers in the waste from the 1st drum depending on the number of wool cardings is 15.6 to 31.5%, the 2nd drum – 12.2 to 29.0 and features of the underwool, by volume and length as compared to the underwool from the 3rd drum, can be more clearly traced in Figure 3.

In general, waste falling out in the process of wool processing is made mainly through the drums of work tools, and partly through the card machine tray.

The waste that falls out of machine tray mainly consists of garblings and dust with low content of coarse fiber and underwool.

More valuable for both manufacturing similar products in the form of "construction wool", and using as quilt filler based on the preliminary partial cleaning of crude fibers, is the waste from the 1st and the 2nd drums [9].

Conclusion

Increasing the number of wool cardings improves the "comfort factor" indicator (CF) that shows content of fibers with fineness in the product investigated, which is characteristic for underwool fibers (up to 30 microns) - 60.44 to 85.27 %. Improving of quality is manifested by fiber crimp – 46.5 to 74.54 deg/mm, which indicates the fact that they take a more desirable curly crimp form.

Underwool production cost according to the studied technology is competitive and is ensured by high yield capacity of the equipment made in Italy.

Conclusions

An important economic indicator for the studied technology per 1 kg of produced underwool was 621.25 tenge.

In the world market there is no product in the form of sheep underwool except for experimental batches made in China. Cost of the similar underwool

in the markets of this country, depending on its quality, ranges from 5 to 12 U. S. dollars.

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