1.1. INTRODUCTION

The word coir is derived from 'Kayar' which in Malayalam language means rope. The word seems to have been introduced into the European literature by the Italian traveller, Marco Polo who visited India in the thirteenth century. Ropes of coconut fibre have been in use ever since the dawn of civilization and the term coir has come into use for designating the fibrous mass present between the outer husk and the shell of the inner kernel of the coconut fruit which grows on coconut palm (Cocos nucifera). Coconut trees are abundantly cultivated in the tropics, particularly in India and the south east Asian countries and play a very vital role besides in the economy in the social and cultural life of these countries.

Extraction of coir fibres from the matured nuts consists of several processes. The first step in this direction is removal of the husk from the nut, the process being known as dehusking. The extraction of fibre from the husks involves the following operations : retting, cleaning, drying and combing. Among these, the most import one is retting operation by which the fibres are separated from the husk by treating the husks with saline water. It is mainly a biological operation and is based upon the differences that exist in the susceptibility to rot or microbiological decay of the different constituents of the husk. It involves the use of living organisms accidentally present in the retting atmosphere, in exerting their degrading action upon the particular tissues which are intended to be preferentially destroyed. Research on retting initiated in India by Fowler and Marsden [1] and subsequently followed by Pandalai et al [2] indicates that microbiological action takes place quickly and efficiently only in brackish or saline water.

The retted fibres are finally cleaned by washing and combed before being used as coir for different commercial and household purposes. The weight of the husk and its thickness are usually controlled by both hereditary and environmental conditions.

The ultimate coir is mainly a multicellular fibre which contains 30 to 300 or more cell in its cross-section which is polygonal to round or oblong with blunt or rounded ends. Individual fibres are 0.3-1.0 mm (av. 0.7 mm) long and 0.010-0.024 mm (av. 0.020 mm) in diameter; the ratio of length to diameter is 35. Cells in natural fibres like coir refer to the crystalline cellulose arranged helically in a matrix consisting of non-crystalline cellulose lignin complex [3]. The two main non-crystalline constituent in coir are lignin and hemicellulose which form the cementing materials of fibre cells. These constituents increase with age while pectins decrease. As the lignin content decreases, the fibre becomes stiffer and tougher. Lignin is also, to some extent, responsible for the natural colour of the fibre. Complete delignification of coir results in break-down of the fibre structure to the ultimate cells and the subsequent loss of spinning value. This fact emphasizes the importance of the study of coir in its natural form without removal of lignin for exploring the potential of its industrial use in real life. The chemical composition of coir vary with its origin, however the essential chemical constituents of any coir are cellulose (36-43%) lignin (41-45%), hemicellulose (0.15-0.25%) and pectins (3-4%) together with some water soluble minerals. The average chemical compositions of coir fibres of different origins are shown in Table 1.1.

Table 1.1 Chemical composition of Coir fibre (%) [4]

Source of Fibre	Water soluble materials	Pectin and other soluble in boiling water	Hemi-cellulose	Lignins	Cellulose
Old nut	5.2	3.0	0.25	45.8	43.4
Young nut	16.0	2.7	0.15	40.5	32.9
Very young nut	15.5	4.0	0.25	41.0	36.1

Table 1.2 Chemical composition of some ligno-cellulosic fibres

Fibre	Cellulose	Hemicellulose and Pectin	Lignin	Extractive
Ramie	76.2	16.7	0.7	6.4
Cotton	91.8	6.4	-	1.8
Sisal	73.1	14.2	11.0	1.7
Jute	71.5	13.6	13.1	1.8
Flax	71.2	20.6	2.2	6.0

Depending on the physical properties and their ultimate uses, coir fibres are broadly divided into two major types. They are white fibre, also called yarn or mat fibre and brown fibre. The white fibre is the longest and finest and is suitable for spinning into coir yarn for making ropes and mats. The brown fibre is further divided into two varieties namely, bristle and curled. The bristle fibre is long and thick and in used for brush making. The curled or mattress fibre which is a shorter staple fibre, finds use as stuffing materials in making upholstery, mattresses etc. The white fibre is extracted from green husks by the bacteriological process of retting while the brown one is extracted from ripe dry husk by the mechanical defibering process.

Perhaps, coir is the cheapest and most widely used of all the natural fibres. The multiplicity of its uses and the immense potential for its commercial exploitation stem from its several valuable physical properties. Among these properties mention may be made of its length, fineness,

strength, spinnability, elongation, elastic properties, resistance to heat, electricity, dampness and also to fungal and bacterial decomposition. The textile and paper industries are the primary converters of coir into product with properties directly related to these unique characteristics of the fibre. As mentioned earlier, because of these properties the fibres can be spun into yarn which can be used for making various types of ropes, mats, carpets and mattresses. Besides these, coir also finds extensive use as packaging and stuffing materials. Another interesting development in the application of coir is its use as a construction material in buildings. Recently various types of composites with rubber and polymer have been developed. These composites are finding wide industrial applications. Material scientists all over the world have been engaged in the development of coir composites by judicious combination with different polymers having several useful properties. A very good account of the properties and uses of coir has been given in a CSIR publication (1960).

Coconut and coir play a very dominant role in the social and economic life of the people living in the coastal region of our country.

1.1.1 MORPHOLOGY OF CELLULOSIC FIBRE

A fibre is defined as a flexible, macroscopically homogeneous body having high ratio of length to width and a small cross section. The gross structure of cellulosic fibres is much more Complex than that of the man made fibres from synthetic polymers. It may be unicellular (e.g. ramie, cotton etc.) or multicellular (e.g. jute, coir) according to as it consists of a single plant cell or many cells respectively. The gross morphology of plant cell