CHAPTER 1

INTRODUCTION

India has been home to almost all of the world's most important natural fibres. Besides cotton, wool and silk, India produced jute, hemp, rhea and several other fibres that even 100 years ago were considered important items of trade. Cotton, wool, silk and jute are today grown or produced in different parts of the country and their processing has given birth to one of the world's most important textile industries, whose products still reach the globe. The availability of these raw materials has enabled the creation of a vast variety of products, woven domestically on handloom or industrial powerlooms and encompassing a seemingly endless array of uses, designs and decorations.

But amongst these fibres, jute has until now remained the poor relation. While silk, cotton and wool adorned ceremonies, furnishings or fashion parades, jute seemed condemned eternally to its use as humble sacking for packaging or temporary coverings on construction sites.

Plate 1 .1 Bundling of jute rope

(Source: https://www.google.co.in/imgres?)

However, nobody can pinpoint the first human use of jute. It was certainly known and used from the times of India's great epics, the Mahabharata and the Ramayana. In the "Subha Parva" section of the Mahabharata, the Kaurava prince *Duryodhana* tells his father of the gifts received by his cousin *Yudhishthira* at a ceremony that he had just attended. Amongst the many things listed were gems, jewels, grasses, clothes made of grasses and the cloth woven from jute. The Ramayana tells how Hanuman on his mission to rescue *Sita* from the king of Lanka, *Ravana*, was captured. On the orders of *Ravana* his long tail was set alight. The material used to bind and burn his tail was jute.

The author H.D. Goyal in his book Indian jute industry: Problems and Prospects also mentions the 16th century Bengali book "*Kavikankan Chandi*" by Mukundaram Chakarvarty where there are references to jute bags. Another mention of the use of jute during this period is in the *Ain-i-Akbari*. In the English translation by Jarret, the author identifies that as jute cloth from the Bengal region. [54]

For over 100 years, jute had been used for the production of sacking and sacks. As other fibres became more and more varied, almost all the production of jute remained confined to these forms. A mindset was established that jute had no other possibilities. As a result no new technology was applied, no experiments carried out. Only in the last decade of the 20th century a massive potential to be unlocked from this humble plant.

Jute is a natural and bio-degradable fibre. Jute, the golden fibre is said to have derived its name from the word "jaht" a Sanskrit word. This golden fiber is used extensively in manufacturing sacks or bags which are used as packaging material for agriculture and industrial products. In India mostly jute is grown in Kolkatta and around it in warm and humid regions. The only country exporting jute on commercial scale today is India. Since jute is produced in India, the price is competitively less here compared to other countries. Jute is considered the eco-friendly alternative due to its bio-degradability and recyclable property. It is vegetable bast fibre extracted from the stem of Corchorus plant. These stems are used as renewable energy resource and for other diversified uses. Its products are re-usable, sustainable and bio-degradable and deserve policy support towards environmental commitments.

