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Part III: A Comparison of the Worsted, Semi-Worsted and Woollen Routes for Processing Karakul

by

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PART III: A COMPARISON OF THE WORSTED, SEMI-WORSTED AND WOOLLEN ROUTES FOR PROCESSING KARAKUL

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ABSTRACT

Two commercial types of sorted karakul (a black/brown type, 65-115 mm long and a grey type, 50-75 mm long) were processed into yarns via the worsted, semi-worsted and the woollen route to compare their relative processing performance on these three systems. Based upon mass of scoureds, the woollen route produced the highest sliver yield, followed by the semi-worsted route and the worsted route. The worsted route, however, produced the best slivers and yarns in terms of irregularity, neps and other imperfections. While there was very little difference in tenacity between the worsted and the semi-worsted yarns, the tenacity of the woollen yarns, on the other hand, was about 30% lower. Slivers processed along the semi-worsted route had a lower spinning potential than those processed along the worsted route.

INTRODUCTION

In part II of this series[1], work concerned with the processing behaviour of sorted karakul in five different trade types was described. These included greys and black/browns in various lengths, all essentially free to nearly free. It was shown that by following a worsted route, tops with extremely low residual vegetable fault can be obtained by judicious selection of settings, with mean fibre diameter values, on average, some 3 to 4 μm coarser than those of the raw fibre. Although variability in mean fibre diameter was found to be high for both the raw fibre and the finished top (CV's of 42 to 49%), the variability in mean fibre length (Hauteur) in the top was not much different to typical values found in merino wool tops. Noil values tended to be higher for the shorter grades.

The conversion of karakul to a spinnable product does not necessarily have to be via the worsted route. In fact, in relation to the price of the raw material, it is quite expensive to comb karakul. Alternative or shorter routes would therefore be much more attractive from a cost point of view, particularly if such routes would also be suitable for the more seedy types. Such aspects will be dealt with separately in further papers in this series. The semi-worsted system of processing offers one such an option as far as karakul is concerned[2], while the recent installation of a woollen plant at SAWTRI[3] has provided a further possibility for a study of this nature. In this paper, attempts that have been made to process two types of karakul, on a comparative basis, along a worsted, semi-worsted and woollen route are discussed.

MATERIALS AND METHODS

Raw Materials

Two commercial types of sorted karakul were selected for the processing trials, namely a Type 603 (described as black/brown, 65 to 115 mm, free to nearly free) and a Type 625 (described as a grey, 50 to 75 mm and free to nearly free). After opening, both were core-sampled and tested for mean fibre diameter, wool base and vegetable matter base. The results are given in Table 1.

TABLE 1

RAW FIBRE DATA

PROPERTY			TYPE 603	TYPE 625
Wool Base (%)			54,3	49,9
Estimated Scoured Yield (%)			65,7	60,4
Vegetable Matter (%)			0,65	0,51
Fine Component	By mass (%)		35,2	51,2
	Fibre Diameter	Mean (μm)	25,1	27,6
		CV (%)	46,2	40,9
Coarse Component	By mass (%)		64,8	48,8
	Fibre Diameter	Mean (μm)	36,1	36,1
		CV (%)	40,2	40,7
Weighted Fibre Diameter		Mean (μm)	32,2	31,8
		CV (%)	45,0	41,4

Scouring

The raw fibre was scoured in a one-foot (305 mm) wide Petrie & McNaught pilot scouring plant at a nominal production rate of 100 kg/hr, greasy. Various attempts were made to scour each type to residual grease levels between 0,7% and 1,5%. This was achieved by experimenting with a two, three or four bowl sequence at temperatures varying from 40 to 55° C in the first bowl to 40° C in the last bowl. Trace quantities of ®Berol Lanco synthetic detergent were added during the course of scouring as appropriate, and no soda ash was used since previous work[1] has shown that the high levels of suint in karakul tends to increase the liquor pH, which in turn tends to assist the self-scouring ability of the fibre.

