CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Wool fibre has a composite structure with three major parts such as cuticle, cortex and medulla, in which the inner cortex is hydrophilic in nature due to the large number of polar groups contained in the polypeptide chains of the cortex. The outer surface of wool fibre is hydrophobic due to the presence of a high degree of disulphide cross-linkages in the cuticle layer and the 18-methyleicosanic acid bound on the surfaces which are thought to provide a surface barrier against diffusion of chemical into wool fibre (Peet et al 1995; Maclaren and Milligan 1981).

Many chemical treatments have been developed to modify the wool fibre surface, they are sodium hydroxide (Miro and Gacia 1973), vinyl monomer (Ceresa 1973), formic acid (Leeder et al 1983), aliphatic amines (Coderch et al 1991), epoxide polymer (Ito et al 1994), protease enzyme (Heine et al 1995), chlorination (Kan et al 1998), plasma treatment (Erra et al 1999), aliphatic acid anhydride (Freddi et al 1999), dichloroisocyanuric acid (Cardamone et al 2004) and lipolytic enzyme (Kantouch et al 2005).

The chemical modification of wool fibre can be regarded as a powerful tool to improve aesthetic and functional performances and to impart new physio-chemical and functional properties suitable for technological implementation in order to meet market requirements for better wear and
maintenance behaviour of woolen materials, and for developing new textile products. Wool fibre has natural felting shrinkage property due to the presence of scale structure (Lewis 1992). The degradative chlorination treatment followed by application of an anionic polymer called Hercosett 57 on woolen material imparts shrink resistance (Earle et al 1971). Similarly without chlorination, application of Synthappret-BAP an anionic polymer on woolen materials imparts shrink resistance with slight reduction in softness (Guise and Jackson 1973).

Wool is more likely to suffer bacterial attack than cotton and so the application of antimicrobial finishing on wool and cotton textiles had more attention than other textile fibres (Schindler et al 2005). Recently cyclodextrin, a biopolymer has been used in textile industry for anti-odor as well as anti microbial finishing agent for wool and cotton (Buschmann et al 1998).

Generally aesthetic properties of the textile material can be improved by the application of finishing chemicals with prior modifications in fibre surface or in morphology by a suitable chemical treatment. Many chemical treatments had been developed as pretreatment and finishing over the years for all wool fabrics and their intimate blended fabrics in order to improve their aesthetic properties. However the literature review revealed a void in research in chemical treatments that improve aesthetic properties of the woolen products made from Indian wool. It is believed that if the prior enzyme treatment(s) enhance the finishing performance of a woolen materials, then their aesthetic as well as functional properties will be improved after finishing, which is the main purpose of this doctoral thesis.

In agreement with the objectives defined for the present thesis, the first part contains the general introduction corresponding to Indian textile
industry with reference to woolen sector. The second part contains a brief bibliographic revision of the topics related wool processing and use of different chemical treatments for the improvement of aesthetic and functional properties of woolen materials. The experimental plan for carrying this research work is coming next to literature survey. The third part presents the major results attained in the scope of this thesis with a general discussion and the major conclusions.

Thus, the organization of this thesis comprehends three major parts:

i) 1st part-Introductory chapter: This part contains about general introduction to Indian woolen sector and aims of the work – Chapter 1.

ii) 2nd part-Chapters developing the main theme of the thesis: This part contains the literature survey and the experimental procedures – Chapters 2 and 3.

iii) 3rd part-Results, Discussion and Conclusion: This part contains the attained results, respective discussions and conclusions – Chapters 4 and 5.

1.2 INDIAN TEXTILE INDUSTRY

The Indian textile industry is one of the largest and most important sectors in the economy in terms of output, foreign exchange earnings and employment in India. It contributes 20 per cent of industrial production, 9 per cent of excise collections, 18 per cent of employment in industrial sector, nearly 20 per cent to the country’s total export earnings and 4 per cent to the GDP. The sector employs nearly 35 million people and is the second highest employer in the country (Anon 2005).
The textile sector also has a direct link with the rural economy and performance of major fibre crops and crafts such as cotton, wool, silk, handicrafts and handlooms, which employ millions of farmers and crafts persons in rural and semi-urban areas. It has been estimated that one out of every six households in the country depends directly or indirectly on this sector. India’s textile industry comprises mostly small-scale, non-integrated spinning, weaving, finishing, and apparel-making enterprises (Anon 2007a). The consolidated picture of Indian textile industry textile industry is described below.

1.3 TYPES OF TEXTILE INDUSTRY

1.3.1 Spinning mills

In 2003-04, India’s spinning sector consisted of about 1,135 small-scale independent firms and 1,564 larger scale independent units. Independent spinning mills account for about 75 per cent of capacity and 92 per cent of production.

1.3.2 Weaving mills

India’s weaving and knitting sector contains powerloom, handloom and mill sector. In 2003-04 it consisted of about 3.9 million handlooms, 1.8 million powerlooms, and 0.1 million looms in the organised sector. The decentralised power loom sector accounts for 95 per cent of the total cloth production. The knitted sector contributes about 18% of the total fabric production.
1.3.3 Processing units

The processing industry is largely decentralised and marked by hand processing and independent processing units. Composite mill sectors are very few falling into the organized category. There are about 2,100 independent and 200 composite units in India.

