# Technology Section

Pakistan J. Sci. Ind. Res., Vol. 21, No. 2, April 1978

## STUDIES ON THE DIFFERENT PARTS OF THE FLEECE OF HASHTNAGRI SHEEP

### Part III. Nonuniformity in Dyeing of Root, Middle and Tip Portion of Wool Fibres

MUMTAZ AHMAD KHAN, AMIR MOHAMMAD KHAN and ASADULLAH JAN

PCSIR Laboratories, Peshawar

(Received February 7, 1977; revised December 6, 1977)

Samples of the five different parts of Hashtnagri fleece were collected from the autumn clip and the fibre samples were prepared by cutting equal segments of root, middle and tip portion. The damage to the samples was determined by the alkali solubility method. Tip, middle and root portions were dyed by using acid, reactive and basic dyes. The results on the variations in dye uptake of the three segments in the various parts of the fleece have been discussed.

## INTRODUCTION

Loebner in 1890 associated yellowing and harshening of certain portions of the fibre on the sheep's back with exposure to sunlight [1]. It was, however, about thirty years later that the important part played by climatic factors in affecting the properties and processing behaviour of wool was realised, when differences between normal and sufficiently weathered wool were methodically studied. This pioneer work was carried out with particular reference to what is now known as "tippy" dyeing.

There are a number of reasons for nonuniformity in dyeing of carpet wool. One of the reasons is that the tip of the staple behaves differently to that of the rest of the fibre as regards absorption of the dye. It has been found that tippiness is also caused by the damage due to weathering [2]. It has been observed recently that more tippiness is obtained in the autumn clip than in the spring clip [3]. This may be due to the fact that the autumn clip was subjected to more severe climatic conditions, i.e. increased exposure to sunlight, etc.

Weathered and sound wool differ in many of their physical and chemical aspects [2]. This study is specifically aimed at the damaged and dye absorption of tip, middle and root end of the fibre, and was carried out to establish the extent of nonuniformity in dyeing between the different parts of Hashtnagri fleece as well as between the root, middle and tip portions of the fibre.

## MATERIALS AND METHODS

The wool samples were collected from the Hashtnagri breed kept on the sheep farm at the PCSIR Laboratories Campus. The samples were collected in October 1970 from the autumn clip. The samples were sheared from the following parts of 10 of the randomly selected sheep: (i) back, (ii) body, (iii) belly, (iv) neck, and (v) britch wool.

The above samples were purified by Soxhlet extraction with ethyl ether followed by soaking in ethanol and finally washed with distilled water [6]. The staples from each of the five parts of the sheep were cut into three equal parts i.e. tip, middle and root portion, and subjected to the following investigations.

*Medullation.* Medullated and true fibres were separated as described elsewhere [7], after cutting the fibres into the segments as described above.

*Alkali Solubility.* The damage to all the samples was determined by the alkali solubility method [8].

*Dyeing.* (a) Acid dye bath consisted of 2% dye (Croceine Scarlet 3RS), 4% sulphuric acid (concd) and 10% sodium sulphate based on the weight of fibre [9]. In order to avoid unevenness in dyeing, the temperature of the bath was raised slowly and boiling was done for 1 hr.

(b) Reactive dye bath consisted of 2% dye (Cibalan Brilliant Yellow), 1% acetic acid which ensures the maintenance of pH 6 (approx) [10]. The bath was heated to about 50° and the material was treated for 10 min. The temperature was raised to the boil within 15-45 min and dyeing continued at this temperature for 30 min.

(c) Basic dye bath consisted of 2% dye (Methylene Blue) 0.5% acetic acid [11]. The bath was heated to 50°, the well-dissolved dyestuff was added, and dyeing continued at 90° for 30 min.

*Determination of Dye Uptake.* The dye uptake of the tip, middle and root portions were determined with a leukometer (Dr. Burno Lange GmbH, Berlin) using red, green and blue filters [12]. The dye uptake was calculated from the percentage reflectance of the dyed fibre. Normally, measurements were made by comparing a known percentage of Standard White for which the reflection of the measuring instrument was adjusted to the nominal value of the standard. The intensity of colour of the specimen under test was read off as a percentage of the whiteness of the standard.

*Spectrophotometric Determination of Dye Uptake.* The dye uptake of the tip, middle and root portions were determined by spectophotometer, Spectronic 20.

The dye uptake was calculated with the help of standard curves obtained from the transmittance of the known concentration of Cibalan Yellow Brilliant and Crocein Scarlet 3RS using constant frequencies of 580 and 610 nm respectively.

