CHAPTER II

REVIEW OF LITERATURE

A literature review is usually a highly synthesized critique of the status of knowledge on a carefully defined topic. A review of related research serves important purposes and helps the researcher at every step of her venture, as a researcher can build appropriate methodology and design keeping in view the strengths and failure of previous researches. A review of literature yields useful hints for further research, which may prove beneficial to the future researchers.

In this part of the study, previous studies are categorized and reviewed under different section

2.1 ENVIRONMENT AND HEALTH AWARENESS

2.2 SOURCES OF NATURAL DYES

2.3 EXTRACTION AND APPLICATION METHODS

2.4 MORDANTS, MORDANTING METHODS AND FASTNESS PROPERTIES

2.1 ENVIRONMENT AND HEALTH AWARENESS

Literature available on environmental issues and health hazards cause due to the use of synthetic dyes, chemicals and auxiliaries in the processing of textiles, dyeing and printing have been discussed in the present section.

Shakuntala Ramani (1989) highlights the relevance of Natural dyes in the present day context. According to her the true understanding of the nature of natural dyes craft is necessary for the formulation of any programme for its revival. She further stated that

the helter-skelter growth of technology in all walks of life has brought in its wake attendant ills of hazardous wastes and atmospheric pollution.There is a movement the world over to return to nature and protect the environment from indiscriminate exploitation and pollution by industries. Higher energy costs and strict environmental controls are already beginning to affect the manufacture of organic chemicals particularly dyes and pigments, which are closely linked to human exposure. The harmful and sometimes poisonous substances used in the colouring of toys, textiles, food and other articles meant for human consumption are now coming under strict scrutiny and rightly thinking people are advocating a return to the use of vegetable dyes. Many of the natural dyes are derived from medicinal herbs with proven value for human health.

Sewekow (1988) overview that recent ecological concerns and pollution standards have focused on the textile dyeing industry, which have brought som attention upon the use of natural dyes as an alternative to modern chemical dyes. Smith and Wagners (1991) have compared the environmental attributes of synthetic and natural dyes.

A short history of synthetic dye production has presented. Production processes and application characteristics of synthetic and natural dyes have discussed.

It is unlikely that the present demand for dyes could be met by natural dyes alone; but the need for improvement in application technology is emphasized to achieve the necessary substantivity levels.

Most of the dyes based on benzidine rings are toxic and pose health hazards to humans. India is eliminating the use of some toxic dyestuffs. It is being asked to

supply cotton dyed with natural dyes such as indigo. Natural dyes can achieve satisfactory shades of yellow, dark blue, and navy blue among the colours. Some dyes such as indigo and madder red currently are in big demand. German manufacturers are demanding indigo dyed fabrics (Venugopal 1993).

Agrawal et al., (1993) has reported that, recently many companies have been exploring the commercial potential of natural dye sources. Such dyes are considered desirable because of their natural glow and variability, and because they do not create the pollution problems that arise during the manufacture of synthetic dyes. Kaul (1994) believes that the ability to produce environmentally safe dyes will influence the future success of the Indian dye production industry. He has also reported that the Indian government, recognizing this fact, recently organized a workshop on natural dyes. Leading Indian dye manufacturers, foreign exporters, and research and development organization attended the meeting. In an effort to revive the natural dye production industry the workshop encouraged the development of appropriate production technology.

Anonymous (1993) emphasized that continued pressure on synthetic dye manufacturers will lead to the development of less polluting chemicals and application processes, an environmentally responsible and realistic goal and it is believed that even though it is impossible to eliminate completely the use of synthetic dyes, enough natural dyes should be produced to satisfy current or future demand.

On the contrary to above, colourant manufacturers dispute the claim that natural dyes are more environmentally friendly than synthetic dyes. Similarly natural and synthetic colourants have been compared where toxic and/or carcinogenic effects of several natural substances used as natural colourants were found to be as environmentally detrimental as common synthetic chemicals used as colourants. It has also been said

that a high percentage of agricultural land would be needed to produce sufficient vegetable dyes for cotton and would exacerbate the waste effluent burden.

