J. Agric. Sci. Mansoura Univ., 30(11): 6533 – 6541, 2005

CORTICAL PATTERN OF COARSE BARKI WOOL FLEECES WITH DIFFERENT COTTING LEVELS

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ABSTRACT

Five adult Barki ewes of each of the four cotting levels: high, medium, low and zero were used. All the experimental animals grazed at Maryout Research Station (35 kilometers south west of Alexandria). Observations on cortical segmentation of fibres in the follicles were conducted .

The nature and presence of bilateral and radial cortical patterns of coarse Barki wool sheep is observed and discussed in relation to some physical properties of cotted fibres. The asymmetry in the cortex was studied using skin sections. The bilateral structure was present in both primary lateral and secondary fibres. Differences ($p<0.05$) occurred in mean area of par- cortical segment and mean ortho- to para- ratio between different cotting levels. The coarse wool fibres which were associated with low cotting levels were found to have the radial asymmetry which originated from the primary central follicles.

Regardless of follicular origin, there was a significant increase in the percentage of radial cortical type and a decrease in bilateral cortical type percentages with increasing cotting level, therefore selection for increasing bilateral pattern in fibres, through increasing S/P ratio, might contribute to a reduced ability towards cotting.

Keywords: Cotting; bilateral and radial wool fibres; cortex; skin; histology; sheep.

INTRODUCTION

Wool follicles produce fibres with cortices basically built up of two types of cells: ortho- and para-cortex (Horio and Kondo, 1953). It has been demonstrated that the cortex of a crimped wool fibre comprises two hemi-cylinders differing in both chemical and physical properties. This structural feature is bearing a direct relationship to the occurrence of crimp. Fibre crimp is thought to arise from the bilateral configuration of ortho- and para-cortical cells. The latter is usually found on the concave side of the curve of any crimp, and ortho-cortical cells on the convex side.

In an earlier study of wool cotting, one fault in coarse wool fleeces that affects wool prices, as it requires extra opening during processing consequently resulting in breakage of wool fibres and reduced fibre length, it was concluded (Guirgis *et al.*,2001) that high cotting in Barki sheep was associated with low values of S/P ratio, fibre diameter and medullation thickness. It was the purpose of this work to further study some wool fibre cortical components associated with different types of cotting.

MATERIALS AND METHODS

Five adult Barki ewes (aged 3-3.5 years and weighed about 40-45Kg on average) of each of the four cotting levels: high, medium, low and zero were used. All the experimental animals grazed at Maryout Research Station (35 kilometers south west of Alexandria).

Observations on cortical segmentation of fibres in the follicles were conducted on 6-8 µ paraffin sections cut from freshly collected skin samples from the midside position of each experimental animal (Barker,1958) which had been fixed in formol-calcium for 24 hours and treated (Barker,1958). For staining (Clarke and Maddocks, 1965), the sections were immersed in descending concentrations of ethyl alcohol(100%, 90% and 70%) and then in distilled water and stained in 0.1 percent methylene blue in 0.03M phosphate buffer at PH 7.4 for 10 minutes and then thoroughly washed in 1 percent aqueous acetic acid. They were then washed in running tap water for 20 minutes and finally dehydrated in butyl alcohol.

The two differentiated cortical segments of wool fibres in both primary and secondary follicles were detected and classified into bilateral and radial types. The area of each segment was measured using Image analyzer (LEICAQ 500 MC) with lens 40/0.65.

The mean diameters of the fibres produced by both primary and secondary follicles were calculated in the cross sections by measuring the major and minor diameters with an eye piece micrometer of each fibre and divided by two.

Data were statistically analyzed according to SAS (1995) using general linear models (GLM) classification followed by Duncan's multiple range test to examine the significance between means. Fibre diameter was a significant parameter in cotting. These diameters for each fibre were examined and used in a covariate analysis to adjust for the differences in fiber cortical segments between the groups.

RESULTS AND DISCUSSION

Cotting was one of the important factors that were affected by the wool fibre diameter. There was a decrease in primary and secondary fibre diameters with increasing cotting level (Table 1). It was observed that fibre diameters in high cotted levels represented 65.4, 67.8 % of that of zero cotting level of primary and secondary fibre diameters, respectively. Guirgis *et al.* (2001) confirmed these results in Barki sheep and showed the negative effect of cotting on the wool quality.

