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Micro-Encapsulated Aroma Treated Cotton Knit Material using Selected Herbs

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ABSTRACT

Antimicrobial fabric is gaining significant importance during recent years. As synthetic antimicrobial agents are non-eco-friendly and non-biodegradable, there is an increased demand in the usage of natural antimicrobial agents for functional finishes to textiles. The present study focused on the ecofriendly cotton knit fabric which was subjected to selected three herbs for its activity tests and applied to the material by microencapsulation, to test for its antimicrobial activity. The same was given an aroma finish with natural herbal oil. The treated material was subjected to certain cycles of washes to find the antimicrobial effect in the fabric. The antimicrobial aroma treated knit material was then subjected to qualitative and quantitative test before and after washings. The result proved that the Datura metal showed the highest zone of antimicrobial effect among the other selected herbs.

KEYWORDS: *microencapsulation, antimicrobial finish, aroma oil, cotton knit fabric*

I. INTRODUCTION

Naturally derived products play an essential role as a source of medicine. Plants are one such example which is a sound source of natural products and their extracts have attracted a lot of interest due to large contributions to some important applications Angela Rubio-Moraga et al. (2013). The textiles are bigger carriers of microorganisms such as pathogenic bacteria, odour generating bacteria and mold or fungi. Fabrics contaminated with bacteria have been the major cause of skin infections and irritations VaishaliRane (2011).

Clothing and textile materials act as carriers for the growth of microorganisms. Natural textile fibers like cotton are highly prone to microbe growth than the synthetic fabrics, due to their porous and hydrophobic nature. Direct contact of textiles with human body provides warmth, humidity and nutrients; particularly an excellent environment and best conditions for microorganism growth on textiles Akroum (2009). Moreover, the moisture regain of cotton, climate conditions in India and the cellulose present in cotton also favors the microbe growth. Microbial growth on textiles may cause foul smells, skin irritation, cross infection, discoloration and colour stain also affects the functional properties of fabric like strength and elastic properties (Roman 2006, Vidushi et al. (2011).

Infectious disease recently throughout the world outbreaks are caused by antimicrobial productsWannang (2009). Antimicrobial finishes on fabrics can protect human beings against microbes. Synthetic antimicrobial agents have excellent antimicrobial efficacy for a wide range of

microbes. Such antimicrobial agents destroy the growth of micro-organisms and their negative effects of odour, staining and deterioration Dring (2003). Although a wide range of synthetic antimicrobial agents like triclosan, metals and their salts, organometallics, phenols and quaternary ammonium compounds have been applied to cotton, its issues of eco-friendliness and biodegradability limit the use of these synthetic antimicrobial agents, in addition to commercial initiative, scientific studies are going on production of natural based antibacterial finishes (Kayahan et al. 2013, Mahltig (2005).

Durability of the antimicrobial finishes on fabrics can be enhanced by microencapsulation techniques. Microencapsulation may be defined as the micro packaging technique where in active core materials are encapsulated in a polymer shell of limited permeability Ramesh (2004). The objective of this technology is either to protect the active core material from the external environment till required or to affect the controlled release of the active core on active desired delay until the right stimulus is encountered. This process is initially developed for the carbonless copy technologies Gang Sun (2001). However, it has now attracted the attention of wide range of industries including pharmaceutical, agriculture, chemical, food processing, cosmetics and also in textiles. The encapsulation method of finishing in herbal materials provides a high surface area and extends the shelf-life of the finish on cotton HidekazuYoshizawa (2004).

In the present study eco-friendly cotton knit fabric was developed and selected for the study. The same was treated with selected herbal extracts and the best antimicrobial efficacy was found. The selectedbest antimicrobialextract was microencapsulated and finished on the cotton knit fabric. An aroma finish was also given using an herb oil. The durability of the developed fabric was evaluated using wash durability tests at different washes and tested for antimicrobial activity.

II. METHODOLOGY

Materials

Cotton is one of the best suitable vegetable fiber for apparel purpose, especially in tropical zone where comfort stands the most important wearable aspects infer Tasnim Shaikh (2012). 30's combed cotton yarn was selected for the study. Cotton knitted material is a commonly used fabric with good absorbency. So investigator selected cotton knit (CK) fabric for the study.