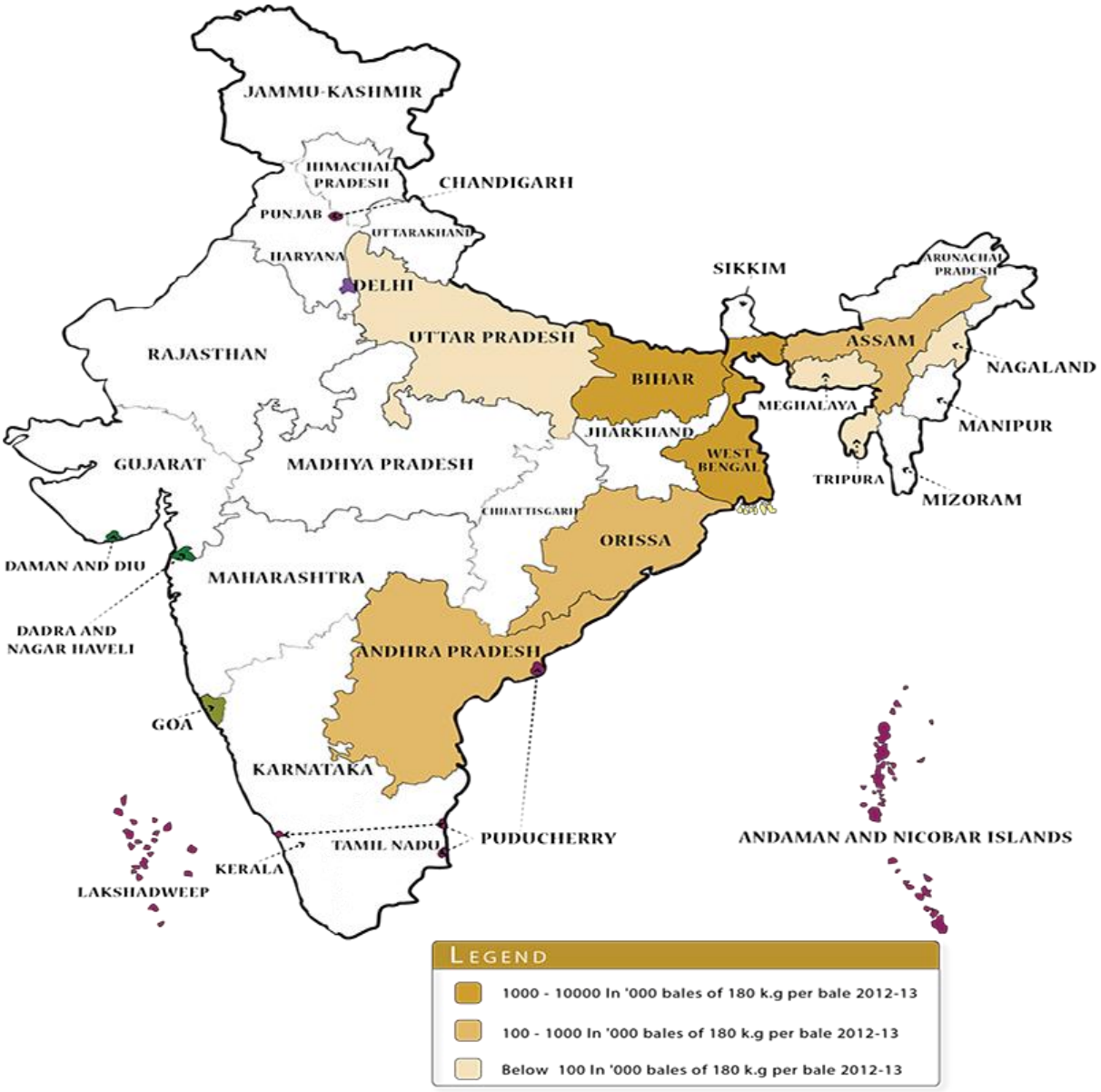

Plate 1.2 Jute growing states in India

(Source: http://farmer.gov.in/imagedefault/juteindia.png)

The main constitution is cellulose, hemicellulose and lignin as it is a lignocellulosic fibre. It is available in inexhaustible quantities and at comparatively low prices and hence can be considered to replace several expensive fibres with same characteristics. It has inherent advantages like silky luster, high tensile strength, low extensibility, considerable heat and fire resistance, high moisture regain, good dyeability and long staple lengths. These advantages make it directly cater to technical and industrial requirements through its appropriate functional end-uses.

Jute is dyeable with all the dyes used for dyeing cotton. It also exhibits strong affinity towards basic dyes. This affinity is due to the presence of non-cellulosic constituents. Among these dyes, only direct, acid and reactive dyes are used extensively for dyeing as they are cheap and easier in application. But the current world awareness about environmental pollution has once again revived the use of environmentally friendly, less pollutant dyes. This has also directed the researches towards natural dyes. Some of the advantages of using natural dyes:

1) It is obtained from renewable resources.
2) No health hazards, sometimes it acts as health care
3) Practically no or mild chemical reactions are involved in its preparations.
4) No residual problems.
5) It is harmonized with nature.