The wide spread adoption of natural products would necessarily result in a major shift in land usage through out the world (Glover and Piercel993). Although natural dyes are derived from nature but the metallic mordants used for improving, fastness and better fixation of textiles, are not always eco-friendly (Dalby, Gill 1993)

Another review discusses the use of dyes to colour textile materials and the subsequent process waste generated, problems encountered in the industry, including the use of natural dyes. It has been said that, the majority of natural dyes are mordant dyes, requiring application with metal salt to assist in fixation. Use of heavy metals will increase toxic waste generation and further complicate waste effluent treatment.

Recent German regulations have banned the certain consumer goods containing azo dyes, due to their carcinogenecity. Although this, regulation has an international impact (Burdett 1995).

Glover (1995), compared the feasibility of natural dyes with that of synthetic dyes. Plants are the common source of natural dyes. These colourants have several disadvantages including higher costs, the required use of metal containing mordants, poor colourfastness, and poor reproducibility. Furthermore, little research has been conducted to ascertain the toxicity of natural dyes. These problems prevent natural dyes from being a viable alternative to synthetic products. The dyeing industry can reduce the environmental impact of synthetic dyeing processes by continuing its present efforts to minimize waste and improve the environmental compatibility of the dyes.

To overcome the problems regarding toxicity, the chairman of BTRA has discussed the strategies to meet increasingly stringent environmental regulations.

BTRA offers the infrastructure necessary to implement test methods that standardize the estimation of red listed chemicals at the mill level. BTRA is working to standardize dyeing methods with natural dyes and has developed effective substitutes for citric and acetic acids and is applying biotechnology to wet processing methods. (Anonymous 1995). With relevance to the strategy, the study has conducted by Niyati Bhattacharyya et al., (1995) from BTRA. In their study the eco friendliness of natural dyes and textiles, detection of heavy metals and analysis of pesticides in Natural dyes, and banned amines on Natural dyes was carried out and concluded that Natural dyes are safe and eco-friendly whenever the dyeing is carried out as per eco-standard specifications. The application of non-toxic natural dyes and food colours on textile fibres avoids many of the problems associated with the use of more hazardous dye materials.

Application of food dyes to various natural and synthetic fibres improved the fastness properties. Compounds used in food colouring offer a safe route for dyeing materials (Naik et al., 1996).

According to (Hill 1997), Natural dyes are becoming more important to the textile industry due to consumer interest, but production is currently on a relatively small scale. Dyes that were used 100 years ago are more difficult to find now because the natural resource from which they are derived have been reduced. Many dye sources could be developed for commercial production using modern agriculture. Modern dye houses using manmade dye could be converted to natural dye processes. Techniques using natural dyes are available in countries such as India. Human and environmental toxicity of natural dyes is lower than that of manmade dyes, with the exception of some mordant dyeing techniques using heavy metals. Recent research into natural dyes suggests a number of innovations of conventional dyeing techniques, such as

microbial indigo production. Many natural dyes are comparable in quality with manmade dyes. International quality standards can be written to guide the growing natural dye industry. Natural dyes can be economically viable. Where as Chan, et al., (1997) said that, Natural dyes have the potential to replace some carcinogenic dyes. The annual meeting of the International Textile and Apparel Association, Anonymous (1998), discussed upon safety, health and environmental issues in the textile industry, which highlighted the biodegradability of bagasse geotextiles, safety of amateur dyeing and decided to make the product durable. Safety, health, and the environment must be addressed individually for each product. However, increasedenvironmental awareness has sparked a renewed interest in natural dyes (Tusek and Golob 1998).

2.2 SOURCES OF NATURAL DYES

The sources of natural dyes are broadly classified based on cultivation and collection. The natural sources cultivated are marigold, annatto, indigo etc. The collections of natural dyes are from cooperative stores and wholesale ayurvedic shops (Teli and Nayak 1994). The importance of vegetable dyes has increased presently, with increased awareness about harmful effects of chemical dyes both in production and in its usage by human beings. In the light of these factors there is a very huge potential for vegetable dye and food colors, since all of them are extracted from natural sources and are having no harmful effects 15 (Industrial Extension Bureau (iNDEXTb 2004)Different parts of plants, animal residues and some of the minerals are the sources of natural dyes. Vegetable source of natural dyes are renewable (Janhom and Watanesk 2006) Pigments extracted from the roots of vegetable sources are mostly