## RESULTS AND DISCUSSION

Table 1 shows that, in general, the tip portion contains a larger medullated portion than do the middle and root ends. This is because coarse (medullated) fibres grow more rapidly in comparison with the fine (true) fibres [13]. However, in the belly and britch wool the percentage of medullation in the three portions is approximately the same. It confirms the earlier work [14] that wool from belly and britch is inferior compared to that from other parts and is also contaminated with urine, dung etc.

Table 2 shows that the tip portion is generally more damaged as compared to the middle and root portion of the same fleece. This is in accordance with the German Industry Standard (DIN) using alkali solubility method.

There are a number of causes for tippiness. It has been reported that lack of uniformity in length is often manifested as tippiness, one cause of which is the more rapid growth of the coarse or hairy fibres, which results in the staple having a pointed tip. Tippiness can also be caused by damage due to weathering and a "wispy' tip in the Merino is caused by thin fibres [7] resulting from poor nutrition [13]. In the case of carpet wool it has been observed [5] that the staples of the autumn clip have more tip portion, whereas the majority of the staples of spring clip do not have as large a tip portion. The probable cause of this may be attributed to the fact that the exposed part of the fibre are easily eroded by contact and rubbing with hot bodies during the hottest period of the year. From this it appears that the problem of nonuniformity in dyeing due to tip portion will occur largely in the autumn clip. The tip portion of Hashtnagri wool is quite prominent. During growth, the tips of the fleece, particularly back, belly and shoulder wool are exposed to weathering (sunlight, excessive moisture etc.) and suffer degradation. The damaged tips show a deficiency or total loss of scales and they are more readily wetted out and swell to a greater degree in the dye bath than does the undamaged portion of the fibre. Through the weathering on the sheep's back, the disulphide bonds in the wool fibre are broken [16]. As a result of this rupture, higher rates of dye absorption and higher alkali solubility are observed.

Table 3 shows that the tip portion is heavily dyed as compared to the middle and root end. Reactive dye (Table 4) and basic dye (Table 5) behave in the same manner as the acid dye. The acid dyes (levelling) were found to have a tendency towards 'negative' tippy dyeing as in the case of other dyes (Tables 6 and 7). It is due to the good migration power of levelling dyes. In the case of fine wool (Merino), the difference in % dye absorption in tip, root, and middle portion is greater as compared to the carpet wool under study. It appears that fine wool suffers more through expsoure to sunlight than does the coarse fibre. This can be explained on the basis of the greater fibre sufrace per unit weight exposed.

The graphs for Cibalan Yellow Brilliant and Croceine Scarlet 3RS obtained by spectrophotometric determination of known dye concentration and unknown dye liquor also show that the tips portions are dyed heavily as compared to the middle and root portions, which is in conformity with the dye

Table 1. True and medullated fibre in various parts of Hashtnagri fleece.

| Part | Tip | | Middle | | Root | |
|---|---|---|---|---|---|---|
| | True % | Medullated% | Ture % | Medullated% | True % | Medullated% |
| Back | 44·2 | 55·8 | 70·7 | 29·5 | 79·2 | 20·8 |
| Body | 57·9 | 42·1 | 66·3 | 33·7 | 76·9 | 23·1 |
| Belly | 38·7 | 61·3 | 42·5 | 57·5 | 36·4 | 63·6 |
| Neck | 36·3 | 63·7 | 66·2 | 33·8 | 77·0 | 33·0 |
| Britch | 44·8 | 55·2 | 57·2 | 42·8 | 42·3 | 57·7 |

Table 2. Alkali solubility of various parts of Hashtngari fleece.

| Part | Tip % | Middle% | Root% |
|---|---|---|---|
| Back | 20·0 | 10·9 | 10·8 |
| Body | 19·7 | 8·0 | 9·3 |
| Belly | 26·2 | 9·2 | 8·0 |
| Neck | 8·3 | 9·2 | 8·1 |
| Britch | 17·3 | 12·0 | 14·5 |

Table 3. Mean percentage reflectance of Hashtnagri samples dyed with acid dye (Groceine Scarlet 3RS)I.

| Part | Reflectance% | | |
|---|---|---|---|
| | Tip | Middle | Root |
| Back | 69·8 | 72·8 | 72·3 |
| Body | 57·5 | 59·0 | 59·5 |
| Belly | 62·5 | 66·0 | 66·9 |
| Neck | 55·5 | 56·5 | 56·2 |
| Britch | 62·3 | 67·7 | 67·0 |

Table 4. Mean percentage reflectance of Hashtnagri wool samples dyed with reactive dye (Cibalan Yellow Brilliant).

| Part | Reflectance% | | |
|---|---|---|---|
| | Tip | Middle | Root |
| Back | 83·8 | 86·6 | 84·0 |
| Body | 81·4 | 83·7 | 82·5 |
| Belly | 82·1 | 84·7 | 83·6 |
| Neck | 83·4 | 81·8 | 83·9 |
| Britch | 82·7 | 81·7 | 77·4 |