Preparation of the Fabric

Scouring

Cotton knit fabric (CK) was scoured to remove the naturally occurring impurities such as natural fats, oils and lubricants. Scouring helps to remove naturally occurring impurities from the fabric. The treatment was carried out at high temperature in alkaline solutions containing caustic soda.

Bleaching

Bleaching treatments were evaluated in terms to improve the brightness, molecular weight and carbonyl content. The cotton knitted (CK) fabric after bleaching was subjected to mercerization. The investigator selected hydrogen peroxide to bleach the cotton knit (CK) material.

Mercerization

Mercerization involves immersing cotton knit material (CK) into caustic soda solution and neutralized in acid. The process causes a permanent swelling of the fabric, resulting increase in luster strength, residue to mildew and affinity to lint. The investigator selected caustic soda to mercerize the cotton knit material.

Selection of Herbs

Medicinal herbs were identified, collected from the Mother Nature in its pure form and chosen for the study. *Daturametel,* a shrub-like perennial herb found in the warmer parts of the world especially in India contains both the ornamental and medicinal properties Helmut Mucha (2002). The entire parts of *Daturametel*contain highly toxic tropane alkaloids, which is harmful to humans and other animals. But this plant is also known for its properties to possess antioxidant and antimicrobial Gopalakrishnan (2017). *Mimosa pudica* have medicinal properties to cure skin diseases Jency George (2013). *Mimosa pudica* herb is used for migraine, insomnia, headache, diarrhea, dysentery, fistula, piles and fever Sowmya et al. (2011). *Shorearoubesta* plant is traditionally used by tribal people as medicine to treat various diseases like skin allergies, dysentery and also used as an astringent Murthy (2009). Imbibing the above medicinal microbial properties of the herbs, the investigator planned to select the three herbs *Daturametel(D),* Mimosa pudica*(M)* and *Shorearoubesta(S)* for the study.

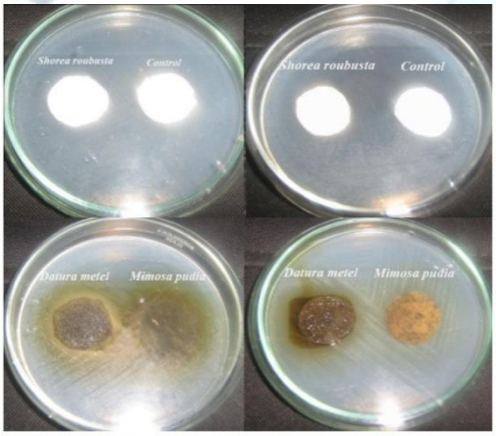
Extraction of Antimicrobial Plant Bioactive Compounds

The leaves of *Daturametel(D), Mimosa pudic (M) and* bark of *Shorearoubusta (S)* were used for extraction. The finely grinded dry powders from

each herb of *Daturametel(D), Mimosa pudia (M)* and *Shorearoubusta(S)* were taken separately and mixed with the solvent methanol. The container was closed and kept for overnight. After overnight incubation, the extract was filtered through filter paper. After filtering the herbal extracts, methanolic solvents were evaporated and the herb extract was condensed. The condensed herbal extracts of *Daturametel(D), Shorearoubesta(S) and* Mimosa pudica*(M)*were stored separately in a closed sterile container.

Qualitative Antibacterial Test of Herbal Extracts

Qualitative antimicrobial test of*Daturametel(D), Shorearoubesta(S) and Mimosa pudica(M)* were subjected to qualitative bacterial reduction test – agar diffusion method AATCC 147 (Plate 1). In this method highest zone of inhibition was found and is shown under results and discussion in Fig. 1.