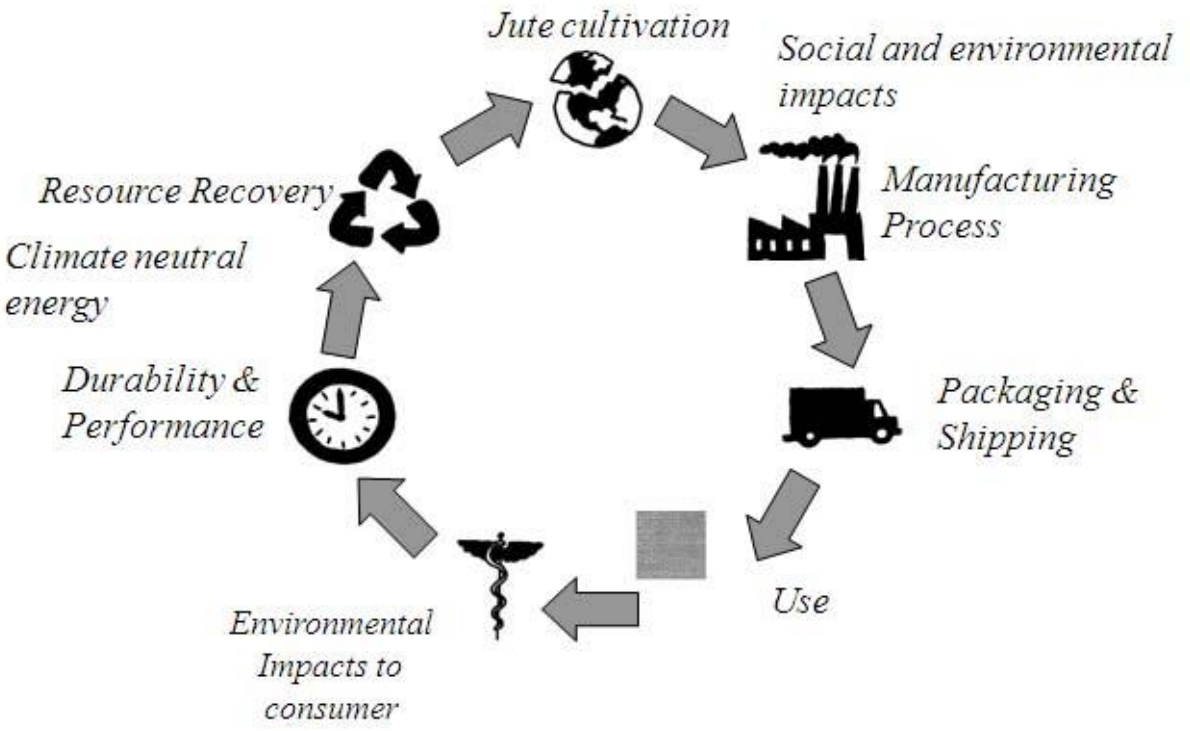

Plate 1.3 Life cycle of jute fiber

(Source: http://textiletoday.com.bd/wp-content/uploads/2015/03/clip_image0011.jpg)

Jute in its natural form does not find many end-uses. Its utility can be enhanced by some modifications which include bleaching, softening and colouration. Substantial researches have been carried out on the effects of different bleaching agents on jute and dyeing of jute with natural dyes but the correlation between effects of bleaching

agents on dyeing performance of jute using different natural dyes is to be explored. Bleaching on jute brings out internal changes in the fibre and therefore it is expected that it will affect the physical properties also. Bleaching results in increasing whiteness index which gives the base for colouration.

Bleach refers to a number of chemicals which remove colour, whiten or disinfect, often via oxidation. The bleaching process has been known for thousands of years, but the chemicals currently used for bleaching resulted from the work of several 18th century scientists. Chlorine is the basis for the most commonly used bleaches for example the solution of sodium hypochlorite. Oxidizing bleaching agents that do not contain chlorine most often are based on peroxides, such as hydrogen peroxide, sodium percarbonate and sodium perborate. While most bleach is oxidizing agents, some are reducing agents such as sodium dithionite and sodium borohydride.[12]

Textile bleaching is one of the stages in the manufacture of textiles. All raw textile materials, when they are in natural form, are known as 'greige' material. This greige material have its natural colour, odour and impurities that are not suitable for clothing materials. Scouring is the first process carried out with the addition of alkali, wetting agents and at suitable temperature. It removes all the waxes, pectins and makes the textile material more water absorbent. The next process of decolourization of greige material into a suitable material for next processing is called bleaching. Bleaching of textiles can be classified into oxidative bleaching and reductive bleaching. Generally, oxidative bleaching is carried out using sodium hypochlorite, hydrogen peroxide. Natural fibres like cotton, jute, ramie, wool, bamboo are all generally bleached with oxidative methods. [12]

Nature has manifests itself in a wide spectrum of rainbow colours. Man fascinated by her glory, strove towards harmonizing with her completely. He internalized colour by responding to its vibrations emotionally and externally he drew from her vast store house, to initially paint himself and then to dye the apparel he wore. Thus started the alchemy of colour, and India was a fore-runner in the art of natural dyeing- an art perfected during the era of the great Epics. The colours used were natural colours derived from plants, insects and minerals.