Table 5. Mean percentage reflectance of samples from various parts of Hashtnagri wool dyed with basic dye (Methylene Blue).

| Part | Reflectance% | | |
|---|---|---|---|
| | Tip | Middle | Root |
| Back | 17·3 | 23·2 | 24·5 |
| Body | 22·5 | 27·6 | 28·3 |
| Belly | 30·5 | 32·1 | 34·4 |
| Neck | 30·1 | 32·4 | 31·7 |
| Britch | 8·1 | 10·2 | 11·5 |

Table 6. Spectrophotometric determination of unknown dye (Cibalan Yellow Brilliant) concentration.

| Part | Reflectance% | | |
|---|---|---|---|
| | Tip | Middle | Root |
| Back | 72 | 70 | 69 |
| Body | 72 | 69 | 69 |
| Belly | 85 | 72 | 70 |
| Neck | 82 | 71 | 69 |
| Britch | 75 | 64 | 62 |

Table 7. Spectrophotometric determination of unknown dye (Croceine Scarlet 3RS) concentration.

| Part | Reflectance % | | |
|---|---|---|---|
| | Tip | Middle | Root |
| Back | 70 | 66 | 67 |
| Body | 76 | 74 | 74 |
| Belly | 79 | 77 | 77 |
| Neck | 83 | 81 | 81 |
| Brith | 72 | 61 | 60 |

uptake determination using the leukometer. However, the spectrophotometric determination covers some of the anomalies which exist in the leukometer method of the dye uptake determination.

The tip portion of the staple is harsh, yellow and weak. The wool buyer pays less for a tippy wool than sound wool. But this applies to fine wool, as in the fine wool there is a greater difference in the properties of the tip and the rest of the fibre. Moreover, the dye absorption is also greater in fine wool as compared to carpet wool. Furthermore, the percentage of noils also increase in fine wool as the tip portions break in processing, especially in carding. In a carpet wool, this does not have much effect as the fibres are much stronger.

In part I of the present series [4], it was concluded that little difference occur in felting behaviour of various parts except belly wool which shows least felting. This minimum felting appeared to be due to an excess of medullated fibres in this part. Part II [5] showed that generally fibre and medulla diameter decrease from root to tip end. However, in the wool from the back, the middle segments of some of the fibres have greater fibre and medulla diameters but others have lower. There was no variation in diameter of the three segments in the case of true wool fibres. In the present study it has been concluded that, in general, the dye uptake of tip portion is higher as compared to middle and root end of the wool fibre by applying acid, reactive and basic dyes. However, by applying reactive dye, the uptake of britch portion is abnormal which may be due to contamination with urine, dung etc.

**Acknowledgements.** The authors are thankful to Dr. S.M.A. Shah for correcting the manuscript, to Mr Abdul Rashid, for determining medullation of the wool samples.

## REFERENCES

1. Anonymous, Wool Sci. Rev., **27,** 27 (1965).
2. Anonymous, Wool Sci., Rev., **28,** 12 (1965).
3. M.A. Khan, Pakistan J. Sci. Ind. Res. (in press)
4. M.A. Khan, Pakistan J. Sci. Ind. Res., **18,** 187 (1965).
5. M.A. Khan, Pakistan J. Sci. Ind. Res., (in press)
6. M.A. Khan, Pakistan J. Sci. Ind. Res., **13,** 305 (1970).
7. Anonymous, Wool Sci. Rev., **13,** 38 (1954).
8. A. Agster, *Farberei und Textilchemische Untersuchungen* (Springer Verlag, Berlin, 1967), tenth edition, p. 389.
9. H. Rath, *Lehrbuch der Textilchemie* (Springer Verlag, Berlin, 1963), second edition, p. 516.
10. C.L. Bird, *The Theory and Practice of Wool Dyeing* (Chorley and Pickersgill, Leeds, 1972), fourth edition, p. 104.
11. E.R. Trotman, *Dyeing and Chemical Technology of Textile Fibres* (Griffin, London, 1964), third edition.
12. B. Lange, Photoelectric Leukometer, German (Berlin) Patent, 829,812.
13. M. L. Ryder and S.K. Stephenson, *Wool Growth* (Academic Press, London, 1968), p. 582.
14. W.V. Bergen and H.R. Mavessberger, *American Wool Handbook* (Textile Wool Publisher, New York, 1969), vol. II, third edition, p. 14.
15. Ref. 8, p. 390.
16. Anonymous, Wool Sci. Rev., **29,** 37 (1966).