Spinable Characteristics of Ecotype Sudan Desert Sheep Wool

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Abstract

The study focuses on finding the spiniable characteristics of Ecotype Sudan Desert Sheep wool. The normal color of the Ecotype Sudan Desert Sheep wool is 'Abrag' spotted (red / white or black / white), or 'Hamra' red. The fleece was divided into two groups: group (A) which represents the fleece of first sheering (Eiga) and group (B) which represents the fleece of second sheering (Khilfa). Then each group was studied by taking samples, scouring them by using carbon tetrachloride (CCL_4).
The SEM micrograph shows that the overlapping surface cell or scale structure in characteristic longitudinal view at 594 X magnifications. The approximate number of surface cells or scales in a length of 254.2 microns is 25 – 35 scales. A dark band/canal type shade is observed along the length of the wool fiber as shown in the photograph indicating 'Medulla' presence. The fineness of the fiber examined is between 87.1 – 95.8 microns. By using the metallurgical microscope – NEOPHOT 32, the fiber length is between (27 – 28) millimeters. Using the Stelometer the tenacity of the fiber examined is between (5 – 6) grams per Tex. In common with other textile fibers, wool absorbs water from moist atmosphere. Also the study shows that when wool is dried from regain below saturation, its absorptive power decreases with increasing temperature of drying. Wool can dissolved completely when treated with Acetic acid (6N NaOH). It is observed that both samples (A&B) decolorized when treated by reducible bleach. Fiber degradation takes place when using oxidisable bleach and the loss in mass is less than 4%. The effective method for bleaching dark pigmented wool is reduction followed by oxidizing process. Addition of formaldehyde is essential for reducing fiber degradation.
Ecotype Sudan Desert sheep wool is coarse and short, therefore it can be classified as carpet.

KEYWORDS: Medulla, ecotype, crutch, bellies, crossbred.

Introduction:

Wool in its simplest terms is a fibrous protein. Proteins are polymeric substances with relative molecular masses of many thousands. The building blocks of proteins are about twenty amino acids all but one of which has the formula +(NH3-CHR-CO2 -), and all of which have the same stereochemistry around the choral carbon atom as shown. (Note that two amino acids have additional choral carbons in their ride chains, R group.
In 1765 Saxony obtained some of the Escurial type, which grows the finest wool. Subsequently, the Spanish Merino was introduced into France (1776), Prussia (1786), South Africa (1789), Australia (1797 from South Africa), USA. (1798) and later on, distributed to other countries.

Utilizing the survey results and applying the basic concepts presented by Mc Leroy (1961), in connection with classifying the sheep of Sudan, it is relatively easy to assign meaningful ecotype names to all major sheep groups originating in the country. However, the issue is somewhat more complicated in the case of several sheep aggregates that have evolved in neighboring areas but now also inhabit enclaves within Sudan. Table (1), summarizes basic classification data on the sheep of Sudan along with numerous other pertinent details.

Table (1): Classification summary of the sheep in Sudan

Sheep Ecotypes	Estimated % in Sudan	Main Tribal Breeders	Probable Allopathic Origin
Sudan Desert	65	Arabs	Northern Sudan
Sudan Nilotic	12	Nilotes	Southern Sudan
Arid Upland	01	Zaghawa	Northwestern Sudan (Darfur) & Chad
Arid Equatorial	01	Taposa	The Horn of Africa
West African Fulani	> 01	Fellata or M'Bororo	N. Nigeria, N. Cameroons & S. Chad
Fusion of Desert X Nilotic	18	Arabs & Nilotes	Fusion Zone
Fusion of Desert X Upland	01	Arabs & Hamites	Fusion Zone
Fusion of Nilotic X Arid Equatorial	01	Nilotes & Nilo-Hamites	Fusion Zone

Most of the researches and the experiments in Sudan were conducted on the sheep products (meat and milk). There were no studies or researches regarding the wool and its usage. Internationally Wool is the second important raw material to the cotton in the textile industry. Therefore, this study is conducted to make the first step in this aspect to know the spinable characteristics of the wool of Ecotype Sudan Desert Sheep for relevant textiles utilization.

Materials & Methods

Materials:

The sample materials were collected from the following areas or "Dar" (homeland or grazing land) representing the normal living area for the Sudan Desert Sheep:-

- Kababish, Hamar, Kawahla, Benigarar, Hawawir, Marareet and other tribes roughly between Wadi Hawer (in the extreme Northwest of the Dar Kababish) and the uplands of Darfur and North of El Fashir - El Nuhud Road.
- Sheep research unit – El Huda (Gezira and Watish tribal breed sheep).
- Livestock main markets at Omdurman include Aamria, Moelih and Sheikh Abuzeid.
- The submarkets at the Omdurman, Khartoum North and Khartoum.
- Omdurman Abattoir.
- Sheep breeding in the capital and its suburbs.

