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Title: **Development of Shades on Wool with Annatto (*Bixa orellana*), Teak (*Tectona grandis*), and Flame of the Forest (*Butea monosperma*) Natural Dyes and their Characteristics Evaluation**

Abstract

Chapter 1 provides a comprehensive and update-to-date systematic literature review on natural dyes, their classification and sources, common textile fibres, mordants and mordanting methods, wool dyeing, and antimicrobial finishing of textiles with natural dyes.

Chapter 2 describes materials and methodologies used in the research work. Materials section includes description of structure and properties of wool, mordants and its types, and details of natural dyes used in the study. Methods section involves a detailed overview of mordanting, dyeing and procedure of evaluating colour, fastness and antimicrobial properties of developed shades.

Chapter 3 evaluates the dyeing ability and potential antimicrobial activity of annatto as a natural textile dye. The influence of different eco-friendly metal salts on colour shade, depth of shade and antimicrobial properties of the dyed wool fibre were also assessed. The dyeing experiments with annatto colourants resulted in beautiful natural colour shades with acceptable fastness properties ranging from bright yellow – to dark reddish with subtle change in hue and tone. The results suggest that annatto dye can be considered as viable alternative instead of toxic synthetic dyes for textile colouration and as well as effective antimicrobial agent for medical and hospital textiles.

Chapter 4 investigates the influence of ammonia after-treatment on colour behavior in wool yarns dyed with annatto extract. The dyeing was carried out using 15% (o. w. f) dye concentration in the presence of stannous chloride as a mordant and then treated with different percentages of ammonia solution. The colour strength (K/S) value of annatto dyed wool was found to increase after treated with ammonia. In addition, it

was also observed that dyed wool yarns after post-treatment with ammonia did not return to their original colour on acidification.

Chapter 5 reports the valorization of aqueous extract of *T. grandis* leaves as a natural dye source to colour as well as impart antibacterial and antifungal properties to wool fibres. The effects of dye concentration and types of metal salts on CIEL*a*b* values, colour strength (K/S), fastness properties and antimicrobial activity were assessed. The mordanted wool fibres, exhibited reasonably good fastness properties and durability; therefore, this natural dye might be alternative source to synthetic dyes currently used in dyeing industry. It can be concluded that a combination of teak natural dye and metal ions as mordants have a good potential to develop colourful shades with antimicrobial activity thus offers full potential to produce antimicrobial clothing and other textile materials for their use in value added products such as sportswear, medical textiles and infant textiles.

Chapter 6 is concerned with extraction of natural yellow dye from *Butea monosperma* flowers and their use in colouring of wool in the absence and presence of different metallic salts. In addition to metal mordants, this chapter also reports for the first time extensive study using *Butea monosperma* flower extract on wool previously pre-mordanted with natural mordants from pomegranate, gallnut, and cutch to develop some novel shades with acceptable fastness properties. The choice of mordants has shown to have important influence on the colour and fastness properties of dyed wool fibres. From the ecological point of view, dyeing studies with biomordants show the promise of decreasing eco-constraint of metal mordanting process, thus making natural dyeing process more eco-friendly.

Chapter 7 encompasses the findings of present research work along with concluding remarks and future perspectives of this research work. All the physiochemical parameters including light fastness, wash fastness and rub fastness have been studied and encouraging results have been obtained with annatto, teak and flame of the forest natural dyes. The promising results reported in present work clearly demonstrate an exciting opportunity for the dyes for producing novel hues and adding antimicrobial properties to clothing for fashion apparel, textiles for sportswear, medical sectors and carpets.