No water or lubricant was added to the scoureds prior to further processing.

Processing via the Worsted Route

From each type, two sample batches (each approximately 50 kg) were selected on the basis of their residual grease levels (around 0,7% and 1,0%, respectively) for processing along the worsted route. Carding was carried out using a double-swift FOR card fitted with clothing suitable for processing merino-type wools (i.e. fillet on workers and strippers and metallic on swifts, breast and doffers). Similar to previous work[1] both the workers on the breast as well as three workers on each swift were rendered inactive by suitably packing the shaft brackets with leather strips. Thus, the only worker/stripper combinations in operation were the fourth pair on each swift. The corresponding settings on the first swift were 0,91 mm (20 gauge) and 0,56 mm (24 gauge) on the second swift. To avoid unnecessary loss of fibre, the burr beater between the breast and the first swift was not put into operation as the raw material was not very faulty (see Table 1). The card was run at a nominal production rate of 21 kg/hr under ambient conditions of 21° C and 65% RH, the swift speeds set at 115 rev/min.

Preparation for combing was carried out as usual using a Schlumberger GNP intersecting gill set at a ratch of 24 mm with successive drafts of 4, 4,5 and 4,5. Water was added to the slivers during the first two passes to obtain a combing input regain of around 19%. The average single sliver input was around 22,5 ktex which effected a total comb loading of around 270 ktex (12 ends).

Comb tests were run on a Schlumberger PB26L rectilinear comb, fitted with a top comb of 25 pins/cm and running at 130 nips/min. Both batches were combed at a 30 mm gauge and a feed of 5 mm. The combed sliver was finished into 24 ktex tops after two autoleveller passages.

All card, gill and comb slivers were tested for VM and neps using a Toennissen top tester, and the comb slivers also for fibre length distribution using an Almeter and mean fibre diameter distribution using a projection microscope.

Processing via Semi-Worsted Route

The semi-worsted system, as the name implies, produces a yarn that bears relation to the product of the worsted system but which is obtained via a much shorter route which does not include combing[4]. The approach is not new, dating from around 1918[5] but general acceptance has only gained impetus much more recently with the development of autolevellers and the increased usage of synthetics in tufted carpets[6]. Current or modern semi-worsted technology is based upon high drafts, high sliver linear densities and only two operations between carding and spinning[7].

In the present investigation, SAWTRI's worsted plant was used in a semi-worsted manner, similar to the approach adopted in various industrial applications since the equipment for the two routes may be virtually identical[8]. Both batches were carded at the settings described above for the worsted route. For this particular application four further batches were scoured to residual grease levels of around 0,7% and 1,0%, respectively and again no lubricant was added. Prior to drawing for spinning, each of the four batches was gilled twice to a final sliver linear density of 24 ktex, the second operation being carried out on an autoleveller gillbox. During the first gilling, water was added to the slivers to increase their regain to approximately 19%. Ratch settings in both cases were 24 mm and the drafts employed were 4,0 and 6,5, respectively.

The slivers were tested for neps and VM on a Toennissen top tester, for fibre length distribution using an Almeter and for mean fibre diameter distribution by the projection microscope method.

Spinning of the Worsted and Semi-Worsted Slivers

Slivers obtained from both the worsted and the semi-worsted sequence of operations were prepared for spinning on a conventional Schlumberger worsted drawing set (four gilling operations of which the second was on an autoleveller). Double-meche rovings of 750 tex were subsequently spun on a Rieter H2 frame equipped with 63 mm x 11,1 mm rings (slightly larger rings are recommended for the commercial spinning of semi-worsted yarns[9]). No spinning lubricant was added in an attempt to keep spinning costs as low as possible. Two yarn linear densities were spun, namely a R74 tex S380/2Z 575 and an R150 tex S150/2Z 260. The former could be considered a limiting linear density while the latter is suitable for the hand tufting and carpet industry. Prior to folding the singles components were Classimat tested without clearing and subsequently also tested for irregularity, breaking strength, extension and hairiness. In addition, the mean spindle speed at break (MSS) values of the various batches were determined in the usual manner[10,11] at two levels, namely at 37 tex and 75 tex. Replicate tests were carried out on 35 spindles per batch.