The wool samples have been chosen randomly avoiding the wool of the lower parts of the legs, round about the head and neck, crutch and bellies. From the forgoing the fleece is classified into two categories as follows:

1) Group (A): which represent the fleece of first sheering (Arabic 'Eiga').
2) Group (B): which represent the fleece of second sheering (Arabic 'Khilfa').

Methods:

Body Characteristics: To know Body Characteristics a questionnaire was given to sheep breeders at Sheikh Abuzied Livestock market.

Shearing: To know the purpose of shearing, time of shearing, the Eiga and Khilfa weight and the local utilization of the wool, a questionnaire was given to sheep breeders and nomads, fifty samples were collected.

Surface appearance: A sample from each group was examined by Scanning Electron Microscope (SEM) with magnification of 594X to know the longitudinal characteristics of the fibers.

Tensile testing: Samples tested with the Presley jaws separated by 1/8 inch.

$$\text{Tenacity in g/Tex} = \frac{\textbf{Breaking Load in Kg X 1.5X10}}{\textbf{Sample Weight in mg}}$$

The 1.5 appears in the equation because the sample length was 1.5 cm when the 1/8 inch gauge was used.

Fiber fineness: Fibers fineness was recorded directly by using Cambridge Instrument make, S240 Model. (Laboratory atmospheric condition: 23±2º C and 46% R.H).

Fiber length: Fiber length was recorded by using Inverted Metallurgical Microscope – NEOPHOT 32. (Laboratory atmospheric condition: 23±2º C and 46% R.H).

Hygroscopic nature:

Absorption curves: Conditional samples at 23±2º C and 46% R.H were taken from each group (A&B) and at intervals of 10% R.H. the mass gain or loss values for each were determined. Curves were produced by plotting gain or loss mass in percent against relative humidity.

Regain – time curves and hysteresis: Two samples from each group one completely wet and the other is dry, were taken into 22±2º C and 51±2 % R.H at intervals of 20 minutes, the regain was measured. The regain – time curve for both samples were plotted.

$$\text{Regain (R)} = \frac{100\ X\ Weight\ of\ Water\ (W)}{Oven\ Dry\ Weight\ (D)}$$

Effect of Acids: The effect of acids on wool samples coded as (A&B) were tested with Acetic Acid (6N), the results were given in terms of variation in pH at different time intervals. Percent of mass loss before exposure to PH of Acetic Acid (6N) = 1.57

Effect of Alkali: The effect of alkali on wool samples coded as (A&B) was tested with 6N NaOH and its results were given in terms of solubility.

Effect of bleaches:

Effect of reducible bleaches: The effect of reducible bleach was tested on wool samples coded as (A&B) with sodium Sulphite and its results were given in terms of color variation.

Effect of oxidisable bleaches: The effect of oxidisable bleach on wool samples coded as (A&B) was tested with hydrogen peroxide and its results were given in terms of percent loss of mass.

Bleaching of darkly pigmented wool:

Oxidizing method: Three grams of scoured wool sample were immersed in the bleaching liquor. The temperature initially was 50ºc and was allowed to fall as the bath stand overnight. At the end of about sixteen hours the sample was removed, squeezed, rinsed well with cold water, dried and weighed. The bleach bath as followed:
20 ml of 50% hydrogen peroxide and sufficient sodium silicate were added to 450 ml of water contained in a stainless steel vessel. The required amount of sodium silicate was determined when the specimen turns pink by adding a drop of phenolphthalein.
Results of test were given in terms of percent loss of mass, color variation and tensile strength.

Reducing followed by oxidizing method:

Three grams of scoured wool were treated with a mordant solution as following:
400 ml of water contained in stainless steel vessel, 10 ml sodium hydrosulphate ($Na_2S_2O_4$), 15 ml ferrous sulphate (Fe SO_4 $7H_2O$), 5 ml Ammonium sulphate $(NH_4)_2$ SO_4, 20 ml of 40% formaldehyde (HCHO) and sufficient amount of acetic acid (CH_3COOH) to maintain a PH of (5-6) for two hours at (65º C - 95º C). Excess liquor was removed and the wool was rinsed with cold water to remove the remaining mordant solution. Bleaching was then carried out for about one hour at 50ºc with the following bath: 450 ml of water contained in a stainless steel vessel are added to 15 ml of 50% hydrogen peroxide (H_2O_2), 20 ml sodium silicate (Na_2SiO_4) and sufficient sodium carbonate (Na_2CO_3) to maintain a PH of 9. Sample rinsed with cold water, squeezed, dried and weighed. The results of test were given in terms of percent loss of mass, color variation and tensile strength.