Escherichia coli *Staphylococcus aureus*

Plate 1: Qualitative Antibacterial Activity of Herbal Extracts

Preparation of Microcapsules from Herbal Extract

From Plate 1 and Fig. 1, the result obtained for the highest zone of inhibition was carried out for further study. The highest zonal inhibition of *Daturametel(D) herbal* extractwas carried out by Ionic Gelation Method. Sodium alginate was used as a wall material. Microcapsule containing the selected herbal extract was formed by the addition of sodium alginate followed by spraying into the calcium chloride solution by means of a sprayer. The droplets were retained in the calcium chloride solution for fifteen minutes for hardening of the capsules. The microcapsules were obtained by decantation and repeated washing with isopropyl alcohol followed by drying at 45°C for twelve hours. The prepared microcapsules of *Daturametel(D)* was kept ready for further process.

Application of Herbal Microencapsulation

The microencapsulated herbal extract of *Daturametel(D),* was applied to the cotton knit (CK) material for antimicrobial finish using Pad-Dry Cure Method. The fabric was padded with three roll padding machines. Required grams of Datura*metel(D)* microencapsulated herb was padded separately on the cotton knit samples at room temperature for five minutes. After padding CKD sample was dried and cured.

Application of Aroma Finish to Microencapsulated Material

The tulsi oil *(Ocimum sanctum)* was selected for the aroma finish for its aromatic and medicinal properties. The microencapsulated CKD, fabric was dipped into the tulsi oil for one hour, then taken out and dried in shaded area. The developed aroma treated CKDT was subjected to wash durability test.

Determination of Aroma in Treated Fabric

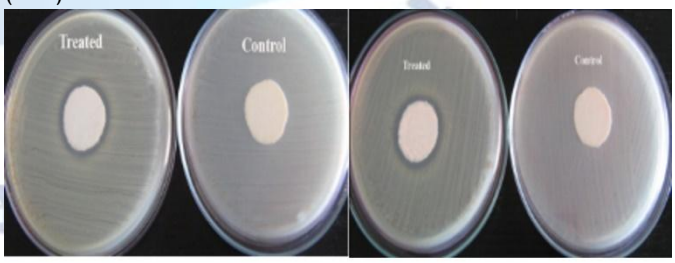
The treated CKDT material was converted into wearable product and tested for organoleptic evaluation and is shown under results and discussion in Fig. 2.

Determining the Wash Durability of Treated Fabric

The treated fabric CKDT was analyzed for their wash durability by subjecting the sample to hand washing using commercial detergent. After every 4 washes (4th wash, 8th wash, 12th wash, 16th wash and 20th wash) the CKDT samples was tested for its antimicrobial activity.

Identifying Antibacterial activity using Qualitative and Quantitative Method

The treated CKDT materials and CK untreated (original) material was subjected to the qualitative (AATCC 147) (Plate 2) and quantitative (AATCC 100) (Plate 3) antibacterial tests against Escherichia coli (-ve) and Staphylococcus aureus (+ve).

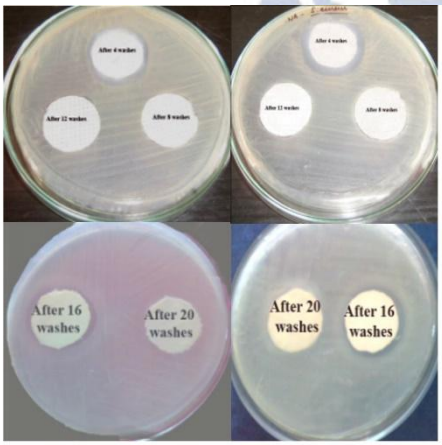


Escherichia coli *Staphylococcus aureus*

Plate 2: Analysis of Antibacterial Activity by Qualitative Test

Escherichia coli *Staphylococcus aureus*

Plate 3: Antimibacterial Activity by Quantitative Test



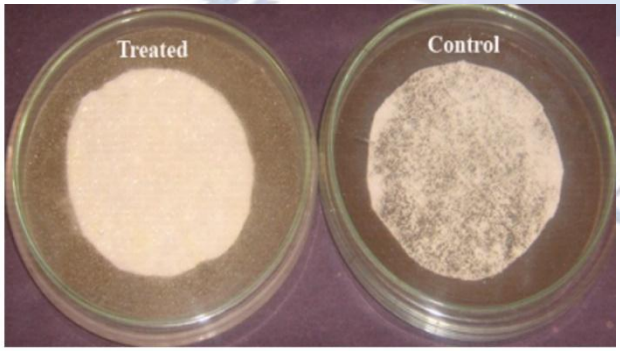
Escherichia coli *Staphylococcus aureus*

