CHAPTER 6

SUMMARY AND CONCLUSIONS
6.0 Introduction

Studies presented in this thesis relate to chemical processing of jute. The chemical treatments were undertaken into three major areas of processing viz. bleaching, dyeing and finishing. Normally, jute is bleached with sodium hypochlorite followed by hydrogen peroxide to achieve a satisfactory level of whiteness. In this study, the possibility of substituting the environmentally hazardous hypochlorite by eco-friendly peracetic acid has been investigated.

There has been considerable interest in the recent years in low temperature bleaching of peracetic acid. Energy efficient option of bleaching jute by peracetic acid developed *in-situ* has been studied.

The dyeing of cellulosic fibres with anionic dyes requires a lot of electrolyte to counteract the repulsion between anionic dyes and the negative charge of the fibre. On the other hand, if positive charge can be generated on the fibre that will accelerate the exhaustion process. The generation of positive charge on the fibre is commonly known as cationisation. The cationisation processes developed, so far, are critically reviewed and a simplified method to cationise cotton / jute was revealed in the present work.

Jute, has started gaining its importance in value added products and quality goods. But a major hurdle for jute fabric to attain popularity in the quality goods is the protruding hairs, which spoil its aesthetic value and handle of fabric. Chemical softeners can improve the softness of jute goods without any significant reduction in surface hairs. Enzymes, an eco-friendly alternative
to toxic chemicals, have already gained a lot of interest of eco-concerned scientists. An optimised method for bio-finishing of jute with cellulase enzyme has also been established in this study. The total study is, therefore, divided into pretreatment (bleaching), dyeing and finishing of jute to find out suitable eco-friendly, energy efficient and better performance giving processes.

A brief report on the findings of these studies are summarised in the following sections.

6.1 Studies on sodium hypochlorite, hydrogen peroxide and peracetic acid bleaching

The bleaching effectiveness of commonly used bleaching agents for jute - viz. sodium hypochlorite and hydrogen peroxide are compared with peracetic acid. The effects of applying these agents, once and twice, on the whiteness and physical properties of jute were studied. It was found that none of these agents provided adequate whiteness during single bleaching operation. The loss in strength, weight and abrasion resistance followed the sequence; NaOCl > H₂O₂ > CH₃COOOH. Single bleaching with commercial peracetic acid showed very little loss in all these properties. Lignin, the cementing material of jute ultimates, were found to be reduced highly due to hypochlorite bleaching which was attributed to be responsible for high loss in weight, strength and abrasion resistance.

The effects were found to be much enhanced when these agents were applied twice. Sodium hypochlorite showed a weight loss of about 8% which resulted a loss of about 30% in strength of the fabric without significant improvement in whiteness. Whereas, double hydrogen peroxide treatment could
improve the whiteness appreciably accompanied by comparatively much higher losses in the properties than peracetic acid. Double peracetic acid bleaching could not produce much improvement in whiteness with a little damage to the fabric.

Peracetic acid bleaching followed by hydrogen peroxide treatment could enhance the whiteness to a very high level with comparatively much lesser damage than the conventional non eco-friendly sequential bleaching of jute i.e. NaOCl followed by H₂O₂ treatment. Thus eco-hazardous NaOCl in the sequential bleaching can thus be substituted by environmentally safe peracetic acid. Moreover, peracetic acid bleaching provided a softer hand to the fabric, when measured by bending length and judged manually.

6.2 Studies on in-situ peracetic acid bleaching

The common stabilizers usually used for peracetic acid bleaching e.g. borax, tetra sodium pyrophosphate etc were found ineffective to produce sufficient whiteness in low temperature (30°C) bleaching of jute. Whereas, sodium meta silicate was found to provide excellent whiteness in such bleaching.

The in-situ peracetic acid bleaching, caused a drop in pH, during the process of bleaching and the reduction in pH was found to be more around pH 7. The shifting of pH was also found directly proportional to the increase in temperature.
The *in-situ* peracetic acid bleaching process could develop excellent whiteness in jute, when a low temperature (30°C) bleaching at neutral pH was followed by a higher temperature (80°C) bleaching treatment at pH 10.

A high degree of whiteness could also be achieved at low temperature (30°C) by treatment of jute with 68 m moles/l of acetic anhydride and 74 m moles/l of hydrogen peroxide for 90 mins at neutral pH.

**6.3 Studies on cationisation for improved dyeability**

A treatment of cotton/jute soda cellulose with 1,2 dichloroethane followed by amination with methyl amine and an subsequent acidic treatment could generate cationic sites in cotton/jute which was manifested by considerable improvement in exhaustion and fixation of reactive dyes, in absence of salt, when compared with the control dyeings without salt addition. The cationisation reaction was proved by the elemental analysis studies and f.t.i.r. spectroscopy. A medium shade could be produced on jute, cationised through this suggested process, using cold brand and HE reactive dyes without any requirement of salt addition. Low reactivity hot brand dyes responded less to this treatment but could also be used for producing light shades without salt addition.

High salt addition requirement in dyeing of jute with reactive dyes can thus be eliminated or minimized by cationising the fibre through the suggested sequence of treatment.
6.4 Studies on bio-finishing of jute

As discussed in the introduction of this chapter protruding hairs from jute fabric cause an irritating sensation to the users. The main emphasis of this study was, therefore, to find out a set of suitable processing parameters required to reduce the surface hairs of jute fabric by an eco-friendly route i.e. by treatment with enzyme. Various sets of parameters (concentration, temperature and time) were selected using Box and Behnken statistical model.

Powder cellulase enzyme (Biosoft P) was employed for this study. Some preliminary experiments revealed that powder cellulases are more effective, on jute, compared to the liquid members. The reduction in surface hairs was analysed through image analysis technique and the handle improvement of the selected fabric samples were assessed by the Kawbata Evaluation System for Fabrics (KES - FB). The effects of such treatments on the physical properties of the fabric samples were also examined and it was found that a 4% (owf) Biosoft P treatment at 50°C for 90 minutes could bring about 15% increase in total hand value of the fabric.
1. Introduction, chemistry and preparatory processes of jute,

2. Peracetic acid – An eco-friendly bleaching agent,

3. Sequential bleaching of jute with eco-friendly peracetic acid and
   hydrogen peroxide,

4. Cationization of cotton for improved dyeability,

5. Chemistry and application of reactive dyes,

6. Applications of enzymes,

7. Bio finishing of jute for improved handle,

8. Low salt reactive dyeing of cotton,

9. Low salt reactive dyeing of jute,
   Chavan R B, Chattopadhyay D P & Sharma J K, Am Dyest Rep (Communicated)

10. In-situ peracetic acid bleaching of jute (to be communicated).