Processing via the Woollen Route

For processing on the woollen system a further 50 kg batch of type 603 (residual grease content around 1,0%) and type 625 (residual grease content around 0,9%) were selected. Prior to carding, each batch was opened on a John Greenhalgh & Sons single-cylinder Willey at a production rate of approximately 200 kg/hr . The opened wool was layered and each layer sprayed with an oil/water emulsion consisting of 12% (omf) water and 5% (omf) ®Bevaloid 4027 fibre lubricant. The oiled wool was opened and blended thoroughly by processing through a Wilson Knowles & Sons Fearnaught machine at a production rate of approximately 25 kg/hr . The opened, oiled and blended wool was then loosely packed into bales and stored for one week under ambient conditions of around 21°C and 65% RH prior to carding.

Carding was carried out at a production rate of 15,5 kg/hr on a 1,5 m wide Tathams Woollen card fitted with a six-height tape condenser delivering 120 good ends. The card was set to deliver 250 tex slubbings.

Both batches were subsequently spun into 200 tex Z180 yarns on a Platt's MWR 4 woollen ringframe (120 spindles) equipped with 100 mm x 16,7 mm rings. A spindle speed of 4000 rev/min and a false-twist tube speed of 2400 rev/min were maintained throughout. The yarns were subsequently tested for irregularity (CV %), tensile strength, extension at break, imperfections and hairiness.

RESULTS AND DISCUSSION

Worsted and Semi-Worsted Routes

Up to and including the carding stage, the processing of both types along the two different routes followed two common steps, namely those of scouring and carding. The processing results are given in Table 2. (The residual grease levels quoted in this Table reflect the values closest to those selected which could be obtained after the various scouring experiments.)

Table 2 shows that there was some evidence that the higher residual grease levels were associated with slightly higher card losses.

TABLE 2

CARD RESULTS : WORSTED AND SEMI-WORSTED ROUTES

Carding Parameter	Type 603		Type 625	
	Residual Grease ≈ 0,7%	Residual Grease ≈ 1,0%	Residual Grease ≈ 0,8%	Residual Grease ≈ 0,9%
Card Rejects (%)	14,0	17,8	14,3	15,0
Card Yield (%)	86,0	82,2	85,7	85,0
VM after Carding (per 20 g)	239	336	297	302
Neps after Carding (per 20 g)	50	46	36	45
Resistance to Compression of Scoureds (mm)	15,3	14,6	16,1	15,6

On average the slightly shorter type (type 625) appeared to suffer about the same losses as the longer type (type 603). Residual grease levels did not appear to affect nep and VM counts of the card sliver consistently.

As mentioned earlier, compared with the semi-worsted route, the worsted route involves, essentially, an intermediate combing process, prior to drawing for spinning. Table 3 contains the combing results for the two types of karakul used in this study.

TABLE 3

COMBING RESULTS

Combing Parameter	Type 603		Type 625	
	Residual Grease ≈ 0,7%	Residual Grease ≈ 1,0%	Residual Grease ≈ 0,8%	Residual Grease ≈ 0,9%
Noil (%)	8,0	7,9	7,0	6,6
Comb Shoddy	1,5	1,3	2,3	2,0
Top Yield (% on scoured)	78,9	75,7	78,4	79,5
Noil Yield (% on scoured)	7,0	6,7	6,0	5,8
Top & Noil Yield (%)	85,9	82,3	84,4	85,3

Table 3 shows that again, differences between types and between different residual grease levels were neither large nor consistent and no evidence of any particular trend could be detected. The realtively high values for comb shoddy, as previously[1], again were apparent.

