Value Addition To Deccani Plateau Wool Fibers

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ABSTRACT

The deccani sheep breed is a source for coarse wool-cum-meat. Gongali/ kambali is a traditional multi-purpose blanket with coarse deccani fibres. On an account of declining institutional and government purchases, the market for the kambali has collapsed. Thus, innovative approaches towards the use of deccani wool fibre will improve value added products that have potential market, which not only helps to provide livelihood security to the rural people but also improves export from the country as well address the burning issues like increasing demand, restoration of endangered sheep breed of the Deccan plateau, employment generation in rural and semi urban areas and will open new avenues in the field of research.

Keeping in view the above advantages, coarser deccani wool fibres were softened with protease enzymes in order to attain pliable and smooth fibers, in turn can get good handle fabrics, thereby improving its processing and utilization. Enzymes being natural products are completely bio-degradable and require low activation energy to soften the fibres for further usage with enhanced fibre properties. Therefore the present study was undertaken to assess the performance characteristics of the deccani wool fibers treated with enzymes (Papain and Pepsin with 1, 2 and 3 per cent concentration). Among all one percent concentration enzyme treatment to fibers was proven to be soften the fiber without much change in its tensile strength.

INTRODUCTION

In India woolen textile industries are relatively small compared to cotton and manmade textiles & clothing industries. Since the global supply of wool is decreasing, it will be difficult to meet the requirement of woolen industry in years to come. However, the woolen sector is a rural based, export oriented industry linking the rural economy with the manufacturing industries. The domestic producer of wool is not adequate, therefore, the industry is dependent on imported raw material and wool is only natural fibre in which the country is deficient.

India's vast genetic resources in sheep and goats are reflected by the availability of 40 breeds of sheep and 20 breeds of goats. India serves as 3rd largest sheep population country in the world having 6.40 crores sheep producing 43.30 million kg of raw wool. Out of this about 85% is carpet grade wool, 5% apparel grade and remaining 10% coarser grade wool for making rough kambals etc. Average annual yield per sheep in India is 0.9 Kg, against the world average of 2.4 Kg. Among the Indian sheep breeds, the most important in number and distribution are Marwari and Deccani. Sheep found to the north of the Tungabhadra River are called "Deccani" **(Acharya, 1982).** The deccani breed of sheep is widely distributed in the Deccan plateau across the three states of Maharashtra, Andhra Pradesh and Karnataka. Andhra Pradesh (AP) has the largest sheep population in the country (213 lakhs as of 2003), of which approximately 40% are of the deccani breed. The deccani breed is valued for its coarse wool, meat and manure. It is unique worldwide because of its wool, which comes in various shades of black. The deccani sheep wool is the source of gongali/gongadi/kambali (local blanket) one of the most essential and multi-purpose traditional apparels worn and used by communities across the Deccan, particularly the pastoral communities. This unique black wool breed of sheep is completely adapted to local ecological conditions in Telangana and other semi-arid parts of the Deccan and provides a livelihood to a wide range of shepherds, crafts people and farmers.

A sheep produces about 250–500g of coarse, hairy wool. The average fibre diameter varies widely, where one fleece may average 35 μm, while another is much coarser up to 70 μm. The overall average is 53 μm. About one-quarter of the fleece is fine, good quality wool, with fibres around 24 μm in diameter. This fibre is suitable for spinning. Another quarter of the fleece is very coarse and hairy, with fibre diameters around 58 μm. Though at the cottage level, certain amount of this wool is being spun into yarn by hand spinning, it suffers with many deficiencies in terms of yarn quality and heavy dropage of 60 to 70% on the original wool reducing the yarn yield from 30 to 40%. This creates a high wastage of fibre which is not used and resulting in meeting the expenses of shearing cost **(Bardhan, 2011).**

When this wool is used in apparels, there is resistance to the utilization, as these items are usually stiff, scratchy, droppings due to fiber breakages and are susceptible to shrinkage. Therefore, it is necessary to utilize this unusable coarse wool in a creative way to produce value added products. For this reason, the need to develop effective methods for utilizing this type of wool has become technologically and ecologically important. The innovative approaches towards the use of deccani wool fiber will also address the burning issues like increasing demand, restoration of endangered sheep breed of the Deccan plateau, employment generation on rural and semi urban areas and will open new avenues in the field of research.

Enzymes being natural products are completely bio-degradable and accomplish their work quietly and efficiently without leaving any pollutant behind as well soften the fibers. The utilization of enzymes in the textile industry has been known and applied commercially from many years, principally in cellulosic fibres. However, for protein fibres enzyme applications are limited, but there are possibilities to change the characteristics of protein fibers through enzyme treatments, which include the use of proteases for wool and silk processing.

