Chapter V

SUMMARY AND CONCLUSION
5. Summary and Conclusions

Based on the studies embodied in the present thesis relating to studies on physico-chemical parameters for sequential and concurrent dyeing and finishing of jute fabric, the following summary and conclusions may be drawn.

5.1 Simultaneous Dyeing and Fire retardant finish for jute fabric using Urea-DAP, Urea-OP and Urea-AS

The different simultaneous dyed and fire retardant formulations based on nitrogen, sulphur or phosphorous based compound applied individually on jute fabric show moderate to fair fire retardancy and good colour parameters to jute fabrics. Among them, sulphur based compound (Ammonium sulfamate) show relatively higher fire retardancy performance on jute fabric as indicated by corresponding LOI values and results of vertical flammability test.

5.1.1 Effect of treatment with different fire retardant Formulations 1 to 3 containing FR compound together in presence of suitable crosslinking agent

- From the present study it is revealed that simultaneous dyeing (with an acid dye) and fire retardant finishing on bleached jute fabric is found to be optimum for
  
  Formulation 1:- Urea 25% and DAP 10% concentration,
  
  Formulation 2:- Urea 10% and OP 8% concentration and
  
  Formulation 3:- Urea 20% and AS 20% concentration.

All the formulations impart reasonable level of fire retardancy property to jute (LOI value is 38) with loss of tenacity lies within the range of 27%-30%.

- Irrespective of the technique followed, the surface colour strength of simultaneous dyed and fire-retardant finished jute fabric is found to increase with an increase the percentage of application of all the fire-retardant finishing chemicals from and beyond which it almost tends to level off.

- The surface colour strength and improvement in fire retardant property thus obtained by the single step simultaneous process of acid dyeing and FR
finishing is found to be at par with that obtained by conventional two-step sequential process of dyeing and fire retardant finishing, the former showing improved light fastness and rubbing fastness as well.

- Single step simultaneous dyeing (with acid dye) and fire retardant finishing (with Urea-DAP, Urea-OP and Urea-AS) of jute fabric by pad-dry-cure technique offers savings in energy, process time and operational cost, giving satisfactory colour strength and improvement in fire-retardant property as compared to the conventional two-step sequential dyeing and FR finishing process.

5.2 Simultaneous Dyeing and Antimicrobial finish for jute fabric using Citric acid and Poly ethylene glycol

In this study, citric acid (CA) is used as a crosslinking agent and mixed with poly ethylene glycol (PEG 400) and the combined action of CA and PEG400 in presence of Sodium hypophosphite monohydrate (SHP) catalyst is applied on jute fabrics by pad-dry-cure method imparts a reasonable good level of anti-microbial and simultaneously crease resistant property. For effective result, the treated fabric is to be cured at 150°C for 5 minutes. In this treatment, both Citric acid and PEG possibly reacts with hydroxyl groups in cellulose form ester and ether.

Possibility of enhanced crosslinking by the presence of additional PEG in combination with CA. The performance of the said finished jute fabric in terms of dry crease recovery, rot resistance (expressed as % retention of tensile strength of the fabric after a standard soil burial test), loss of fabric strength due to such treatment, change in colour parameters and bending length (for stiffness) were also evaluated and finally following results are obtained-

- From the present study it is revealed that combination of CA and PEG finished fabric shows adequate wrinkle resistance, high tensile strength retention property and higher colour value of jute fabric and also rendered high anti-microbial property as indicated by soil burial test and antibacterial test AATCC 100 as compared to untreated fabric.
The optimum performance were obtained when jute were treated with 10% CA, 10% PEG 400 with 6% Sodium hypo phosphate monohydrate(catalyst) and cured at 150°C for 5 min.

Untreated jute fabrics loose 92% of its strength in 21 days soil burial test while Citric acid treated jute fabric retains 51% of original strength in 21 days soil burial test and improvement in crease recovery up to nearly 210°.

Citric acid mixed with poly ethylene glycol (PEG-400) imparts higher strength retention in 21 days soil burial test. The strength retention of Jute fabric after 21 days soil burial is found to be nearly 72% to 78% and crease recovery angle of 252°, when treated with 10% citric acid and 10 % PEG in presence of sodium hypophosphite as catalyst by pad-dry-cure technique. The CA and PEG finished fabric has less adverse effect on increasing stiffness and loss of tensile strength. FTIR spectroscopy study indicate the formation of both ester and ether crosslinkage between the jute fibre, citric acid and PEG with formation of hemiacetal linkages. Hence, the proposed reaction mechanisms found to be quiet acceptable as evidenced by FTIR spectroscopy.

The CA & PEG treatment also render high antimicrobial property as indicated by test results of AATCC 100.

Irrespective of the technique followed, the surface colour strength of simultaneous dyed and anti-microbial and crease resistant finished jute fabric is found to increase with an increase the percentage of application of anti-microbial finishing chemicals.

Single step simultaneous dyeing (with acid dye) and anti-microbial finishing (with CA, PEG and SHP ) of jute fabric by pad-dry-cure technique offers savings in energy, process time, giving satisfactory colour strength and other physical parameter as compared to the conventional two-step sequential dyeing and crease resistance and anti-microbial finishing process.
5.3 Simultaneous Dyeing and Aroma finish for jute fabric using rose oil with beta-cyclodextrin (by microencapsulation technique), Dextrin and DMDHEU

- From the present study it is revealed that combination of dyed and microencapsulated aroma finished fabric shows good tensile strength retention property and higher colour value of jute fabric and also rendered higher retention of aroma finishing as indicated by olfactometry test.

- The optimum performance were obtained when jute were treated with 10% beta-cyclodextrin, 10% CA, 6% SHP (catalyst) and cured at 140\(^0\)C for 5 min.

- K/S value of simultaneous dyed and aroma finished jute fabric is found to increase with an increase the percentage of application of both beta-cyclodextrin.

- The fastness parameters are also moderately satisfactory.

- The compatibility rating shows jute fabric treated with beta-cyclodextrin and DMDHEU is more compatible than dextrin.

- Single step simultaneous dyeing (with acid dye) and aroma finishing of jute fabric by pad-dry-cure technique thus offers scope for value addition for this newer finishes on jute fabric with advantages of savings in energy, process time, giving satisfactory colour strength with reasonable / acceptable retention of other physical parameters as compared to the conventional two-step sequential dyeing and aroma finishing process.

**Concluding Remarks:** The present work thus show way forward towards development of few important formulations for improving (a) fire retardant finish and (b) simultaneous rot resistant and crease resistant finish (c) aroma finish of jute fabric with optimum balance of its textile related properties which offer lab to industry transfer and may be commercialized to promote the marketing of jute based simultaneous dyed and fire / antimicrobial/ aroma finished jute diversified product for different applications in future.
LIST OF PAPERS PRESENTED IN SEMINARS AND CONFERENCES


List of Publications


SCOPE FOR FUTURE WORK

From the present work, some new ideas and thoughts have emerged out for future scope of work.

The following are such areas of future work for developing Simultaneous dyeing and flame retardancy/ antimicrobial / aroma finishing on jute based fabrics.

1. Studies on simultaneous dyeing and finishing of jute fabric with other synthetic dyes like reactive and vat for corresponding finishing.

2. Studies on simultaneous dyeing and finishing of jute fabric for other finishing property like water/oil repellency, anti photo fading etc.

3. Studies on simultaneous dyeing and finishing with other fibres like cotton, silk and wool.

4. Study on compatibility between dyes and finishes.

5. Study of eco friendly fire retardant, antimicrobial and aroma finishing of jute fabrics using different natural products.