Plate 4 Antibacterial Activity of CKDT washed Samples

CKDT washed material specimens of 4th wash, 8th wash, 12th wash, 16th wash and 20th wash (CKDT4, CKDT8, CKDT12, CKDT16 and CKDT20) samples (Plate 4) tested for qualitative and quantitative test. The result analyzed is recorded under results and discussions in Fig. 3 and Fig. 4.

Identifying Antifungal Activity using Qualitative method

The treated CKDT material and CK untreated (original) material was subjected to the qualitative against *Aspergillusniger* (AATCC-30) (Plate5).



Aspergillus niger

Plate 5: Antifungal Activity by Qualitative Test

Aspergillus niger

Plate 6: Antifungal Activity of CKDT washed Samples

checked for their antibacterial activity and is shown in Fig. 1.

CKDT washed material specimens of 4th wash, 8th wash, 12th wash, 16th wash and 20th wash (CKDT4 CKDT8, CKTD12, CKDT16 and CKDT20) samples (Plate 6) tested for qualitative test. The result analyzed is recorded under results and discussion in Fig 5.

III. RESULTS AND DISCUSSION

ANALYSIS OF ANTIBACTERIAL ACTIVITY OF THE HERBAL EXTRACTS

The herbal extracts of Daturametal(D), Shorearoubusta(S) and Mimosa pudica(M) waschecked for their antibacterial activity and is shown in Fig.1.

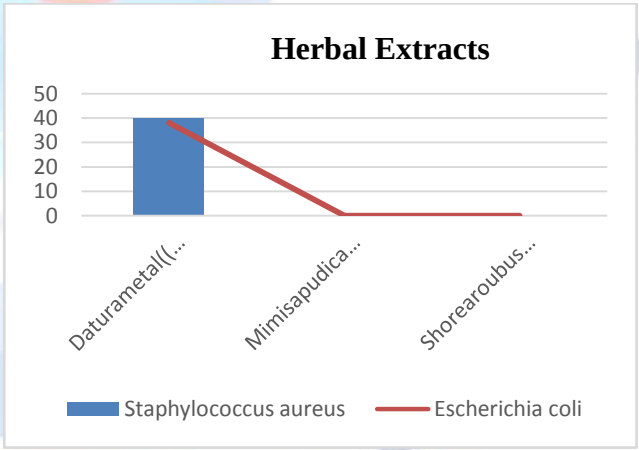


Fig. 1: Antibacterial Activity of the Herbal Extracts

The herbal extracts of *Daturametal(D), Shorearoubusta(S)* and *Mimosa pudica(M)* were tested as per AATCC147 standards for qualitative method. From Plate 1 and Fig. 1, it is shown that*Daturametal(D)* showed 40mm and 30mm bacteriostasis zone against *Staphylococcus aureus* and *Escherichia coli* respectively, whereas *Mimosa pudica(M)* and*Shorearoubusta(S)* had nil antibacterial zone against *Staphylococcus aureus* and *Escherichia coli.* So it can be inferred that *Daturametel(D)* which had the highest antibacterial

zone formation among the three herbs was selected for the finishing of microencapsulation process of the cotton knit (CK) material.

Analysis of Aroma Finish by Organoleptic Method

CKDT which is the control sample exhibited good antibacterial activity when compared with CKD. Further, it is seen that CKDT4 and CKDT8 samples had excellent and good aroma even after 4 and 8 washes, followed by CKDT12 and CKDT16 which showed fairly good aroma, but only accepted CKDT16 aroma and CKDT20 aroma sample to be poorly fair.