MATERIAL AND METHODS:
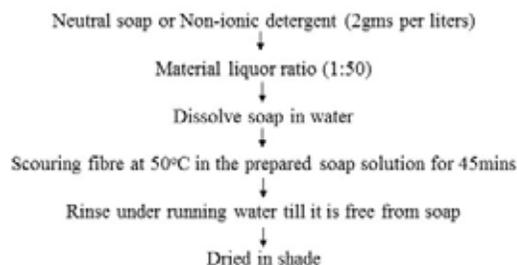
Selection of fibre

Popular varieties of Deccan plateau wool in Andhra Pradesh namely, Nellore mixed white (NMW), Deccani brown with black (DBB) and Deccani black (DB) were selected for study. Pilot study was conducted in order to assess the strength of the Deccan plateau wool fibre varieties by tensile strength tester in

the Department of Textile and Engineering, DKTE (Dattajirao Kadam Technical Education) Society's Institute Textile and Engineering, Rajwada, Ichalkaranji, Kolhapur Dist, Maharashtra.

Based on observation of the tested fiber varieties, deccani black variety was selected for the study. Selected fibre was procured from Deccani Wool Society that belongs to shepherd (kurba) community from Shankerpally village, Ranga reddy district, Hyderabad. As the Fibres were randomly collected from different body parts of the sheep, their length vary from 2 to 6 inches.

Scouring
Raw wool contains dirt, grease and sand. To remove contaminants, the wool is scoured before enzyme treatment and subjected to washing under the following procedure:

Neutral soap or Non-ionic detergent (2gms per liters)
↓
Material liquor ratio (1:50)
↓
Dissolve soap in water
↓
Scouring fibre at 50ºC in the prepared soap solution for 45mins
↓
Rinse under running water till it is free from soap
↓
Dried in shade

Selection of enzyme
Enzymes are biocatalysts, without which no life in plant or animal kingdom can be sustained. Enzymes are complex molecules and proteases are the main class of enzyme used for modifying protein fibre surfaces. Utilization of protease enzymes can improve some physical and mechanical properties of protein fibres such as smoothness, drapability, water absorbency and dyeing affinity. Two laboratory grade protease enzymes Papain (Pa) and Pepsin (Pe) (Rolex Chemical Industries, Mumbai) were selected for the study.

Optimization of enzyme concentration
To standardize the softening treatments on Deccani wool fibre, two varieties of enzymes namely Papain and Pepsin with three different concentrations of 1, 2 and 3 percentages were selected for the study. 100 grams of fibre was weighed and used for enzyme treatment. Based on the weight of fibre the enzyme requirement was calculated for providing concentration of 1, 2 and 3 percentages with M: L ratio of 1:30. To attain the stable pH 5 for proteolytic enzyme in the solution, buffer is needed. Fibre was placed in the solution for 30 minutes under continuous rotation. Later it was rinsed and dried in shade.

Assessment of physical properties of enzyme treated deccani wool fibre
The enzyme treated Deccani wool fibres were subjected to physical testing to determine the quality parameters which play a major role in evaluation of the quality of the fabric.

Determination of moisture
Moisture content is the weight of moisture in a material expressed as a percentage of the total weight of the material and *moisture regain* is the weight of moisture in a material expressed as a percentage of the oven dry weight of the material (Angappan and Gopalakrishnan, 1997). The test was carried out as per the test method IS 6637-1972.

Linear density
IS 234-1973, test method was used to test fineness of the fibre.

Fibre tenacity (gms/tex)
The maximum load (force) suggested for test specimen in a tensile test was carried out to rupture, is the breaking load or the tensile strength of the fibre. The breaking strength of the fibre

determined is usually taken as an index of fibre quality and is expressed either in grams or pounds. The specimens were tested on Instron 5565 machine with the 10mm/min testing speed, CRE principle in the DKTC'S Institute of Textile and Engineering, Rajwada, Ichalkaranji, Kolhapur Dist, Maharashtra.

Enzyme treatment on fibre
Two enzymes, Papain and Pepsin were selected for the study with 1, 2 and 3 percentages. Based on the SEM analysis and properties of the tested samples, one per cent of both enzymes were selected for the study.

To carry out the treatment temperature was maintained between 40^0-60^0C with MLR of 1:30 for 30 min. The pH was maintained to 5 by using buffer. Buffer is an aqueous solution that has a highly stable pH, by adding acid or base to a buffer solution can be maintained.

