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ANALYSIS OF THERMAL CONDUCTIVITY OF MICRO AND NANOENCAPSULATED ORGANIC COTTON FABRIC

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Abstract : Clothing is regarded as a second skin, and it has been worn for safety since the dawn of time. Yet, in recent decades, the phrase "Health Based Apparel" has become synonymous with the use of clothing. Herbal completed Antimicrobial fabrics have a lot of potential right now since they are eco-friendly, readily biodegradable, and have no health risks. Plants have antibacterial qualities and are used to treat a variety of illnesses. Microbial development in textiles is reduced when they are finished with plant extracts. As a result, the antibacterial properties of plants and garments may be combined to get greater advantages. The Finished and unfinished Organic cotton knits were tested for Thermal conductivity using standards. In Organic cotton, fabric finished with nanoencapsulation showed an insulation rate of 24.68 per cent, unfinished and microencapsulated showed 23.61 per cent and 22.47 per cent respectively.

IndexTerms **- Antimicrobial, Organic Cotton, Knitted Fabric**

I. INTRODUCTION

Researchers have devised novel methods to address the environmental issues that have arisen as a result of textile manufacturing. Natural herbal extracts applied to natural fibres in dyeing and finishing may prevent the negative effects of chemicals. Substitutes for toxic chemicals should be used for better health and environmental reasons. Organic cotton and natural colours on the cloth, for example, are not commonly used. Similarly, oils can be utilised to impart other finishes such as antibacterial and antiodour properties.

Textile testing is essential in generating useful information that allows for new advancements and growth in the textile industry. As a result, more durable and serviceable textiles for specific applications may be created. Textile testing is used to determine the worth of a product, confirm regulatory compliance, and calculate the production of any textile material. Testing is a crucial way of measurement and verification throughout the process, starting with the raw material and ending with the finished textile. Thermal conductivity testing can link textiles' thermal properties to their advantages and pitfalls as heat insulators. The heat is transmitted in a fabric by the transference of air into the fiber and through radiation also. Thermal conductivity can also be termed as the sum of heat tramsmitted into textile material per unit time along with the distinction in unit temperature. Thermal Resistance is the reciprocal of thermal conductivity. The source of heat exchanged between the environment and people, moisture performance, and heat transmission in the midst of movement are all key comfort and performance properties of textiles.

The heat conductivity, moisture-holding ability, air-permeability, abrasion resistance, and air resistance characteristics all influence the comfort attributes of textile materials (Pamuk, 2008). Air permeability, temperature resistance, and moisture management are the most important comfort attributes (Latif et al., 2018).

II. MATERIALS AND METHODS

2.1 *Punica granatum*

Punica granatum has antimicrobial properties, implying the possibility of discovering antibacterial principles (Dahham et al., 2010). *Punica granatum* aqueous leaf extract was shown to be efficient as an antibacterial agent against the microorganisms that were tested (Bacillus subtilis, Staphylococcus aureus and Salmonella typhi). This progress will aid in the discovery of new chemical classes (Kumar et al, 2015). The presence of phenols, Saponins, alkaloid, terpenoids, tannins and flavonoids was discovered in the phytochemical contents of *Punica granatum* L. ethyl acetate peel extracts. The antibacterial efficacy of Ethyl Acetate peel extracts of P. granatum against pathogenic plant bacteria was revealed in this study, and it might be of considerable agricultural utility (Ayad et al., 2016).

2.2. *Moringa concanensis*

Moringa concanensis is believed to be anti-inflammatory, antibacterial, diuretic, antiurolithiatic, and antihelmintic, in addition to being an excellent source of protein, vitamins, lipids, fatty acids, micro-macro mineral elements, and different phenolics. In the

traditional medical system, its many pharmacological benefits are exploited as therapeutic remedies for various ailments (Farooq et al., 2012).

This herb may be used to treat twenty different sorts of human illnesses using easy preparations (Anbazhakan et al.,). Its purpose is to strengthen the cardiovascular system, promote normal blood glucose levels, neutralise free radicals, hence lowering cancer risk, and serve as a good support for the body's anti-inflammatory processes, as well as to enrich anaemic blood and boost the immune system (Mahmood, 2010).

2.3. Psidium guajava

Psidium guajava L. is a South American medicinal tree. It is generally known as guava (belongs to the Myrtaceae family) and is used in Traditional medicine for a variety of ailments all around the world. In many nations, the tree's leaf, root, bark, and fruits are used to treat stomachaches and diarrhoea. It has anti-inflammatory, anti-diarrheic, and cancer-fighting effects (Ryu et al., 2012). Four antibacterial substances were discovered and extracted from guava leaves (*Psidium guajava* L.) during a research (Arima & Danno, 2002). *Psidium guajava* is also used to treat cholera, ulcers, sores, and gastrointestinal problems (Sanches et al., 2005).