In the Barki wool follicles, it was found that two cortical structures of fibres were present, the bilateral which represented about 90.5% and the radial type that occupied about 9.5% of the tested samples (Table 2).

Regardless of follicular origin, there was a general increase in the percentage of radial cortical type and a decrease in the percentage of bilateral cortical type with increasing cotting level (Table 2). Therefore, selection for increasing bilateral fibres might contribute towards less cotting. In other words, *high levels of S/P ratio might contribute to a reduced ability* towards cotting.

Table 1: Diameter (µm) of fibres produced by both primary and secondary follicles with increasing cotting severity

Cotting	Diameter (mean±SE)	
	Primary fibre	Secondary fibre
Zero	61.6 ±1.79 a	24.7 ±0.35 a
Low	60.3 ±1.46 a	24.6 ±0.37 a
Medium	46.0 ±2.35 b	17.6 ±0.35 b
High	40.4 ±1.03 c	16.7 ±0.33 b

In each column only values with different letters are significantly different ($p<0.05$).

Table 2: Percentages of both radial and bilateral cortical types of all measured fibres with increasing cotting severity

Cotting	Cortical pattern	
	Radial %	Bilateral %
Zero	8.8	91.2
Low	8.9	91.1
Medium	9.6	90.4
High	10.7	89.3
Average	9.5	90.5

The basic difference between the two cortical types of wool (radial and bilateral) seemed to lie in the ability of the follicles with radial types to form more para-cortical cells in their larger fibres, and in the arrangements of these cells in the fibre (Donald, *et. al.*,1984).

In the follicle group of Barki sheep, all the secondary follicles produced fibres with bilateral cortical asymmetry (Plate 1). Fibres produced by the primary lateral follicles showed a bilateral asymmetry type (Plate 2), while the radial type (Plate 3) was only observed in the fibres produced from primary central follicles which possessed fibres with the highest diameter of the follicle group. Results obtained were in agreement with those of Fraser and Rogers (1955) where ortho- and para-cortical cells might be differentiated in coarser wools, but there was a transition from a bilateral structure to the radial asymmetry as the diameter of fibres increased from about 25 to 40 µ.

Dick and Sumner (1995) observed that primary fibres in Perendale sheep were coarser than secondary fibres and the proportion of fibres with a bilateral cortical cell type arrangement decreased with increasing fibre diameter. They also confirmed that while primary and secondary fibres were different in the mean fibre diameter and cortical structure, the relationship between cortical structure and fibre diameter did not differ between the two follicle populations.

Fraser and Rogers (1955) believed that the chemical differences in the proteins of the two segments originated in the very early stages of the biosynthesis of the cortex where fibrillation begins and the sulphydryl reaction can be first detected.

The analysis of the amino acid composition between the two cortical segments showed that there was more cystine in the para-cortex than that of the ortho-cortex, which might account for the enhanced stability of the former, and might indicate differences in the basic, acidic and other amino-acids (Mercer, 1954).

