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Effect of Antimicrobial Agents on Modification of Coir

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Abstract

Coir yarns were coated with three natural anti-microbial agents - Cashew Nut Shell Liquid (CNSL), neem oil and tulsi oil for improving its hydrophobicity, tensile strength and biological resistance. Microbial degradation study was performed with *A. niger* as test organism. The results indicated that coating of coir yarns was capable of increasing tensile strength by 17% and reducing moisture absorption by 34%. Microbial activity of CNSL coated coir yarns was reduced to 95%. Coating with neem oil was found to be less effective while coating with tulsi oil adversely affected the physical and engineering properties of coir.

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Keywords: Coir geotextiles; CNSL; natural antimicrobial agent.

1. Introduction

The term natural fibres refers to a wide range fibres of vegetable, animal and mineral origin. They have complex three-dimensional structure composed of cellulose, hemicellulose, pectins, and lignin. Natural fibres such as jute, coir and bamboo are increasingly being used as soil reinforcement due to their tensile strength. Such reinforcements are found to reduce the development of crack during shrinkage due to improvement in the ductility behaviour of soil [1, 2]. Application of geotextiles made of natural fibres has received impetus in erosion control and as reinforcing material for short term engineering applications. Coir geotextiles have been reported to perform efficiently in areas

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of soil water interaction [3, 4, 5, 6]. Soils which exhibit low shear strength and high compressibility can be improved by the use of coir geotextiles. Jute geotextile impregnated with rot resistant bitumen is found to serve as a successful fabric form for concreting and also as a secondary liner for landfills [7]. The feasibility of using of coir geotextiles as attachment media in filters for treatment of wastewater has also been reported [8].

Natural geosynthetics can be designed based on the end use of the product. The requirements to solve an existing problem are first identified and a design is developed. A good design can result in natural fibre products which can compete with synthetic materials. In specific applications, their performance may even leave behind their synthetic counterparts [9]. For load-bearing applications, the use of reinforcements in the form of continuous aligned fibres is essential for the full utilization of fibre efficiency. Natural plant fibres possess only discrete length. For reinforcement application, the natural fibres need to be processed into yarns. These are then converted into continuous products such as mats or textiles with highly controlled fibre orientation [10].

Natural fibres are relatively inexpensive, easy to process, renewable and have less carbon footprint. However, high biodegradability of these fibres sometimes poses problems in long term engineering applications [2]. Use of natural fibres in civil engineering applications is limited mainly due to their tendency to degrade under certain environmental conditions; especially in tropical climatic conditions [11, 12]. Hence it is necessary to subject these to modification processes. Such processes are intended to clean and alter the surface properties of fibre. This ultimately reduces the moisture absorption rate and enhances mechanical properties of fibres [13].

Many attempts have been made in the past to modify natural fibres by treating them with various synthetic chemicals. Most of the conventional modification methods which are found to be efficient in altering fibre properties have proved to trigger environmental pollution [14]. In view of promoting sustainable techniques, there is a continuous pursuit for different methods of environment friendly methods for preservation of lignocellulosic materials [15]. Natural antimicrobial agents such as chitosan, neem (*Azadirachta indica*) oil, cashew (*Anacardium occidentale*) shell oil, tea tree (*Melaleuca alternifolia*) oil, eucalyptus (*Eucalyptus radiata*) oil, aloe vera (*Aloe barbadensis*, Miller) extract and tulsi leaf(*Ocimum basilicum*) extract have been found to be effective in imparting antimicrobial finishing effect to textiles [16].

Neem is recognized as one of the most effective antimicrobial and insecticidal natural agents. Neem seed extract when applied on polyester/cotton blend fabric imparts antibacterial property to the fabric while maintaining its key properties [17]. CNSL is a cheap agro by-product with germicidal and fungicidal properties [18]. Coating of CNSL containing copper sulphate on coconut leaf thatch has extended its life from 1 to 4 years [19]. Copperised CNSL and copperised neem oil have proven as low cost environment friendly preservatives for wood against the attack of termites and fungi [15]. Methanolic extracts of tulsi leaf when applied on cotton fabric exhibits high bacterial reduction [20]. The application of these natural agents on lignocellulosic materials gives promising results. Studies on the effect of natural antimicrobial agents on coir have not been reported. It is expected that coir being a lignocellulosic fibre, may also respond to these natural antimicrobial agents in a similar manner. In this study, three natural antimicrobial agents, CNSL, neem oil and tulsi oil were used for modification of coir.

2. Materials and Methods

2.1. Materials

Coir geotextiles for the experimental work (Vycome coir, simple weave panama) were collected from Charangattu Coir Manufacturing Co. (P) Ltd., India. Properties of coir geotextiles are listed in Table 1. Processed CNSL was supplied by Vijayalaxmi Cashew Company, India. Neem oil manufactured by HIMEDIA and tulsi oil manufactured by Greenleaf Extraction Pvt. Ltd. were used for coating applications. Kerosene was procured from a local supplier. Copper sulphate and sodium hydroxide pellets (laboratory grade), potato dextrose powder and potato dextrose agar (bacteriological grade) were used for experiments.

2.2. Coating application

Experiments were conducted on coir yarns pulled out in warp direction from coir geotextiles. Coir yarns were cleaned and washed in slightly alkaline solution containing sodium hydroxide and oven-dried until constant weight was attained. Yarns were pre-treated by dipping in 1% copper sulphate solution for 24 hours and were then dried at