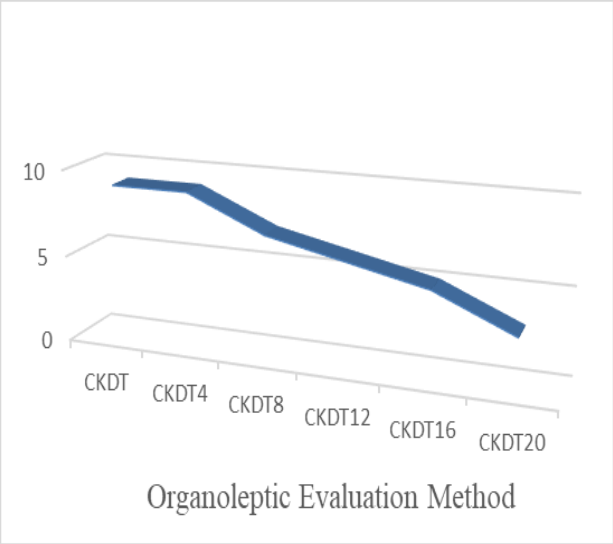


Fig. 2: Aroma Finish by Organoleptic method

CKDT samples had detoriating aroma effect after laundering were significantly different at ($t<0.05$).

Analysis of the Antibacterial activity by Qualitative Bacterial reduction Test

When compared between CKD (original) and CKDT (aroma treated) from (Plate 2) for antibacterial activity by qualitative test against Staphylococcus aureus and Escherichia coli, CKDT sample had good antibacterial activity.

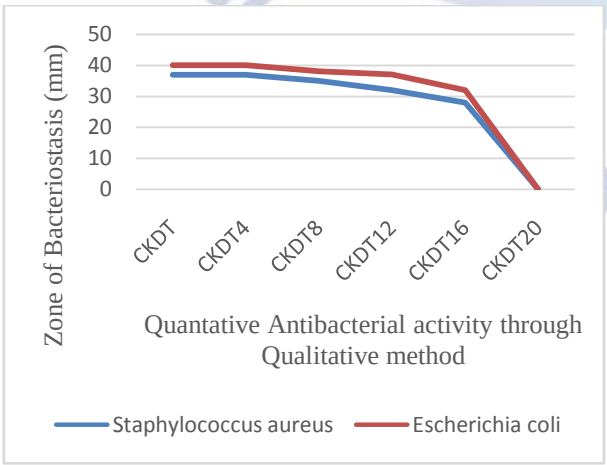


Fig. 3: Qualitative antibacterial activity of washed samples

From Plate 4 and Fig. 3, it shows that the control samples CKDT and CKDT4 had developed the highest and similar antibacterial zone of 40mm and 37mm against *Staphylococcus aureus* and *Escherichia coli* before and after four washes of aroma treated samples respectively. Whereas after 8 and 12 wash cycles of CKDT8 and CKDT12 had developed antibacterial zone of 38mm and 37mm against *Staphylococcus aureus*,35mm and 32mm against *Escherichia coli*. Sample CKDT16 showed the lowest antibacterial activity of 32mm against *Staphylococcus aureus*and 28mm against *Escherichia coli* but the sample CKDT20 after twenty washes showed nil antibacterial activity against both the bacterial species. All the aroma treated control and washed samples CKDT, CKDT4, CKDT8, CKDT12, CKDT18 and CKDT20 were significantly different at ($t<0.05$) in antibacterial qualitative values when compared with the controlled sample CKDT.

Analysis of the Antibacterial activity by Quantitative Bacterial reduction Test

When compared between CKD (original) and CKDT (aroma treated) from (Plate 3) for antibacterial activity by quantitative test against *Staphylococcus aureus* and *Escherichia coli,* CKDT sample had best antibacterial activity.