2.4. Organic cotton fabric

Organic cotton is grown without the use of any chemicals, fertilisers, or pesticides. Organic cotton was originally planted in the 1980s for sustainability, ecological protection, and biodynamic agriculture. It has several advantages for both humans and the environment. Despite its financial limits, it continues to grow in leaps and bounds in the market due to its distinctiveness.

2.5. Thermal Conductivity

Experiments on heat transmission by conduction through several types of textiles employed as thermal insulators have been carried out. Thermal transmission through conduction is determined by the heat conductivity of the materials, or their ability to transmit heat from a warmer to a colder medium (Rehim et al., 2006).

2.6. Tests for Comfort Properties

The comfort qualities of finished and unfinished organic cotton single jersey knit textiles were examined. The qualities of nonsensorial comfort aspects in textiles are measured using an objective manner. Comfort qualities such as air permeability, moisture management property, thermal conductivity, porosity, drop test, sinking test, and wicking test can be assessed on unfinished and finished organic cotton single jersy knit textiles to know about its quality.

III. EXPERIMENTAL PROCEDURE

3.1. Specifications of Knitted Organic cotton fabric

Organic cotton single jersey fabrics were Knitted with 30's count of 130 GSM, for herbal finishing (Figure1).

Fig 1. Unfinished organic cotton knit

3.2. Identification of the final Herbal Extract Combination

The synergetic effect of herbs is achieved when two or more herbs or substances combine and generate an outcome greater than the sum of their separate effects, according to a review of the literature. When two extracts are combined, the antibacterial action of both extracts is additive and synergetic (YuJie Fu et al., 2007). When evaluating the antibacterial and antifungal action, the 1:2:3 ratio (*Punica granatum: Moringa concanensis: Psidium guajava*) produced the best results. As a result, the 1:2:3 ratio was chosen for further research.

3.3. Microencapsulation in Fabric

More developed countries are looking into textiles with novel qualities. They are pushing research for value-added goods, medical textiles, and technological textiles, which is a paradigm change. Microencapsulation is a technique for imparting a fabric finish and incorporating characteristics into textiles utilising low-cost technologies (Nelson, 2002). As a result, microencpsulation was chosen as one of the techniques for further processing. Organic cotton fabric was microencapsulated using exhaust method.

3.4. Nanocapsulation in Fabric

Nanoencapsulation is a technique for coating nanoscale particles with another material. This approach has a number of advantages when it comes to changing the characteristics of a material at the nanoscale. Nano particles indicate changes in a substance's functional qualities that can't be achieved with other finishing processes. Bovine albumin fraction was used as the wall material and nanoparticles as the core material to encapsulate the herbal extract composite (Punica granatum, Moringa concanensis, Psidium guajava- 1:2:3 combination).

3.5. Finishing of Fabric

Fig 2. Finished organic cotton knit

The herbs Punica granatum, Moringa concanensis and Psidium guajava were taken in the ratio 1:2:3 and the fabric Organic cotton were finished (Figure 2).

Antibacterial activity by well diffusion using Bacterial cultures Staphylococcus aureus (ATCC 6538), Escherichia coli (ATCC 8739) and Antifungal activity by well diffusion using Aspergillus niger (ATCC 6275), Trichoderma reesei (ATCC 26921) were performed on finished and unfinished Organic cotton.

3.6. Flat-plate Fabric Heat retaining Instrument

The equipment (Figure 3) makes use of a sample that is placed on the testing plate. Then it's time to create standards. On the LCD display, the test results (Figure 4) (insulation rate, heat transfer coefficient, and CLO value) may be shown.

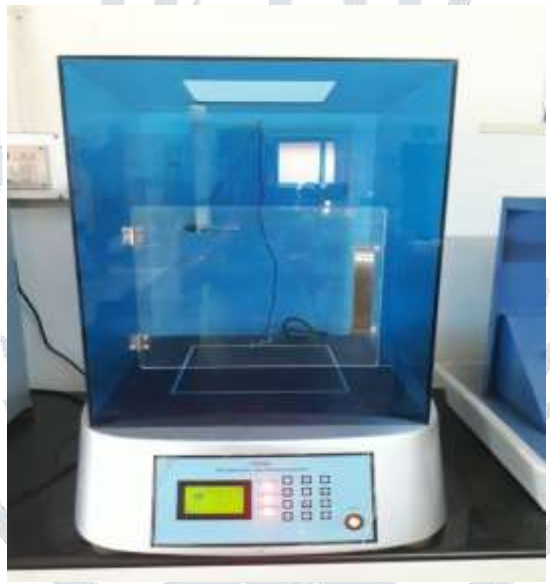

Fig 3. Flat-plate Fabric Heat retaining Instrument

Fig 4. LCD display of test results in Flat-plate Fabric Heat retaining Instrument

IV. RESULTS AND DISCUSSION

The assessment of unfinished, microencapsulated, nanoencapsulated Bamboo and organic cotton single jersey knit fabrics were tested for thermal conductivity and the results of all the six fabrics are given below.