The physical characteristics of the two sets of slivers, prior to preparation for spinning, showed distinct differences as a result of the combing process. Table 4 summarises the results in respect of various parameters of the slivers processed on the semi-worsted and worsted routes, respectively. (The results have been averaged for the two sub-sets representing the two different levels of residual grease.)

From the mean fibre diameter results it can be seen that combing tended to remove fine fibres as noil, resulting in a top that was 0,8 to 0,9 μm coarser than the carded sliver. The obvious effects of combing are also clearly reflected in the Almeter fibre length data, which shows that the uncombed (semi-worsted) route produced sliver which was considerably shorter and more variable in length than did the worsted route. Furthermore, if sliver quality is defined in terms of neps and residual vegetable particles, Table 4 also clearly illustrates that the worsted route produced a far superior sliver, even from types which were free to nearly free in terms of vegetable fault in the grease.

TABLE 4

PHYSICAL PROPERTIES OF THE WORSTED AND SEMI-WORSTED SLIVERS PRIOR TO DRAWING

Sliver Parameter		Type 603 Worsted Route	Type 603 Semi-Worsted Route	Type 625 Worsted Route	Type 625 Semi-Worsted Route
Fibre Diameter	Mean (μ m)	30,9	30,1	31,1	30,2
	CV (%)	46,3	46,4	42,7	43,9
Almeter Hauteur Data	Mean (mm)	47,1	33,4	48,2	36,4
	CV (%)	49,1	75,2	50,7	74,9
	Short Fibre (% < 25 mm)	13,4	44,4	14,1	39,8
	Tail Length (mm)	87,4	80,5	92,6	86,6
Neps (per 20 g)		5	65	4	82
VM (per 20 g)		14	218	25	199
DCM Extract (%)		0,8	1,1	0,6	0,9

Table 5 summarises the spinning results of the various batches in terms of calculated number of fibres in the yarn cross section and the corresponding MSS data. In general, type 603 appeared to have a higher spinning potential than type 625 for the same number of fibres in the yarn cross section, although the observed differences did not reflect large differences in fibre data between types for a given route. Of more interest, however, were the differences between routes for a given type, which is clearly reflected in the data contained in Table 5. Since the comparisons were made on the basis of a fixed yarn linear density, even the fact that the semi-worsted route produced a sliver with a slightly lower mean fibre diameter (i.e. proportionally more fibres in the resultant yarn cross section) could not mask the effects of the large differences in the Almeter fibre length data. Furthermore, in addition to the higher short fibre content, higher CV of length and lower mean fibre length, it is also quite conceivable that a large

TABLE 5

SPINNING RESULTS

Yarn Linear Density (tex)	Spinning Data	Type 603		Type 625	
		Worsted Route	Semi-Worsted Route	Worsted Route	Semi-Worsted Route
37	Fibres in Cross Section	31	33	31	33
	MSS (rev/min)	5242	4513	4687	4326
75	Fibres in Cross Section	63	66	64	67
	MSS (rev/min)	7833	7312	7569	7465

proportion of the observed differences in the spinning potential could be due to the presence of excessively high numbers of neps and vegetable particles in the semi-worsted slivers. The detrimental effects of neps in semi-worsted processing is well-known[13]. Furthermore, one may assume that these observed effects, in general, would be much more acute when spinning relatively fine yarns (i.e. under near-limiting conditions than when spinning heavier yarns more suitable for the more traditional end-uses for karakul. This is also borne out by Table 5 which shows that the mean difference in spinnability between the worsted and semi-worsted routes was almost twice as large for the finer yarns (37 tex) than for the coarser yarns (75 tex).

As far as the physical properties of the various yarns were concerned, Table 6 summarises the results for the two types tested in the singles form prior to plying.