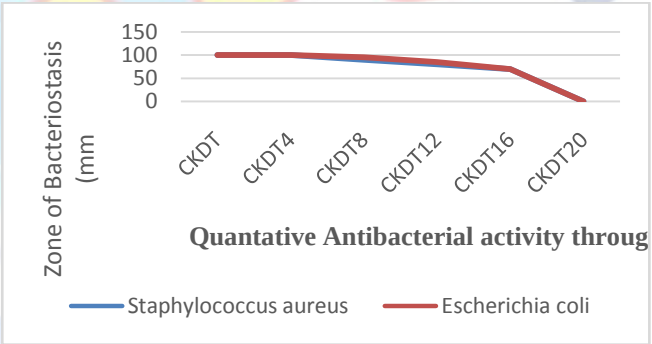


Fig. 4: Quantitative antibacterial test of washed sample

Plate 4 and Fig. 4 shows, the controlled sample CKDT and CKDT4 had developed hundred per cent antibacterial zone *against Escherichia coli* and *Staphylococcus aureus*. 95 and 85 per cent antibacterial activity coverage was found against *Staphylococcus aureus*, whereas 90 and 80 per cent antibacterial zone coverage against *Escherichia coli for samples CKDT8* and *CKDT12* respectively. Sample CKDT16 showed the same antibacterial zone of 70mm against both the *Staphylococcus aureus*and *Escherichia coli* bacteria. Sample CKDT20 had nil antibacterial activity against both the bacterial species. All the aroma treated control and washed sample CKDT,

CKDT4, CKDT8, CKDT12, CKDT16 and CKDT20 were significantly different at (t<0.05).

Analysis of Antifungal activity by Qualitative test before and after washings

When compared between CKD (original) and CKDT (aroma treated) from (Plate 5) for antifungal activity by qualitative test against *Aspergillus Niger*, CKDT sample had recorded good antifungal activity.

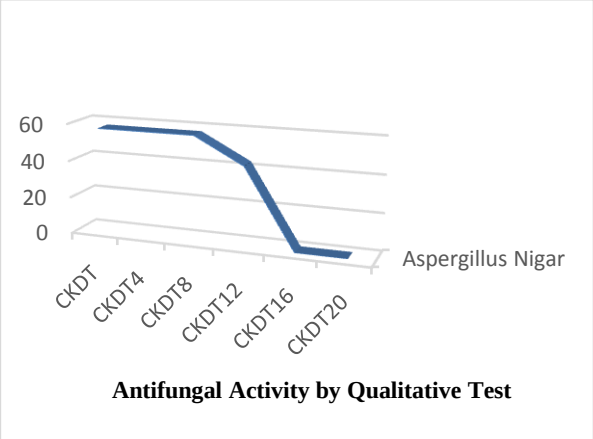


Fig. 5 Qualitative antifungal activity of washed samples

It is noted from Plate 6 and Fig. 5, the washed samples CKDT4, CKDT8 had the highest Antifungal zone of **fifty seven** per cent against *Aspergillusniger.* 12 cycle washes of sample CKDT12 showed **fourty three** per cent of Antifungal zone and sample CKDT16 and CKDT20 showed nil Antifungal zone against *Aspergillus Niger.* All the aroma treated controlled and washed samples CKDT, CKDT4, CKDT8, CKDT12, CKDT16 and CKDT20 were significantly different **at** (t<0.05) in Antifungal values when compared with the controlled sample CKDT.

IV CONCLUSION

Apparel consumers all over the world are demanding functionality in the product attributes such as water absorbency, abrasion resistance for microbial invasion. Among these the antimicrobial property of fabric is being considered to be an important and inevitable parameter for garments which are in direct contact with the human body Helmut 2002. Cotton textiles in contact with the human body offer an ideal environment for growth, microbial infestations process danger to both living and non- living matters. Thus, inorder to inhibit the growth of microbes many synthetic agents are used. Though synthetic agents possess excellent inhibition activity against wide range of microbes, issues of eco-friendliness and biodegradability limit the use of such agents. Thus the present study focused to develop a natural antimicrobial extract from the herbal plants to finish textile material.

From the study*Daturametel* had recorded the highest antimicrobial zone among the three herbs by qualitative and quantitative analysis. The herb *Daturametel*was microencapsulated by using Ionic Gelation method and the same was applied to cotton knit material. After microencapsulation, the cotton knitted sample was given an aromatic finish using tulsi oil. The treated fabric was found to be durable upto eighteen to twenty washes. The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation of a wide range of textile products finished with antimicrobial properties. Thus, the developed eco-friendly herbal microencapsulated functional finish material with unique properties could be used in medical textiles and can spread its wings to a wide range of application in textile industries.

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