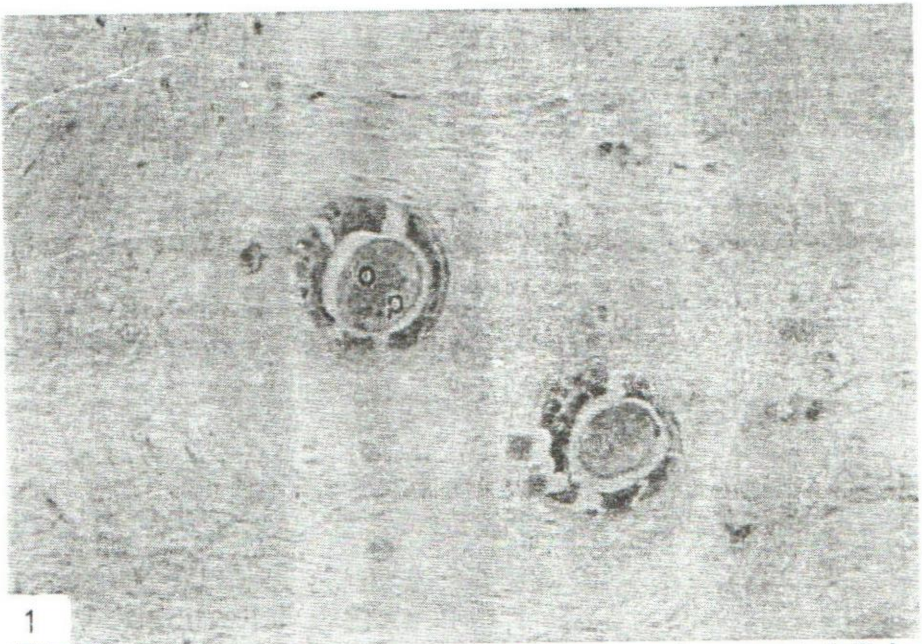

Plate 1. Transverse section through the secondary wool follicles showing the bilateral cortical asymmetry. Ortho-cortex, O; Para-cortex, P (Methylene blue. X 400).

Plate 2. Transverse section through a primary wool follicle showing the bilateral cortical asymmetry. Ortho-cortex, O; para-cortex, P (Methylene blue. X 400).

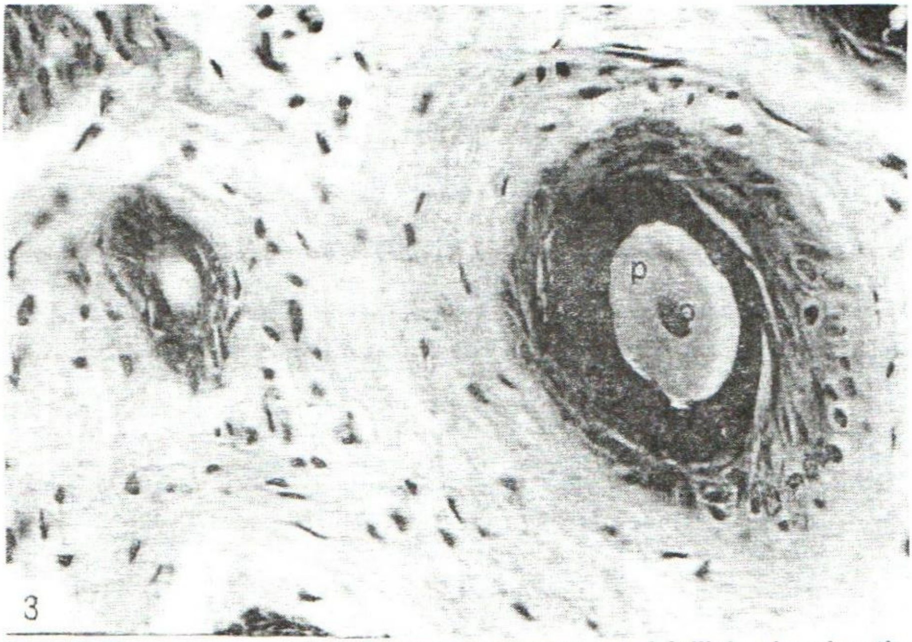

Plate 3. Transverse section through a primary wool follicle showing the radial cortical asymmetry. Ortho-cortex, O; para-cortex, P (Methylene blue.X 400).

In the radial type the mean ortho-cortical cross sectional area were 43.7 ± 6.44 μ^2 and that of para-cortical cells were 48.6 ± 1.77 μ^2 (Table 3). However, ortho-cortex occupied 53.3 and 54.1 % of the area in the secondary and primary fibres with bilateral structure (Table 4), and 47.4 % in fibres with radial orientation (Table 3).

Table 3: Mean area (μ^2 ± SE) of the two fibre cortical segments and ortho/para ratio in different cortical patterns.

Cortical pattern	Mean ±SE		
	Ortho-cortex	Para-cortex	Ortho/para ratio
Radial	43.7±6.44 ^{a}	48.6±1.77 ^{a}	1.0±0.05 ^{a}
Bilateral	104.9±4.09 ^{a}	79.6±1.13 ^{b}	1.3±0.03 ^{b}

In each column only values with different letters are significantly different ($p<0.05$).

Table 4: Mean area (μ^2 ± SE) of the two fibre cortical segments and ortho/para ratio in different follicle types.

Follicle type	Mean ±SE		
	Ortho-cortex	Para-cortex	Ortho/para ratio
Primary	74.5±5.36 ^{a}	65.2±1.47 ^{a}	1.1±0.04 ^{a}
Secondary	74.2±8.19 ^{a}	63.0±2.22 ^{b}	1.2±0.06 ^{a}

In each column only values with different letters are significantly different ($p<0.05$).