Results & Discussion

Body Characteristics: A detailed study of body colors was made at Sheikh Abuzied Livestock market. Although homogenous groups were seen, most flocks were found to consist of a number of characteristics colors. Generally speaking, most flocks tend to be “Abrag” spotted, (either red/white or black/white) or “Hamra” red. From personal observations, coolers are not of much interest to the shepherds concerned, and have no meaning as trademark symbols, but different colors of hair are desired for tribal use.
The marks of a well bred of this ecotype sheep are deep bodies, big, strong, heavy boned, course and upstanding enough to resist the burdens of moving vast distances looking for water and pasturage. The tail is thick (act as a storage site for excess fat in its upper

portion), tapering and long (reaching to or overlapping the ground). Figures (1- a & 1- b) represent the out view of Ecotype Sudan Desert Sheep.

Figure 1-a: Ecotype Sudan Desert Sheep

Figure 1-b: Ecotype Sudan Desert Sheep

Shearing:

Questionnaire results: 60 % of population advised that the most suitable time for sheering is the beginning of November (season of seed fall), to remove cumulated dust, dirtiness, thorn 'Haskanit', lice from the fleece. At this time of beginning, sheering allows next growth of wool before the winter season. The rest of population advised that sheering must commence at the beginning of March, so as the sheep face the summer season. Generally, in rain season, there is no sheering, so as to avoid insects' bites. Also we can observe that fleece weight of group (B) is greater than that of group (A). This is due to the differences in animal size. The hair coat is often plucked or cut but is used only in local barter or for private needs. Some animals tend to produce a mat of ragged felt (Gutn) form the shedding of an undercoat of extremely fine wool-like fibers that sometimes appear when feed conditions are good. Many of the skins are locally tanned with fleece on, for use as "Farwas" (combined prayer rug and saddle seat). The shorn wool is used alone or blended with goat's hair to improve the strength for making rope, woolen houses "Bait Shugag", rugs, bags and belting.

Surface Appearance:

The SEM micrograph shows the overlapping surface cell or scale (epithelial) structure in characteristic longitudinal view at 594 X magnification. The approximate number of surface cells or scales, for group (A) in a length of 254.2 microns, between the marks was as shown in the micrograph. Figure 2 is 35. But for group B in a length of 242.9 microns between the marks as shown in the micrograph Figure 3 are 24. The scale or cell pattern is not uniform along the length of the fiber.

In group "A" and "B" it can be seen that the scale or cell pattern is not uniform compared with a merino wool fiber Figure 4. This may have been affected by weathering. Also we can observe that, fleece of group (A) shows more scale per length than that of group (B). A dark ban/canal type shape is observed along the length of the wool fiber as shown in the photograph indicating "MEDULLA" presence, which is cortical cell debris. A modulated fiber is usually from a fleece of coarse wool, such as from across-breed or English breed of sheep.

Figure 2: Micrograph of group (A) fiber.

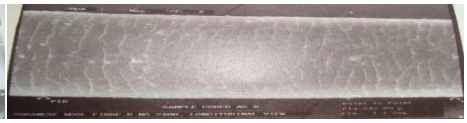

Figure 3: Micrograph of group B fiber

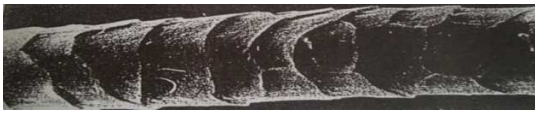

Figure 4: Micrograph of merino wool fiber,

Tensile Testing:

Tenacity in grams per Tex for group (A) is $\frac{4.23\times1.5\times10}{11.64} = 5.45 g/tex$

Tenacity in grams per Tex for group (B) is $\frac{4.24\times1.5\times10}{11.31} = 5.65\ g/tex$

It can be seen that fiber tenacity of group (A) is slightly less than that of group (B).
Figures: (5 & 6) shows weight-breaking load curves for group A & B respectively.
The curve for group (A) shows more fluctuation than that of group (B). This is due homogenous of group (B) than that of group (A), as mentioned previously in fiber fineness.