It is believed that the art of dyeing was known in India as early as in the Indus valley period. In the 7th century India had a virtual monopoly in the production of dyed, painted and printed textiles with natural colours. Dyeing is mentioned in the Vedas; red, yellow, blue, black, and white were the main colours. From the historical records it is learnt that only natural colourants were only available to the people during Greco-Roman periods. This is evident with the wall paintings of Ajanta, Ellora and Sithannavasal which had been done with natural colouring matters still demonstrate the efficacy of dyeing craft that has been inherited from ancient times.[34]

The age old art of dyeing with natural dyes was common in India. The Indian dyers were famous for creating variety of shades with the help of natural and metallic mordants. India had a monopoly in the production and application of natural dyes. Dyeing and printing was a craft up to the middle of 19th century and India has a very rich tradition of using natural dyes. India had produced in the past a fabulous range of beautifully coloured, hand painted and printed cotton textiles which were exported all over the world. [34]

Natural dyes were forgotten and abandoned as a part of history due to the neglect for about 150 years. It is only during the last one and half decade, when concern for environment created an interest in natural dyes, its production, research and development. Plant wealth is main source of colours and there are more than 300 species, which yield colour. In view to preserve public health and protect environment, a lobby of environmentalists, educationists, scientists, social workers, NGO's are creating awareness towards the revival of natural dyes.

Presently there is a great trend towards the use of natural colours throughout the world. It is our good fortune that we are people steeped in tradition, and in some remote areas of our country, natural dyeing of fabric is still a way of life, else, revival of this ancient art would have been a near impossibility. [34]

To understand and formulate the objective for the present study and to relate pretreatments and natural dyes the following researches were studied:

1.1 Studies related to pretreatments of natural textile fibres and work related to natural dyes:

Patel F., (2010) conducted a research on dyeing of minor fibres with natural dyes. Two cellulosic minor fibres namely sisal and jute and two protein minor fibres namely eri silk and kutch goat hair was taken for the study. Madder, ratanjot, marigold, heena, catechu and flame of forest were the six dyes selected and three dye mixtures of two dyes were derived for the study. The variables of the study were variation of pH during dye application, use of natural mordants tea and pomegranate rind and composite dyeing. A total of 180 shades were produced. Products designed and exhibited were highly appreciated and showed a good applicability of the dyes used.

Nagrani J., (2007) studied on value addition of khadi silk fabric by natural dyes. Premordanted khadi silk fabric was block printed and dyed with madder and turmeric. Metal mordants were used for mordanting. A variety of 48 shades was produced and krutis were designed using these shades, to evaluate the market of these products.

Gogoi N. & Kalita B. (1999) experimented on dyeing of silk with natural dyes. Mulberry silk fabric was dyed with heena leaves using alum as mordant. Results reveled that fabric thickness increased after dyeing the fabric without mordanting. All the samples treated with mordant show increasing trend in fabric weight/unit area. From this study it was concluded that silk fabrics dyed with mordant at different percentages showed better results respect to physical as well as color fastness properties. Fabrics mordanted in 3% concentration performed best than the other two concentrations.

Shetti, V. (1998) sucessfully carried out the softening of chemically pretreated cotton banana union fabric. It was observed from the study that by marginal changes in the physical properties of the fabric as weight and strength the cotton banana union fabric under optimum condition of temperature, time and chemicals (as softeners, cross linking agents, bleaches etc.) can be bleached and made soft to quite a degree thus improving its handle and visual appeal.