used for red dyes (NCIB Pubmed 2002). The organic cultivation of dye plants for the certified natural textile industry is as emerging and promising sector of organic farming (Anna Hartl and Vogl 2003). Henna or Egyptian privet is the source of an ancient and very important yellow dye (El-Shishtawy 2002). This dye has the rare distinction of being a dye whose use can be traced back to antiquity and which continues to be as commonly used all over the world today as it is in the ancient times (Christie et al 2006). Turmeric is the most commonly used yellow dye followed by harshingar (nyctanthes arbortristis) and palash (butea frondosa). Weld has been the most commonly used natural yellow color in Europe countries (El Molla and Schneider 1995). Coreopsis, goldenrod, onion skins give yellow color. Lilies, queen anne`s lace, rhododendrum give green color (Bechtold et al 2002). For purples or lavenders the sources are blackberries and grapes (Clipson 1989). Acrons, marigold, pomegranate give brown color (Traci Vandermar 2002). Lac is a unique dye material of animal origin being the secretion of tiny insect kema lacca (Kamel et al 2005). Most of the plant materials used for the extraction of dyes are also credited with medicinal properties, and are rich in napthoquinones (Kamel et al 1998). Black walnut (juglans nigra), pecan (carya illinocnsis), shagbark hickory (carya ovata mill). Nut hulls can be used to make a dye to color the textiles to a brown color, pecan and a red/orange. 16 Indigo is the most important blue component in the class of natural dyes for cellulosic and protein fibers (Janhom et al 2004). Brown from tengar, bakau, obah, durina. Reddish brown from engkerbai psychutria viridiflora reinu, megkudu angsana (Kamel et al 2005). Yellow from the wood of asepang, bebaru, engkala burong, pedalai. Blue from tarum, indigofera. Purple from the pods of jering (Dumitrescu and Varga 2006). Teak plants are abundantly available in the forest of orissa, west Bengal and in many other states (Mason 1999). Teak leaves are left as

waste which can be utilized to get dye for textile industry. It is reported that the teak leaves contain 6% of tannin and also brownish red dye pigment in large quantity (Ahulwalia and Seshadri 1957, Chari et al 1969)

2.3 EXTRACTION AND APPLICATION METHODS

The review of the past researches in accordance with the extraction and application methods has been presented in this section.

Verma and Gupta (1995) extracted the dye from wattle bark, which comprises 15 to 20 percent of the barks dry weight. Tests of wattle bark dyes on 36 woollen fabric samples investigated the influence of copper, alum, iron and chrome mordants for dyeing at 100 degrees centigrade for 1 hour at pH 6.5.

Singth et al., (1996) attempted to standardize the process for dyeing silk fabrics with a natural dye derived form the *Sectreasea pallida* plant. Tests indicated that l00 gms of fresh Nargis leaves in 100 millilitres of water with 60 minutes of extraction time and 30 minutes of dyeing time achieved the best result.

Researchers have also investigated the use of natural Kamala dye for the dyeing of silk. The experimental dye derived from a fine powder obtained from dried kamala fruits and verified that ideal dyeing conditions included the use of lgm of dye to 100 millilitres of water, the use of 300 milligrams of sodium bicarbonate for extraction, a 60 minutes extraction period, and 30 minutes of dyeing time Sing et al., (1996).

Prabhu and Senthikumar (1997) crushed *Cassia fistula* flowers, dissolved them in distilled water, and allowed the solution to stand for a day. The dye extracts were compared for wash fastness and light fastness. The natural dye yielded a dull yellow

colour for both cotton and silk and achieved good light fastness and fair wash fastness.

Venkiduswamy and Arunkumar (1997) boiled the shoe flowers in water for 20-30 minutes, filtered the mixture using a nylon fabric, dried and ground the filtrate into fine powder, mixed the powder with hot water, boiled the mixture for 30 minutes, and cooled the mixture before dyeing.

Kalyani and Mary (1998) investigated the use of gulmohr dyes extracted from red flowers. Aqueous and alkaline methods of extraction were the best. Optimal concentration for dyeing was 3gms of gulmohr flower in 100 millilitres of water.