For each type, the effects of yarn linear density are quite evident, the heavier yarns generally being slightly stronger in terms of tenacity as well as having higher extension at break values and less Classimat faults. The higher linear density also effected improved regularity in terms of CV, neps and thick and thin places. These trends were quite obvious for both processing routes for each type. In general, the two types did not appear to differ much, with Type 625 perhaps being fractionally more regular than Type 603 in terms of CV of irregularity, thick places and thin places. No consistent differences in terms of the other parameters, i.e. Classimat faults, tenacity, extension at break, neps and hairiness could be detected.

Comparing the yarns from each processing route within each type, Table 6 clearly shows the considerable difference in quality of the yarns from the

TABLE 6

YARN PHYSICAL PROPERTIES

Yarn Test		Type 603				Type 625			
		Worsted Route		Semi-Worsted Route		Worsted Route		Semi-Worsted Route	
		37 tex	75 tex	37 tex	75 tex	37 tex	75 tex	37 tex	75 tex
Classimat Faults (per 100 km)	Total (A1+B1+C1 +D1)	1138	57	15041	3822	1218	67	11383	1188
	Objectionable (B4+C3+D2)	20	11	375	33	22	13	184	23
Tenacity (cN/tex)		3,4	4,5	3,2	4,9	3,3	5,2	3,3	4,4
Irregularity (CV %)		24,4	20,5	26,6	24,2	23,8	20,0	25,6	23,6
Extension at Break (%)		6,4	11,2	6,3	13,2	6,6	14,8	6,2	12,2
Neps (per 1000 m)		587	56	1548	890	525	61	1337	727
Thick Places (per 1000 m)		566	200	980	516	473	175	786	445
Thin Places (per 1000 m)		1010	258	1280	486	859	222	1054	445
Hairiness (hairs/m)		147	123	95	122	116	130	115	122

worsted route compared with those from the semi-worsted route. Although the yarn tenacities did not appear to differ much, the results indicated that the yarns from the semi-worsted route were from 2 to 4% (absolute) more irregular than those from the worsted route. The large differences in Classimat faults and neps between the two sets of yarns are obvious from Table 6, but, surprisingly very few or consistent differences in the hairiness values could be detected.

Woollen Route

The results obtained for the 250 tex woollen carded slubbings are given in Table 7.

TABLE 7

PHYSICAL PROPERTIES OF WOOLLEN SLUBBINGS

Slubbing Parameter		Type 603	Type 625
Yield (%)		88,0	84,0
Single Fibre Length Data	Mean (mm)	47,8	47,9
	CV (%)	44,0	42,9
	Short Fibre (% < 25 mm)	13,0	13,3
	5% Tail (mm)	88,0	88,0
Fibre Diameter	Mean (μm)	30,0	31,4
	CV (%)	48,4	42,7
Resistance to Compression (mm)		16,5	15,6
Vegetable matter (%)		0,04	0,02

The results show that a slightly higher yield of slubbing was obtained from Type 603 than from Type 625. Resistance to compression of the slubbing produced from Type 603 was also higher and the vegetable matter content of Type 603 was also higher than that of Type 625. These differences were small and in general it can therefore be stated that the carding performance did not differ significantly for the two types.

It is interesting, however, to note that while the length of the fibres in scoured form differed significantly, i.e. 65 to 115 mm for Type 603 and 50 to 75 mm for Type 625, the single fibre length after carding of both types was almost the same i.e. 47,8 mm and 47,9 mm for Type 603 and Type 625, respectively. This indicates that considerable fibre breakage took place in the case of the longer type.

The results obtained for the woollen spun yarns (see Table 8) show that the yarn produced from type 625 was stronger and more even than the yarn produced from type 603. The results obtained for irregularity was confirmed by the results obtained for yarn imperfections. The yarn produced from type 603 showed higher values for thick and thin places as well as a higher number of neps than the yarn produced from type 625.