Sharma I.C., Chattopadhyay D.P, Mukhopadhyay A., Boruah R.K., & Vishwanath (1999) studied the effect of degumming followed by sequential oxidative and

reductive bleaching on physical properties such as tenacity, thickness, fabric weight, bending length, crease recovery, flexural rigidity and air permeability of mulberry and tussar silk fabrics. It was observed that tenacity, thickness, fabric weight; bending length, crease recovery, flexural rigidity decreases whereas air permeability increases after degumming and bleaching.

1.2 Studies related to pretreatment of jute fibre:

George, E.(1994) studied the light and wash fastness characteristics of chemically pretreated jute based fabrics with reactive dyes, where in the measure of degree of fixation of the dichlorotriazinyl (cold brand), monochlorotriazinyl (hot brand) and vinyl sulphone based reactive dyes was a major objective. The results indicated that 100% jute fabrics has superior dye pick up and dye fixation property. Amongst the dyes procion yellow M-Gr had greatest affinity for the substrates and procion bril blue M-R had least affinity for the substrate. Jute yarns in weft were seen to have higher dye fixation than cotton warps.

Gupta, R. (1992) conducted a study on the physico- chemical characteristics of chemically modified and resin finished jute and jute multi fibres fabrics. It was concluded that the test conducted on different fibres after pretreatment and on the pretreated samples subjected to ageing, accelerated heat and resin finishung showed improvement in particular wear characteristic such as abrasion resistance, strength retention, crease recovery angle and resistance to heat treatment indicating less damage on the fabric.

Chattopadhyay D.P., Sharma J.K., & Chavan R.B. (2003) studied bleaching of jute with peracetic acid formed in-situ in bleach bath. It was observed that in an unbuffered system, the bleach bath pH drops from its initial set value. Excellent bleaching of jute with relatively higher loss in peroxide of in-situ peracetic acid bleach bath. A high degree of whiteness in jute with lesser damage was seen at low temperature.

Pandey, S., Chattopadhyay, S. & Pan, N. (1993) studied on recent developments in bleaching of jute and allied fibres. The paper critically reviews the merits and demerits of different bleaching agents used for bleaching jute and allied fibres to obtain maximum whiteness retention with minimum strength and weight loss. The

results revealed that generally three bleaching processes for jute were known and practiced in the industry. They are hypochlorite bleaching at pH 10-10.5, Sodium chlorite bleaching at pH 4.0-4.5 and Hydrogen peroxide bleaching at pH 10-11. Jute and allied fibres belong to a heterogenous system eg, cellulose, hemicelluloses and lignin. Lignin is an organic aromatic polymer which strongly absorbs UV radiation present in the sunlight. So, it is difficult to get an uniform and expected results. So, the study also throws light on recent developments in bleaching and the future direction of research.

BH Patel and et al (2014) studied the changes in cotton treated with choline chloride. The main purpose of this study is to improve the dyeability of the cationised cotton towards anionic dyes particularly reactive and direct dyes. In this study, choline chloride- a quaternary ammonium salt was linked to the cotton fabric on a process that can improve dyeability. Effect of this treatment on mechanical properties of cotton was measured in terms of tensile strength and % elongation of the cationised cotton compared to the untreated cotton sample. Different dyeing conditions were tested with acid dyes and direct dyes, with and without salt, at different pH levels. Results revealed that cotton treated with a choline chloride can be dyed without electrolytes with improved color strength values with a variety of direct dyes with minor loss in tensile strength. Both the wash and light fastness of direct dyed cotton were also upgraded due to the pretreatment. Cotton treated with a choline chloride that provides cationic dye sites can be dyed with acids dyes. However, their fastness to wash and light was found to be poor.

1.3 Studies related to application of natural dye on jute

Pan N.C., Chattopadhyay S.N. & Day A. (2003) conducted a study on dyeing of jute with vegetable dyes. Raw jute fabric was bleached and mordanted with different concentration with potash alum. Then the mordanted bleached jute fabrics were dyed with jackfruit leaf and marigold flower petals seperately. The results revealed that the vegetable color dyed jute fabrics premordanted with 10% potash alum showed better dye uptake and wash fastness properties. Brightness index values of these samples premordanted with potash alum were lower as compared to without mordanted jute fabrics with the same dyes.