Changes in cell-type arrangement with increasing fibre diameter were reported (Orwin and Woods, 1980). An increase in para-cortical cell proportions with increasing diameter has been reported in some breeds (Thorensen, 1958) and this was confirmed in the present study in the radial type of the primary central fibres. Different studies showed mean percentages of ortho-cortical cell areas that were higher than 50% for wools of various mean diameters (Ahmad and Lang, 1957; Snyman, 1963; Chapman, 1965; Bone's and Sikorski, 1967).

In general, fibre diameter and shape changes were found to be predominantly due to changes in numbers of ortho-cortical cells. In part, this dominance of ortho-cortical cells might be the result of the larger cross-sectional area (by about 30%) of individual ortho-cortical cells as compared to para-cortical cells (Donald, *et al.*, 1984). This difference was earlier recognized (Kassenbeck,1958; Bone's and Sikorski, 1967) and was measured directly by Donald, *et al.*(1984). They also added that the mean cross-sectional area of the same cell type varied considerably in different fibres.

Fibres are with equal numbers of ortho- and para-cortical cells. A greater area of the fibre cross-section would be composed of ortho-cortical cells, and changing the numbers of ortho-cortical cells would affect fibre shape and diameter to a greater extent than a similar change in para-cortical cell numbers (Donald *et al.*, 1984).

The mean ortho- to para- ratio was found to be about 1.1±0.04 and 1.2±0.06 in both primary and secondary fibres (Table 4), while the ratio obtained from zero to high cotted samples were 1.2±0.03 and 1.3±0.04, respectively (Table 5).On the other hand, the analysis of covariance in table (7) illustrated that the interaction between cotting levels and cortical pattern had a significant effect ($p<0.05$) on the ortho- to para ratio. These results might indicate that in the bilateral pattern ortho- segment might occupy the higher mean area of cortical structure.

Table 5: Mean area ($\mu^2 \pm$ SE) of the two fibre cortical segments and ortho/para ratio with increasing cotting severity.

Cotting level	Ortho-cortex	Para-cortex	Ortho/para ratio
Zero	91.4±4.89 [a]	58.3±1.35 [a]	1.2±0.03 [a]
Low	69.3±5.81 [a]	65.9±1.60 [b]	1.1±0.04 [b]
Medium	73.0±5.41 [a]	69.2±1.49 [c]	1.2±0.04 [a]
High	63.7±5.80 [a]	63.1±1.62 [d]	1.3±0.04 [c]

In each column only values with different letters are significantly different ($p<0.05$).

The study of fibres with radial asymmetry type of the cortex, in Barki sheep, revealed the presence of two different arrangements of the ortho- and para-cortical cells, in which there were two hemi cylinders, one in the core and the other surrounding it. The changes in cortical cell-type arrangement with increasing fibre diameter were earlier reported (Fraser and Rogers, 1955; Orwin and Woods, 1980).

The overall means of fibre diameters were generally affected by the cotting level where values decreased towards the high cotting level, and it was found (Table 6) that cotting level, follicle type, cortical pattern and their interactions affected (p <0.01) the fibre diameters.

Table 6: Analysis of variance of some factors affecting fibre diameter.

S. O. V.	D. F.	M. S.
Total	670	------
Cotting level (CL)	3	2652.98 **
Follicle type (FT)	1	132774.13 **
CL X FT	3	1108.53 **
Cortical pattern (CP)	1	1256.02 **
CL X CP	3	215.93 **
FT X CP	1	20608.79 **
CL X FT X CP	3	86.37 *
Error	655	20368.65

* = Significant at (p<0.05).
** = Highly significant at (p<0.01).

In a covariant analysis (Table 7) after adjustment for differences in fiber diameter between the groups, It was found that the paracortical segment was highly affected (p<0.01) by each of cotting level, cortical pattern and fibre diameter and also between the interaction between them. On the other hand the ortho- to para- ratio was affected (p<0.01) by fibre diameter and cortical pattern and at (p<0.05) by cotting level and by both cotting level and cortical pattern interaction.

Table 7: Analysis of covariance of some factors affecting fibre area.