Buffer preparation: Each of the enzymes acts/reacts in certain conditions. Citrate phosphate buffer was required for Papain, which is prepared by mixing 0.2M dibasic sodium phosphate and 0.1M of citric acid making a volume of 100ml with deionized water.

where as Pepsin required Hcl / Kcl buffer, which was prepared by mixing 0.1M potassium chloride and 0.1M hydrochloric acid making a volume of 100ml with deionixed water **(Gholamreza et al., 2008).** pH can be ensured by using sensitive pH meter **(Pearse,1980)**

Enzyme was added to the prepared buffer solution in which fibres was immersed for 30 min. Later, the fibres were rinsed and shade dried.

Scanning electron microscopy (SEM) analysis
The dried wool samples were mounted over the stubs with double-sided carbon conductivity tape subjected for vacuum desiccated for 2 hours and a thin layer of gold coat over the samples were done by using an automated sputter coater (Model- JEOL JFC- 1600) for 3 minutes and scanned under Scanning Electron Microscope (SEM-Model: JOEL-JSM 5600) at required magnifications as per the standard procedures at RUSKA lab, College of Veterinary Science, SVVU, Rajendranagar, Hyderabad.

RESULTS AND DISCUSSION
Selection of fibre variety depend on tensile strength. The three types of Deccan plateau wool fibres were tested to ensure its tenacity, among which Deccani black fibres has more strength, which in turn requires more energy to rupture the fibre compared to the other fibres, as shown in Table 1. Hence, Deccani black fibres were selected for further study.

Table 1 Tensile strength of selected fiber varities

Samples	Linear density (Tex)	Breaking load (gms)	Tenacity (gms/Tex)	Extension at break (mm)	Secant modulus (gms/Tex)	Nominal rupture energy (gms/Tex)
NMW	25.3	36.64	1.44	3.80	0.38	27.56
DBB	26.0	37.80	1.45	3.06	0.47	22.28
DB	27.0	48.33	1.79	4.59	0.39	41.09

Properties of enzyme treated fibres
From the Table 2, it was observed that tenacity of one per cent enzymes treated-Deccani black are in par with control sample. Therefore, one per cent enzymes treated Deccani black was taken for further study.

SEM analysis

Sample	Moisture content (%)	Moisture regain (%)	Linear density (Tex)	Breaking load (gms)	Tenacity (gms/Tex)	Tensile strain (%)	Elongation at break (mm)	Relative extension (%)	Secant modulus (g/Tex)	Nominal rupture energy (g/Tex)
Control	13.2	39.8	27.8	48.14	1.76	41.42	4.19		0.39	41.20
1% Pn	10.0	38.2	21.3	39.14	1.84	11.16	3.97	71.4	0.42	25.82
2% Pn	10.0	31.9	22.3	28.15	1.34	41.23	3.42	80.1	0.35	25.76
3% Pn	12.0	42.8	18.1	28.77	1.26	46.08	4.21	135.4	0.38	20.82
1% Ps	11.4	37.6	23.4	41.78	1.46	48.31	4.89	187.1	0.28	34.26
2% Ps	10.0	46.8	21.7	28.49	1.39	42.82	4.26	70.1	0.36	42.21
3% Ps	12.0	31.4	38.6	24.28	1.21	17.20	1.78	124.2	4.21	38.47

DB Fibers treated with Enzymes and control sample were subjected to SEM analysis to determine surface modification that occurred on the fibre structure.

SEM analysis of DB fiber with Papain enzyme
It was observed that 1 percent Papain enzyme treated wool fiber have shown flattened scales, where as scratchy and disappearance of scales was noticed in 2 and 3 percentages respectively. 2 percent treated fibers were not only limited to primary layer scratching but also affected second layer as shown in Figure 1. With the destruction of the scales, 3 per cent enzyme treated fiber showed smooth surface, which means cuticle layer was destroyed as well affecting the secondary layer.

SEM analysis of DB fiber with Pepsin enzyme
From the Figure 2. SEM analysis showed that 1 per cent Pepsin treated wool fibre has flattened scales which imparted softness to the fibres. In 2 per cent Pepsin treated wool fibre there were reduced scales from the surface of the fibre and it imparted softness to fibre. 3 per cent Pepsin treated wool fibres have shown rinse scales from the surface of the fibre by softening the fibre. 3 per cent treatment has not only showed scratches on primary layer but also destroyed secondary layer. However the scales were not removed completely for 2 and 3 percentages.