Table 1. Fabric thermal conductivity of finished and unfinished Organic Cotton

S. No.	Fabric Samples		Insulation rate (%)	Transfer coefficient	CLO value (clo)	F Value	p-value
1	Organic Cotton	Unfinished	23.61	36.37	0.18	1.2572	.349938
2		Microencapsulated	22.47	38.78	0.17		
3		Nanoencapsulated	24.68	34.71	0.19		

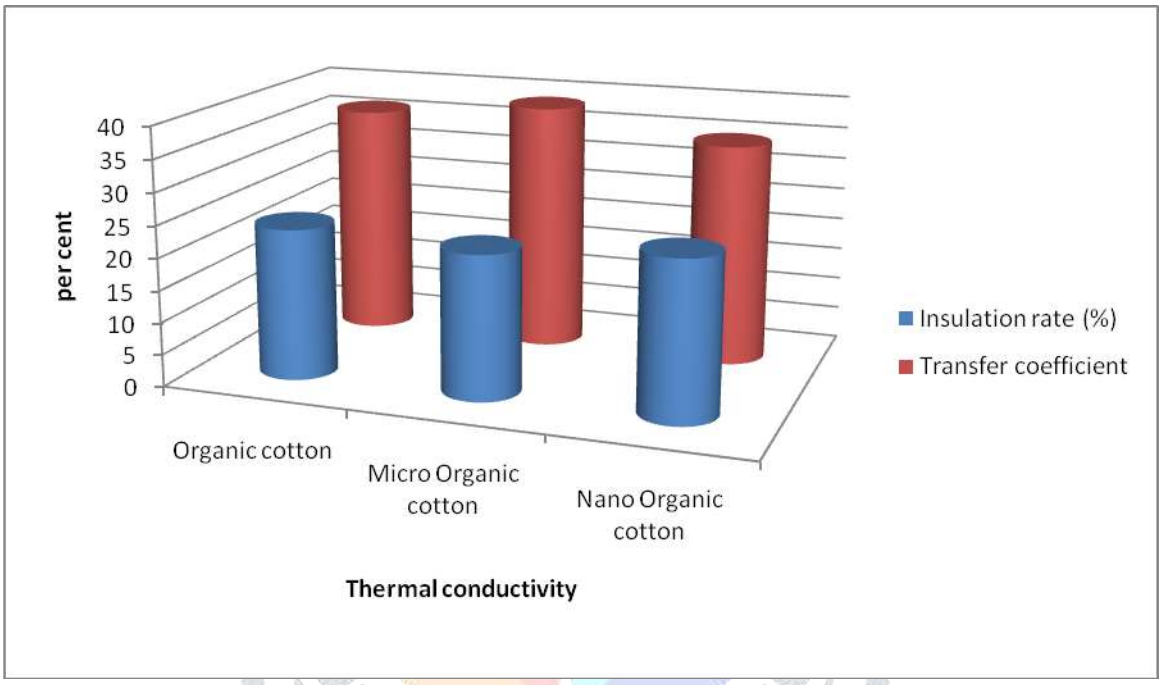

Fig 3. Fabric thermal conductivity of finished and unfinished Organic Cotton

From the Table 1 and Figure 3, it is evident that, Organic cotton fabric finished with nanoencapsulation had a 24.68 percent insulation rate, unfinished fabric had 23.61 percent, and microencapsulated fabric had 22.47 percent. It is identical to the experiment conducted by Pramanik et al., 2018, in which 100% cotton fabric was examined for their thermal qualities, and it was discovered that bamboo fabric had lower thermal conductivity and thermal resistance than cotton.

Fine yarn has a lower heat conductivity and a higher thermal resistance, which might be the explanation. The heat conductivity of knitted materials decreases as the twist rises (Raja et al., 2015).

According to the statistical analysis, there was a significant difference between the groups in terms of bamboo insulation rate, but not in terms of organic cotton single jersey fabric insulation rate at the 5% level.

The fabrics were selected and the prepared herbal microencapsules and nanoencapsules were applied for the antimicrobial finishing on fabric. Exhaust method was employed for antimicrobial finishing on fabric. By exhaust method microencapsules and nanoencapsules were prepared and finished on to the fabric. Organic cotton single jersey fabrics were Knitted with 30's count of 130 GSM, for herbal finishing.

The goal of this study was to determine the antibacterial capabilities and characteristics of eco-friendly fabrics. The results of this study reveal that certain herbal extracts have good antimicrobial activity against pathogenic strains like *Staphylococcus aureus*, *E. coli*, *Aspergillus niger* and *Trichoderma reesci*. The existence of secondary metabolites may be the explanation for extracts' antimicrobial effectiveness against these dangerous bacteria. Combinatorial herbal extracts may be responsible for the improvement in antibacterial potential efficiency. Combinatorial use of these extracts in organic cotton single jersey knit textiles might open the door for the discovery of a wide range of antimicrobial compounds that can fight specific microbes.

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