Ghosh S.B., Bajaj P & Kothari V.K. (2003) studied the effect of different dyes and finishes on UV protection property of jute/cotton union fabrics. It was observed that bleaching with H_2O_2 makes the fabrics more permeable to UV rays. The treatment of jute/cotton fabric with titanium dioxide also provides satisfactory protection against UV rays.

Teli M.D., Adivarekar R.V., Bhagat M., & Manjrekar S.G., (2002) conducted a study on response of jute of the dyes of synthetic and natural origin. 100% jute fabric was used for the experiment, variuos classes of synthetic dyes were used for the study like basic, reactive, vat, metal complex, acid dyes. Among the natural dyes, tea turmeric, manjistha, tamarind, red sandalwood, ratanjot and catechu were used. The results reveled that the wash fastness properties were satisfactory with both the groups of dyes. It was concluded that jute fabric could be dyed in attractive colors using both synthetic and natural dyes.

Verma C., & Venkatachalam V., (2002) studied the effect of mordants on mango (bark) dye for dyeing of jute/cotton union fabric. The mordants used for the study were alum, ferrous sulphate, tartaric acid and myrobalan. The results reveled that the mango (bark) dye yeild yellow shade on the jute/cotton union fabrics with moderate color fastness. The samples dyed with optimized parameters showed good results regarding all the properties such as general apperance, evenness in dyeing, depth of shades, brightness of color and lustre. It was found that the addition of tartaric acid to alum and ferrous sulphate enhanced the brightness and lustre of the samples but reduced the depth of shade.

1.4 Studies related to product diversification using minor fibres

Bhagwate, S. (2006) successfully carried out an experimental study on product development from kenaf fibres. Many products using different techniques like weaving, quilting, macramé, stuffing and tying, finger weaving and braiding were developed and then evaluated in terms of utility, aesthetic appeal and acceptability. The results revealed that the idea of product development from kenaf fiber was highly innovative and the respondents stated that the products had good marketability.

Malhan S. (1999) has done a study on value addition and product diversification of minor fibre fabric (Jute & Banana) using Hand Block Printing. Motifs of Sanganeri

printing of Rajasthan with contemporary colors using pigments were used for printing. Various household articles were constructed like cushion covers, lamp shades, table mats, tray and tray covers, wall hanging, partition panel, bed spreads. Then these were evaluated for market acceptability and the results revealed that the majority of the respondents accepted the product for household use.

Raval, P.(1999) printed the cotton banana union fabric and cotton jute fabric using various colored pigments. When tested or wash, light and crock fastness it was observed that out of the three pigment used i.e. pigment red, pigment yellow and pigment blue, pigment red and yellow gave moderate to good wash fastness on both the fabrics. It was also seen that the cotton banana union fabric was quite resistance to light fading incase of all pigments but the crocking fastness of these dyes came out to be poor on both the fabrics.

Shetti, V. (1998) sucessfully carried out the softening of chemically pretreated cotton banana union fabric. It was observed from the study that by marginal changes in the physical properties of the fabric as weight and strength the cotton banana union fabric under optimum condition of temperature, time and chemicals (as softeners, crosslinking agents, bleaches etc.) can be bleached and made soft to quite a degree thus improving its handle and visual appeal.

Sharma, B. (1993) worked on construction of different types of skirts from jute ands jute multi fibre fabrics and the evaluation results revealed that the majority of respondents (98 percent) appreciated the garments and were ready to add them to their wardrobe. When asked about the suitability, higher number preferred jute cotton fabrics best for skirt constructions followed by jute viscose fabric.

STATEMENT OF THE PROBLEM

Jute is the second largest crop cultivated after cotton in India. It is mainly used for making hessian cloth, sacking material, etc. with the technological advancement. Its use has been extended to various other fields like geo-textiles, furnishings, non-wovens, handmade articles, accessories though to a limited extend. The inherent properties of jute includes silky luster, good tensile strength, high moisture absorption, heat and fire resistant, dimensional stability, antistatic properties, highly dyeable and also good thermal conductivity property. It feels warm in winter and

since it has good moisture absorption property it feels reasonably cooler in summer. But along with these advantages, there are a few disadvantages like harsh feel, stiffness, coarseness, poor wash ability and poor abrasion resistance. The stiffness of fabric has great impact on its bending length or drape co-efficient. These drawbacks restrict its use other than packing material. Its utility can be enhanced by overcoming these drawbacks.