Another study by Katyayini and Mary (1999) extracted a dye directly from mesta calyx and it was found to be optimum as compared to the powdered form of dye extraction such as aqueous, alkaline, acid and alcohol. Aqueous method was found to be the best method. The optimum concentration for dyeing with mesta calyx were 3 grams of mesta calyx in 100ml of water per one gram of sample which gave best results. The optimum time for dye extraction and dyeing was found to be 60 minutes, and 30 minutes of time was considered optimum for mordanting the samples.

Kumar and Bharti (1998) experimented to dye cotton fabrics with Eucalyptus hybrid bark, at a liquor ratio of 1:40, gradually raising the temperature of the dye bath to 100 degrees centigrade. Aqueous extract of the bark yielded bright brown dye and provided the widest range of shades.

Radhika D. and Mary Jacobs (1999) investigated the dyeing of silk fabrics with dye extracted from *Jatropha curcas* (seeds) with acidic methods as optimum. Whereas alkaline method of extraction produced the maximum amount of dye from Jatropha seeds to dye plain weave cotton fabrics.

Extraction of *Terminalia bellerica* fruits under different conditions occurred optimal dyeing when using extracts obtained via boiling 5 grams of fruit in 100 millilitres of water for 90 minutes, adjusting the dye bath to pH7, and dyeing the wool for 60 minutes at the boiling point (El-Zawahry and Kamel 1999).

Extraction conditions for tesu flower, pomegranate rind and dolu bark were optimised by Ansari, et al., (1999) by studying the effect of pH of extraction media, temperature and time of soaking, extraction and mass to liquor ratio on dye yield. The optimum pH values for tesu, Pomegranate and dolu bark were found to be 10 M: L ratio for tesu was 1:20 while for Pomegranate and dolu bark it was found to be 110.

Optimum temperature for tesu and Pomegranate was 80° and for dolu bark it was optimum at 70° C. Optimum soaking time in hours was 16 hours for all the three dyes and optimum extraction time was found to be 2 hours for each dye. The extracted dyes were then dried in hot air over at 70±1° C, cooled in dessicator and crushed to obtain the dyes in the powdered form.

2.4 MORDANTS, MORDANTING PROCEDURES AND FASTNESS PROPERTIES

Studies on the mordants, mordanting procedure and fastness properties were screened and some of the relevant studies were collected and presented as follows.

Goodman (1985) stated that choice of mordant was found to affect light fastness more than the dyestuff or length of exposure.

Anonymous (1988) reported that the dye features a light fastness of 3-4 on wool, depending on the mordant and is also suitable for silk fabrics. Processing requires a

mordant. Improvement of dye fastness to perspiration on woollen fabrics involves increasing the amount of alum up to 10 percent.

Hashimoto (1989) studied the fluorescent behaviour of natural dyes using cotton and silk. It was concluded that the fluorescent intensity depended largely on the dyes and mordants and conformed to concentration quenching. The effect of the mordant on the fluorescent intensity was corrected with the type of metal in the mordant. Copper and iron were found to decrease the fluorescent intensity.

Fluorescent intensity increased when the dyes were exposed to light even though the dyes faded.

Dalby (1993) reported a fixing recipe that uses a 2 percent formic acid additive with only one-third the customary amount of potassium dichromate. Copper recipes can be improved with acetic acid, which improve light and wash fastness.

Gulrajani et al., (1993) employed three methods- pre mordanting, simultaneous mordanting and dyeing and post mordanting to evaluate the effect of mordants on the shade, light fastness, and launderability of silk and woollen fabrics dyed with a series of natural red dyes. Although none of the mordants significantly altered the colour depth of the dyed silk fabrics.

Gupta (1990) stated that Pomegranate rind can be used as a mordant and as a substitute for Harda, and comparable and even deeper shades with equal fastness properties can be achieved. In some cases the rind can be used to produce new shades.

Prior to the application of Madder and Savalkodi, Padhye and Rathi (1990), treated cotton fabrics with mordants and other chemicals and stated that depending on the nature of the mordants and the concentrations of mordants and dyes used, shades obtained varied greatly.

Nishida and Kobayashi (1992) evaluated the dyeing properties of a natural vegetable dyes such as chestnut peels, persimmon leaves, oak leaves, coffee and green tea. The dyes were used on plain-weave silk, cotton, silook, silk and silook blend and cashimilon and stated that Ferric sulphate after treatments improved the light fastness on silk and silook more than after treatment with an aluminium salt.