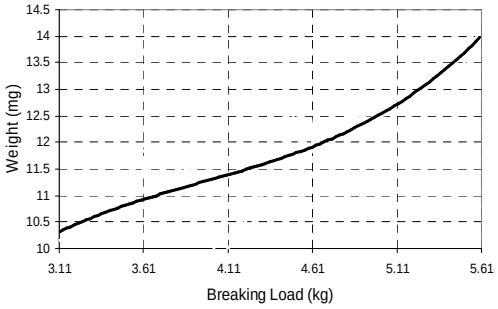

Figure 5: The Tenacity of group A

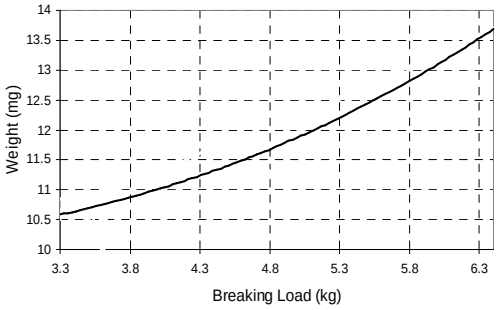

Figure 6: The Tenacity of group B

Fiber Length:
Table 2 shows the fiber length of Sudanese wool-coded as (A) and (B), from which, we can observe that fibers length of group (B) were slightly less than that of group (A). But this variations in fiber length of group (A) is less than that of group (B).

Table 2: Fiber Length of Sudanese wool-coded as A and B

Sample No.	Length in mm		Sample No.	Length in mm	
	Group A	Group B		Group A	Group B
1.	37.0	43.0	11.	37.5	24.0
2.	34.5	26.5	12.	38.0	28.0
3.	28.0	37.0	13.	46.0	4.0
4.	39.5	11.0	14.	6.0	39.0
5.	32.0	2.5	15.	13.0	35.0
6.	20.0	48.0	16.	4.0	33.0
7.	34.5	26.5	17.	36.0	38.0
8.	11.5	27.0	18.	38.0	6.0
9.	40.0	44.0	19.	3.0	22.5
10.	28.5	45.0	20.	32.0	4.0
$\overline{X}$				28.0	27.2
δ				13.1	14.6
c.v.%				46.8	53.7

Fiber Fineness:

The average fineness of Sudanese Wool coded as (A) and (B) was found to be 85.5 and 94 microns respectively, Table 3 and figure 7.

Relative humidity of laboratory when test were carried was (46 %). Therefore, the multiplying factor is 1.019. Therefore, fiber diameter for group (A) is 85.5 x 1.019 =87.1 microns and for group (B) is 94 x 1.019 = 95.8 microns.

We can observe that fibers of group (A) are finer than that of group (B) but the variation in fineness of group (B) is less than that of group (A).

Table (3): Fineness of Sudanese wool-coded as A and B

Sample No.	Diameter in microns		Sample No.	Diameter in microns	
	Group A	Group B		Group A	Group B
1.	90	100	6.	90	110
2.	110	100	7.	100	110
3.	90	100	8.	55	90
4.	100	90	9.	50	70
5.	100	70	10.	70	100
$\overline{X}$				85.5	94
δ				19.3	13.6
c.v.%				22.6	14.5

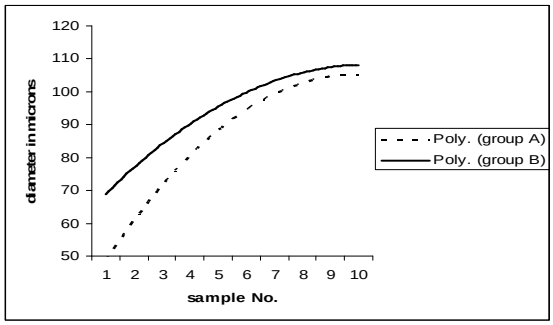

Figure 7: Fineness of Sudanese wool-coded as A and B

Hygroscopic Nature:

The very absorbent nature of wool is due to the polarity of the peptide group, the salt linkages and the amorphous nature of its polymer system. The peptide groups and salt linkage attract water molecules, which readily enter the amorphous polymer system of the wool fiber.

The two curves Figure 8 produced by plotting regain against relative humidity from table 4, for group (A&B), these curves have a characteristic sigmoid or 'S' shape.