1.3.4 Garment manufacturing units

Small-scale fabricators dominate garment manufacturing. Most garment manufacturing units fare reasonably well on the technology count. The bulk of apparel is produced by about 77,000 small-scale units classified as domestic manufacturers, manufacturer exporters, and fabricators. The fragmented structure of the industry provides the advantage of a large pool of skilled workers in different areas of textile manufacturing, and also gives scope for entry of organized integrated textile manufacturers. Small scale units in different sectors can also be leveraged as a supply base for sourcing materials at low cost (Anon 2005).

1.4 INDIAN WOOLEN INDUSTRY

India’s raw wool production in 2005-2006 was over 50 million kg and (Anon 2007c) imports nearly 90 million kg of wool from Australia and New Zealand for apparel production and high quality carpets. The quality of domestic wool is coarse, brittle and is mainly used for production of apparels, various qualities of carpets and also for very low quality carpets, barrack blankets, durries, and kamblies. Among woolen sectors, carpet manufacturing segment is a major contributor to woolen exports (80%). The woolen industries in India are primarily located in the northern states of Punjab, Haryana, and Rajasthan. There are more than 700 registered units in the sector
and more than 7000 powerlooms and other unorganized units. These three states alone account for more than 75 per cent of the production capacity, with both licensed and decentralised players (Anon 2007b).

The apparel and carpet sectors of Indian woolen industry give employment to around 1.2 million people and earn nearly US$ 0.3 billion. Its competitiveness in the global market is very high. In order to compete with global market, attention should be given to improve the quality of the woolen products especially in terms of its softness and handle by applying new processing technologies in specific areas like dyeing, finishing and quality testing.

In the present scenario, consumer preferences are rapidly changing and it is the high time needs to create new innovative products by blending out of wool/speciality hair with cotton, viscose rayon, polyester, acrylic, jute and silk. Almost all published information on processing and product development from wool and speciality hair fibres originated from fine wools of Australian, New Zealand and other western countries, but this knowledge is limited for Indian wools and their blends.

Specifically there is an enormous scope for improving the aesthetic properties of wool and speciality hair fibre products by various chemical treatments like acid chlorination, enzyme treatment, aliphatic acid anhydride treatment, natural dyeing, softening finishing and silicone finishing. The application of such chemical treatment(s) either in individual form or in successive form on woolen products improves their functional and aesthetic properties as well as to fetch more value for them.
1.5 OBJECTIVES OF THE WORK

With this background a research work was proposed with the following objectives.

1. To study the effect of different chemical treatments such as reducing agent, acid, alkali and enzyme treatment on wool fibres and angora rabbit hair in terms of physio-chemical and mechanical properties.

2. To identify and select a suitable chemical treatment for wool and rabbit hair from the above studies.

3. To study the effect of the selected chemical treatment and a subsequent finishing treatment on woolen materials in terms of performance properties.

4. To standardize a sequence of chemical treatments for the improvement of aesthetic properties of woolen material such as softness and handle.

1.6 SCOPE OF THE WORK

India wool is mainly used for the production of coarse woolen materials like carpets, barrack blankets, durries, and kambles. The fine wool (23 to 25 micron) produced from India is used for shawls, knit wears and high grade carpets. Apart from wool, India also produces about 2 million kg of speciality hair fibre comprising Angora rabbit hair, Pashmina goat hair and Camel hair fibre and these are primarily used in cottage industries in pure and blend form. However there is an enormous scope for product diversification.
and improving the aesthetic properties of wool and speciality hair fibre products by suitable chemical treatments.

In this work, wool fibres of different fibre diameter and medullation and Angora rabbit hair were treated with sodium hydroxide, protease enzyme, formic acid and different reducing systems like thioglycollic acid, sodium bisulphite and morpholine. The treated fibres were evaluated for their physiochemical and mechanical properties. This study would give an idea about a suitable chemical treatment for woolen materials, which in turn useful to improve the performance properties of the above materials and to fetch more values.

The utilization of chemically treated Angora rabbit hair in the production of blended yarn with viscose rayon fibre would give a wide scope for the manufacturing of fancy yarn for the fashion textile market. Also it would have a positive impact on the economy of rabbit growers, cottage industries which are engaged in rabbit hair processing.

The main problem in the Indian woolen industry is the limited availability and high cost of wool fibre. This problem can be solved by blending different fibres like cotton, polyester and viscose. With this objective, Central Sheep and Wool Research Institute, India (CSWRI) has developed wool/cotton union fabric of different specifications from Bharat merino woolen yarn as weft and cotton yarn as warp (Anon 2006). For this union fabric, a study is proposed with the application of cellulase and protease enzymes in separate and combined form, followed by finishing with different finishing formulations. From these studies, a suitable finishing treatment is standardized, which would improve the performance properties like softness and handle.
The development of such treatments can be useful to the wool processors to improve the quality and also to fetch more values for their woolen materials. This study will lead to development of innovative fabrics for furnishings, made ups and apparels produced from intimate blending of Indian wool fibre in combination with viscose rayon, cotton, polyester and silk and also promote woolen materials in regular clothing.