The first jute mill in India was established in the year 1855. Today the jute industry is one of the major industries in the eastern region, particularly in West Bengal. It supports nearly 40 lakh farm families, provides direct employment to about 2.6 lakh industrial workers besides livelihood to another 1.4 lakh persons in the tertiary sector and allied activities. The production process in the jute industry goes through a variety of activities which include cultivation of raw jute, processing of jute fibres, spinning, weaving, bleaching, dyeing, finishing and marketing of jute products. The jute industry produces goods worth Rs. 6500 crore p.a. and contributes to export earnings to the tune of nearly Rs. 1200 crores p.a. The jute industry is labour intensive, thus requiring such a large number of people in the value chain. The industry at present faces stiff competition from its cheaper subatitutes and is plagued with many problems ranging from obsolete technology, labour unrest, etc.

With the increased awareness about the environment, textile researchers are attracted towards natural fibres and natural products which are bio degradable and cause minimum or no harm to the environment. Jute is natural and eco friendly vegetable bast fibre and its products are re-usable, sustainable and bio-degradable and deserve policy support towards environmental commitments. To reduce the chemicals in processing of jute, natural dyes are the alternative to produce colour palatte.

Jute has inherent colour which is a drawback to develop colour palatte on jute. Hence, to overcome this, bleaching is required. Bleaching holds the key for successful production of diversified coloured jute products. The primary object of jute bleaching is to get maximum whiteness with minimum loss in strength and retention of whiteness for a longer period. Woolenization is a typical process generally used for jute yarn for imparting crimps in its structure. The crimpness imparted offers wool-like appearance to the fibre.

Substantial research has been carried out on the effects of different bleaching agents on jute and dyeing of jute with natural dyes but the correlation between the effects of bleaching agents on dyeing performance of jute using different natural dyes is hardly available in the literature. The bleached surface assists in obtaining colour palatte.

In the present investigation, therefore an attempt has been made to study the effect of various bleaching agents on the physical properties of jute fabric as well as its effect on the dyeing properties when dyed with natural dyes.

The year 2009 was declared as International year of natural fibres. It was reported by Patel F (2010), "Natural fibres close to thirty million tons are produced annually. Natural fibres form an important component of clothing, upholstery and other textiles. Many of them have industrial application in packaging, papermaking and in composite materials with many uses, including as parts in automobiles. In many developing countries, proceeds from the sales and export of natural fibres contribute significantly to the income and the food security of poor farmers and those working in fibre processing and marketing. Since the 1960's the use of synthetic fibres has increased and natural fibres have lost a lot of their market share. Producers and processors of natural fibres face the challenge of developing and maintaining markets in which they can compete effectively with synthetics. In some cases, this has involved defining and promoting niche market. The main goal of the International year of natural fibres was to raise the profile of these fibres and to emphasize their value to consumers while helping to sustain the incomes of the farmers."

The objectives of the study:

1. To study the effect of different bleaching agents on appearance and tensile properties of Jute fabric.
2. To investigate the effect of woollenization as a pretreatment of Jute fabric
3. To find out suitable pretreatment conditions for attractive colour development on jute using natural dyes.
4. To study the effect of different mordants on colour yield of pre-bleached jute

5. To examine an innovative system of mordanting viz. using nano metal particles
6. To analyze the fastness properties of the dyed samples.
7. To produce a color palette with natural dyes.
8. To analyze the fastness properties of the dyed samples.

Delimitation of the study:

1. The study was limited to only two bleaching agents namely: Hydrogen Peroxide and Peracetic acid.
2. The study was limited to only four natural dyes namely: Madder, Turmeric, Eucalyptus leaves and Indian Almond leaves.
3. The study was limited to the use of two metal mordants; alum and copper sulphate and one natural mordant harda.

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Scope of the study:

- The study was aimed at investigating the relationship between the effect of pre-treatments and the colour absorption of jute fabrics using natural dyes.
- The study aimed for optimization of pre-treatment conditions for better whitness with minimum damage.
- Also the study aimed at investigating of suitable natural dye and mordanting system among the selected natural dyes and mordants.
- This study will give a new dimension in utility of these fabrics as they are eco-friendly and bio-degradable.