Point (a) and (b) are the equilibrium regain at 65 percent relative humidity when approached by group (A&B) respectively. The different results of regain appear for curve (A&B) at equilibrium regain, may be depending on the number of epithelial cells (scales), which were seen more in group (A) than that of group (B).

The official regain for scoured wool is 16 percent, but for both groups (A&B) were less than 4 percent.

Table (4): Moisture content against relative humidity for group (A&B)

R.H%	Moisture content	
	Group (A)	Group (B)
30	-2.23	-2.11
40	-1.13	-1.17
60	2.48	1.52
80	3.52	3.24
90	4.09	3.69

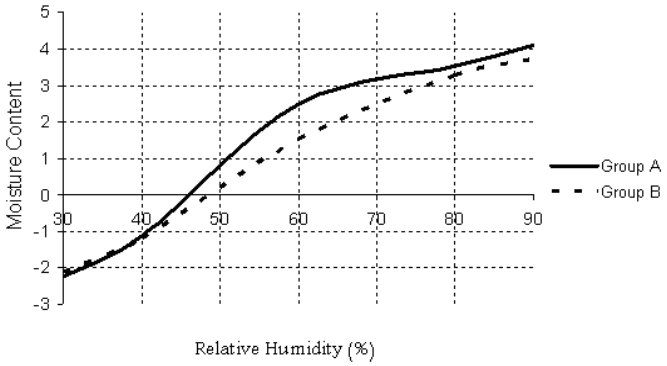

Figure: 8 Absorption curves for group (A&B)

Regain – time curves & Hysteresis:

We can observe that from Figure 9 and Figure 10 respectively, the regain changes fairly quickly at first and then move slowly as equilibrium condition are approached. The sample, which was originally wet, has a higher regain value than the other, an effect known as "hysteresis". The dry curve for group (A&B) were showing approximate linear change due to fact that, when wool is dried from regain below saturation, its adsorptive power decreases with increasing temperature of drying.

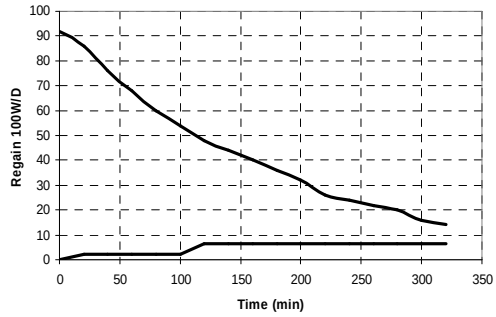

Fig. 9: The regain – time curves and hysteresis for group (A)

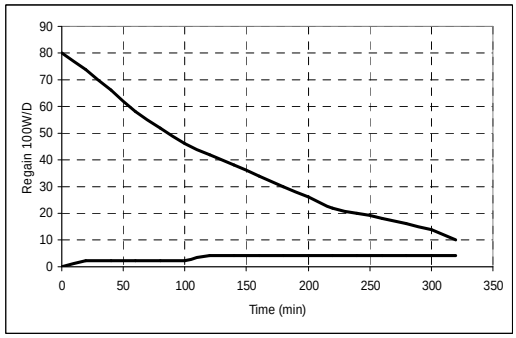

Fig.10: The regain – time curves and hysteresis for group (B)

Effect of acids:

The effect of acid on wool samples coded as (A&B) was tested with 6N acetic acid and its results are given in terms of variation in PH at different time intervals and percent loss of mass. PH of 6N acetic acid before exposure to wool is 1.57. Percentage losses of mass in samples (A&B) are 3.4 and 3.0 respectively.

Figure 11 shows PH-time curves for group (A&B), which were obtained from table (5) (PH of 6N acetic acid after exposure to group (A&B). The curves show that group (A) had a good affinity to acid than that of group (B) that is due to adsorptive power of group (A).

Table (5): PH of 6N acetic acid after exposure to group (A&B)

time (min.)	Group (A)	Group (B)
0	1.66	1.58
30	1.64	1.57
60	1.63	1.57
90	1.63	1.56
120	1.58	1.53
150	1.58	1.58
180	1.58	1.58