TABLE 8

PHYSICAL PROPERTIES OF 200 TEX WOOLLEN SPUN YARNS

YARN TEST	TYPE 603	TYPE 625
Tenacity (cN/tex)	2,56	2,94
Irregularity (CV %)	18,8	16,6
Extension at Break (%)	24,3	16,0
Neps (per 1000 m)	42	8
Thick Places (per 1000 m)	82	22
Thin Places (per 1000 m)	366	82
Hairiness (hairs/m)	100	98

The extension of the yarn produced from type 603 was higher than that of the yarn produced from type 625. Hairiness was similar for the two types.

From the yarn results it can be concluded that a better yarn was obtained from Type 625. In general, the tenacity of the woollen spun yarns was lower than that of the semi-worsted and worsted-spun yarns, most likely as a result of the more random arrangement of fibres within the yarn structure. This more random arrangement generally results in a lower fibre extent and hence a lower yarn tenacity compared with the more parallel arrangement of fibres in the yarns produced on the other two systems.

SUMMARY AND CONCLUSIONS

Two commercial types of karakul (S.A. Wool Board Type No's. 603 and 625) were processed into yarns via the worsted, the semi-worsted and the woollen routes to assess the comparative processing performance of these two types on the three different systems. Yarn linear densities suitable for the hand tufting and carpet sector of the industry were selected for spinning trials, namely R74 tex S380/2Z575 and R150 tex S150/2Z260 in the case of the worsted and semi-worsted routes and 200 tex Z180 in the case of the woollen route.

When comparing the different routes in terms of the amount of material available for spinning, it was found that the woollen route had the highest "yield", namely 86% (on a scoured basis), followed by the semi-worsted route (84,7%) and the worsted route (78,1%). The quality of the slivers produced by the worsted route were, as expected, considerably better in terms of mean fibre length and length distribution, neps and VM although the mean fibre diameter results were up to 0,9 μ m higher compared with the starting material. Judged by the reduction in mean fibre lengths after carding, considerable fibre breakage took place in all three cases. The better length distribution and less sliver impurities of the worsted slivers resulted in improved spinnability (as measured by the MSS technique), compared with the semi-worsted slivers, particularly for the finer yarns.

Type 625 appeared to produce marginally more regular yarns than type 603 in the case of the worsted and semi-worsted routes. The semi-worsted yarns were, in general, some 2 to 4% (absolute) more irregular than the worsted type yarns and had considerably higher nep counts and yarn imperfections. Although the tenacities of the worsted-spun and semi-worsted spun yarns did not differ much, the tenacity of the woollen-spun type 625 was some 15% higher than that of the type 603, both being, as expected, some 30% weaker than their worsted and semi-worsted counterparts. The woollen yarns, on the other hand, exhibited higher extension at break values, less neps and less thick and thin places. However, the higher linear density of the woollen-spun yarns most likely contributed significantly to these differences in eveness parameters.

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USE OF PROPRIETARY NAMES

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REFERENCES

1. Strydom, M.A., *SAWTRI Techn. Rep.* No. 458 (May, 1980).
2. Celliers, W.C., *S.A. Textiles,* **14** (6), 22 (June, 1970).
3. Anon., SAWTRI Annual Report, 12 (1981).

4. Mackereth, L. and Townend, P.P., *Wool Text. Ind.,* **42** (563), 5 (March/April, 1968).
5. Barker, A.F., *J. Text. Inst.,* **48**, P164 (1957).
6. Grafton, P.M., *Wool Text. Ind.,* **42** (571), 5 (Jan. 1969).
7. Haddad, N., *Can Text. J.,* **100** (3), 42 (March, 1983).
8. Veitenhans, R. and Thiel, H., *Text. Praxis Int.,* **37** (1), 22 (1982).
9. Anon., *De Tex-Textilis* No. 4, 10 (April, 1979).
10. Turpie, D.W.F., *SAWTRI Techn. Rep.* No. 240 (Feb., 1975).
11. Gee, E. and Turpie, D.W.F., *SAWTRI Techn. Rep.* No. 317 (Aug., 1976).
12. Townend, P.P., *Proc. 18th Hung. Text. Conf.,* **1**, 265 (Sept., 1970).

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