SEM results were correlating with the findings of **Gholamreza(2008)**, wherein he confirmed that, the enzyme can soften wool fiber's surface and it mostly dependents on enzyme concentration, pH and time. Obtained findings were corroborating with **Nejad's (2001)** research, where the structural damages of wool were found due to increased percentage of enzyme. Among SEM analysis of the Papain and Pepsin treated fibres with 1, 2 and 3 percentage concentrations, fibres with 1 per cent treatment of both enzymes have shown good pliability with strength compared to other per cent treatments.

Bardhan (2011) worked on coarse Indian wools for better utilization, where deccani wool having diameter of 48 micron was opened on the willowing machine and processed on wool card to get uniform web. Felt densities were between 0.1 to 0.5 g/cc. Results reveals that different products were prepared using these felts such as rubber coating for electrical insulation mats and vibration dumping mats, POP and gypsum mixing for false ceiling, wool epoxy composites electrical boards and door panel.
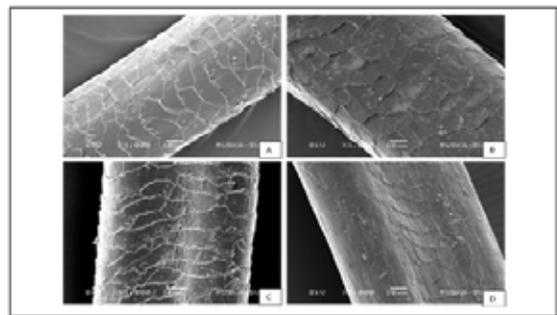

Figure 1. SEM analysis of Papain enzyme treated fibres (A) Untreated fibre, (B) 1%, (C) 2% and (D) 3%.
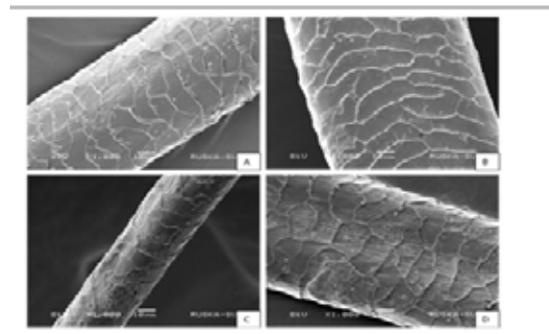

Figure 2. SEM analysis of Pepsin enzyme treated fibres (A)Untreated fibre, (B) 1%, (C) 2% and (D) 3%.

CONCLUSION:
Based on tensile strength, tenacity and break time of the fibres, Deccani black wool fibre was selected for further study. Treatment with two types of protease enzymes, such as Papain and Pepsin was carried out on deccani black wool variety fibres, sourced from AndhraPradesh. Enzymes application has an important influence on surface structure and other fibre properties. To standardize the protease enzyme's percentage for softening of fibers, tests for 1, 2 and 3 percentages was conducted. Deccani black wool fiber with one per cent enzyme treatment can give good pliability and handle, which can be utilized in developing value added textile products.

REFERENCE

1. Acharya, R. M. 1982. Sheep and goat breeds of India. FAO animal production and health paper 30. http://www.fao.org/docrep/004/x6532e/x6532e00.htm#TOC | 2. Angappan, P. & Gopalakrishnan, R. 1997. Textile Testing. 4th edition. Tamil Nadu: SSMITT. | 3. Bardhan, M.K. 2011. Development of composites from coarse Indian wool for better utilization. Wool Research Association, Thane. | 4. Bardhan, M.K. 2011. Softening of coarse Indian wools for better utilization in value added products with pliable feel & handle. Wool Research Association, Thane. | 5. Gholamreza, G., Zargham, S., Mojtaba, T.Y. and Mostafa, J. 2008. Comparison of surface modification of wool fibres using pronase, trypsin, papain and pepsin. Fibres & Textiles in Eastern Europe. 16 (3): 68. | 6. Nejad, N.H., Kordestani, S.S. and Vahabzadeh, F. 2001. Enzymatic Treatment of Wool fabric: Effects of the surfactants. Iranian Polymer Journal. 10 (2): 125-132. | 7. Pearse. 1980. Citrate Phosphate Buffer. | http://books.google.co.in/books?id=Dhn2KispfdQC&pg=PA681&dq=pearse+1980+buffer&hl=en&sa=X&ei=8OB4U9G2OcKxlQWn2ICwBg&ved=0CC4Q6AEwAA#v=onepage&q=pearse%201980%20buffer&f=false |