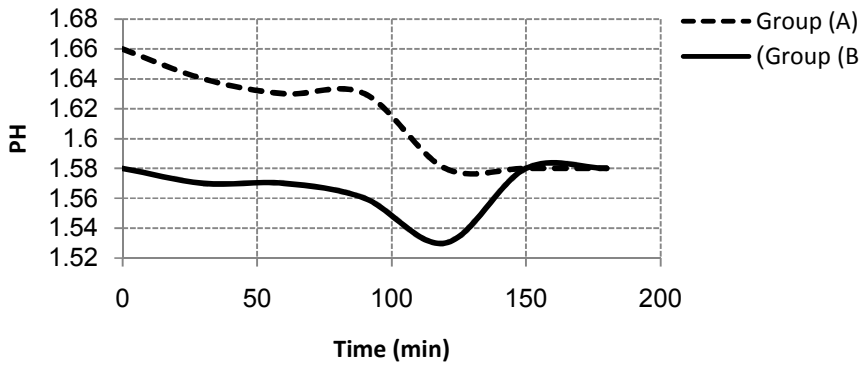

Figure -11: Time - PH of 6N acetic acid after exposure to group (A&B)

Effect of alkalis:

The effect of alkalis on wool samples coded as (A&B) was tested with 6N acetic acid (Na OH) and its results are given in terms of solubility. Both samples were dissolved completely.

Effect of bleaches:

Effect of reducible bleaches: The effect of reducible bleach was tested on wool samples coded as (A&B) with sodium sulphite and its results were given in terms of color variation. It is observed that both samples were decolorized.

Effect of oxidisable bleaches: Percentage losses of mass in samples (A&B) were 2.6 and 0.7 respectively.

Bleaching of darkly pigmented wool:

Degradation relatively easily occurs by using each of the two methods (oxidizing and reducing followed by oxidizing). Percentage losses of mass are same in both methods, which is 20 %. Figure 11 & Figure 12 shows that tenacity of wool bleached by the two methods is 9.55 & 6.95 gram per Tex respectively. Also we can observe that the second curve shows more fluctuation, due to variation in fiber strength.

The second method has a good wool decolouration action, but relatively the strength of fiber will be reduced as observed from Fig. (14, 15 and 16).

Fig. 12: Weight – breaking load for darkly pigmented wool bleached by oxidizing method

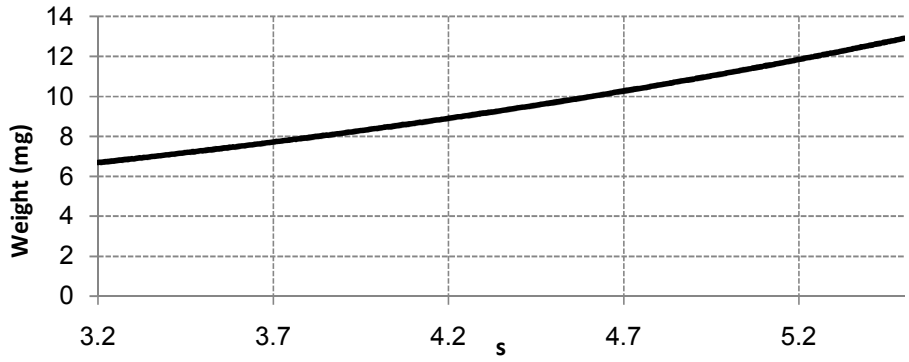

Fig. 13: Weight – breaking load for darkly pigmented wool bleached by reducing followed by oxidizing method

Fig. 14: Darkly pigmented scoured wool

Fig. 15: Darkly pigmented scoured wool, bleached by oxidizing method

Fig. 16: Darkly pigmented scoured wool, bleached by reducing followed by oxidizing method

Conclusions & Recommendation

Conclusions:

From table 6 we can observe that, group (A) 'Aiga' is characterized by, less total fleece weight, higher number of scales per length, lower tensile strength, higher moisture absorbency, fineness and longer length compared with group (B) 'Khilfa'.

Table 6 Summary results of the study

Description	Group (A)	Group (B)
Fleece weight in pound	0.84	1.035
Number of scales in a length of 254.2 microns	35	25
Tenacity in gram per tex	5.45	5.62
Fineness in microns	87.1	95.8
Fibre length in millimeter	28	27.2
Medulla	presence	presence
Absorbency	high	Low
Percentage losses of mass after exposure to 6N	3.4	3.00

acetic acid		
Effect of alkalis	dissolved	dissolved
Effect of reducible bleach	decolorized	decolorized
Effect of oxidisable bleach (percentage losses of mass)	2.6	0.7

Recommendations:

1- Environmental conditions in western Sudan are the most suitable for breeding sheep for its fiber.
2- Raw material for carpet manufacturing is quite enough to establish this industry.
3- High amount of spinable wool fiber can be utilized during tanning.
4- To avoid the negative effect of bleaching, cross-breeding should be directed to predomination of white color sheep

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