S. O. V.	D. F.	M.S.		
		Ortho-cortex	Para-cortex	Ortho/para ratio
Total	565	------	------	------
Cotting level (CL)	3	718863.36 NS	1251.38**	0.2089 *
Follicle type (FT)	1	0.97633 NS	37.28 NS	0.1169 NS
Cortical pattern (CP)	1	59793.98 NS	15296.61**	1.3989 **
CL x FT	3	18483.41 NS	1520.45 **	0.0297 NS
CL x CP	3	6588.19 NS	1287.07 **	0.2166 *
Diameter	1	22710.33 NS	936.45 **	0.4038 **
Error	553	54602893.84	41388.71	28.31

NS Non significant.
* = Significant at (p<0.05).
** = Highly significant at (p<0.01).

Generally, in the four cotting levels , the ratio of the ortho- to para-cortical segments was lower in the radial pattern than that of the bilateral cortical pattern. The highest value was that of secondary fibres (Tables 2 and 3).

Dry *et al.* (1952) reported that differences in the ratio of ortho-to para-cortex varied from fibre to fibre. They demonstrated an inter-fibre distribution in sulfur content and creep behavior, which seemed therefore to be related to variations in ortho- to para-cortical ratio.

They also showed that fibres emerging from primary follicles were higher in cystine and were predominantly para- in character which was in agreement with the results of the primary central fibres obtained from the present study. This seems understandable in terms of the development of the fibre population in the skin and the theory advanced above to account for asymmetrical hardening, for the primary fibres being larger and first established that may well lay down have better "supply lines" in the surrounding tissue. These same fibres are important elements in fleece construction and have been suspected of influencing the handle of fleece and fabric.

It could be concluded that the average ortho- to para-cortical ratio and the distribution of this property among the fibre population might likely to be one of the quantitative factors which, along with other factors as diameter, might explain some performance properties of wool fibres, one of which might be cotting.

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طبقة القشرة فى الصوف الخشن لاغنام البرقى وعلاقته بمستوى التلبد

رأفت أبوسيف جرجس ، عائشه سيد عبده و محمود محمد الجناينى
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أجريت الدراسة بمحطة بحوث مريوط التابعة لمركز بحوث الصحراء والتي تقع علـى بعد ٣٥ كيلومتر جنوب غرب الإسكندرية واستخدم في هذة التجربة عدد عشرون من أغنام البرقى الناضجة البالغه من العمر ٣-٣,٥ سنه والتى تزن حوالى ٤٠-٤٥ كج قسمت إلى أربع مجـاميع (كل مجموعة ٥ نعاج) تمثل مستويات التلبد المختلفة (عالي- متوسط- منخفض- خالي من التلبد) بهدف دراسة طبيعة تركيب طبقة القشرة في صوف أغنام البرقى الخـشن بالعلاقـة مـع بعـض الصفات للألياف المتلبدة.

أوضحت النتائج إن طبقة القشرة تتكون من جزئين ortho-cortex و para-cortex يكون تواجدهما جانبي أو دائري. وكان الترتيب الجانبي ممثلا للألياف الأولية الموجودة على حافة مجموعة البصيلات وكذلك في الألياف الثانوية. واختلفت نسبة مساحة جـزء ال Para-cortex وكذلك نسبة ال ortho-cortex إلى ال para-cortex معنويا في مستويات التلبد المختلفة. أما التركيب الدائري فقد وجد فقط في ألياف الصوف الخشنة المرتبطة بالمستوى المـنخفض مـن التلبد والموجودة في الألياف المنتجة من البصيلات الأولية المركزية.

كما لوحظ أيضا إن هناك زيادة معنوية في نسبة الألياف ذات نوع القشرة الدائري وكذلك نقص في نسبة النوع الجانبي مرتبطين بزيادة مستوى التلبد.

وقد أوضحت النتائج أيضا أن ارتباط زيادة نسبة نوع القشرة الجانبي في الألياف بزيـادة نسبة بصيلات الألياف الثانوية إلى الأولية S/P ratio يكون مرتبطا بانخفاض قـدرة الأليـاف على التلبد. ونستخلص من هذه الدراسة أن متوسط نـسبة ال ortho-cortex إلـى ال para-cortex وكذلك توزيع هذه الظاهرة داخل تجمعات الألياف بجانب بعض العوامل الاخـرى مثـل القطر توضح بعض خصائص ألياف الصوف السالبة مثل التلبد.