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MEDICAL TEXTILES – APPLICATION OF ESSENTIAL OIL AS ANTIMICROBIAL AGENT ON NONWOVEN

[a]Chinta, S.K., [a]Landage S. M., Abhishek , [b]Sonawane K.D. & [b]Jalkate C.B.
[a]D.K.T.E.S., Textile & Engineering Institute, Ichalkaranji
[b]Dept. of Microbiology, Shivaji University

ABSTRACT
Nonwoven material has a wide range of application in the medical field. These are disposable, sterile, cheaper and of single use. They are beneficial in the prevention of cross- infection. Biodegradable fibers are widely used as cotton or viscose in nonwoven. Plant extract as essential oil finished nonwoven dressing possess antibacterial property even in the case of antibiotic resistant microorganism. Surgical and wound dressing application always require absorptive textile. Viscose nonwoven provide water absorptive capacity of about 700% so it is helpful to keep wound moist.

Keyword: Hydroentangled, Nonwoven, essential oil, E- Coli., Staphylococcus aureus.

INTRODUCTION
Textile materials are used to serve several purposes in medical science. Medical textiles are utilized in the form of fiber, yarn, woven fabric, roving and nonwoven. These can be classified in four different groups as follows, non implantable material, extracorporeal device, implantable device and hygiene product. Particularly in the form of non implantable device and hygiene product, nonwoven has vast application. Variety of fiber as well as technology makes it possible to introduce better, cheaper, innovative, compatible and biodegradable product. Viscose, cotton, polyester, polyamide, polypropylene, polyethylene, elastomeric, hollow, polysaccharides and others fiber are used prominently in such disposable textile [1, 2].

Generally spunlaid technique provides operation room disposable garment and clothing. Spunbond and meltblown technology is used to produce such useful composite, where polypropylene, polyester, and polyethylene are the most common polymer. Hydroentangled process is a way of manufacturing that was developed and patented by Du Pont during 1960s. The fibers are entangled by the jet of water at very high pressure through the small diameter jet orifices. The jet of water pushes the fiber from the surface towards the interior of the fabric. These spunlace fabrics are more flexible and less dense. Bonding of different layers of nonwoven is possible to produce composite [3]. Hydroentanglement methodology has shown in figure 1.1

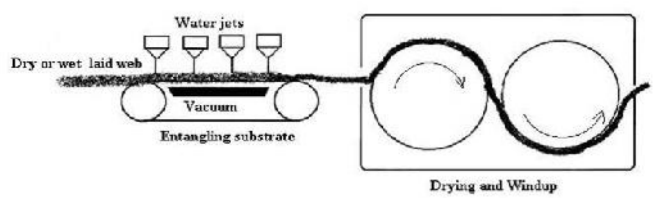


FIGURE 1.1 Hydroentanglement processes [4].

Phytochemicals are derived from plant and some of them are very useful antibacterial drug. The medication process includes both the topical and oral application of these herbs. The growth of micro-organism is inhibited by the oxidation of toxic phenolic component. Approximately 70 – 90% essential oil extracted from clove has eugenol [5]. Neem oil has many antiseptic, antibacterial, antiviral and antifungal qualities. Neem (Azadirachta indica) oils have essential fatty acid which helps wound to keep it moist and gives soft texture and antibacterial effect. Nimbidin is component of Neem oil which is antibacterial, anti ulcer, analgesic, and anti-fungal where as nimbin results anti inflammatory effect [6]. Eucalyptus species produces numerous volatile compounds in a large amount as isoprenoids. The major bio active components for microbial inhibition are 1-8-cineole and ά-terpineol [7].

Dry clove (Syzygium aromaticum) bud contains about 15 to 20 % essential oil. Eugenol is a medicinal component of clove oil and their presence is about 70 to 90 %. Other bio-active medicinal comments of clove oil are acetyl eugenol, crategolic acid, tannins, gallotannic acid, flavonoids eugenins and eugenitin. Eugenol has been used for analgesic, local antiseptic, anti-inflammatory and antibacterial effect. Antiseptic properties of clove oil are useful for wounds as cuts; scabies fungal infection as well as it can be useful for treating sting and insect bites [8]. Pongamia pinnata is known as Karanj it has indicated the presence of abundant prenylated flavonoids such as furanoflavones, furanoflavonols, and the seeds are reported to contain on an average about 28– 34% oil with high percentage of polyunsaturated fatty acids. Seed oil contains karanjin, a bioactive molecule with important biological attributes [9]. Garlic has been recognized as potential medicinal value for wide range of application for example; anti fungal, antibacterial and anti-inflammatory [10]. An emulsifier is known as surfactant which stabilizes an emulsion. Polyethylene Glycol (PEG) Esters are non-toxic, non-irritant and nonionic emulsifiers [11]. They are prepared by the esterification of fatty acids with polyethylene glycols. HLB (Hydrophilic – lipophilic balance) ratio of PEG 400 is 11.6. Polyethylene glycols can also be used to enhance the aqueous solubility or dissolution characteristics of poorly soluble compounds by making solid dispersions with an appropriate amount of polyethylene glycol. Antibacterial finished, nonwoven fabric was used as a dressing material for wound. Wound healing involves complex series of interaction between different cell types. The test result of nonwoven indicate that it has enough strength, elongation and water absorptive capacity, which is about 700% , Antibacterial finishes, coating, and lamination make it more serviceable.

1. MATERIAL AND METHOD

1.1. Substrate

Fiber – 100% Viscose Hydroentangled nonwoven
GSM – 83.4 g/m²
Thickness - 0.6 mm
Denier – 1.5 Denier with 37mm cut length.

1.2. Chemicals

1.2.1. Five essential oils

I. Neem (Azadirachta indica) oils – 100 % Pure
II. Clove oil (Syzygium aromaticum) – 100 % Pure & 1% to 10%
III. Karanj oil (Pongamia pinnata) – 100 % Pure
IV. Garlic oil (Allium sativum) – 100% Pure
V. Eucalyptus oil – 100% Pure

1.2.2. PEG 400

1.3. Method of preparation from essential oil

Five essential oils in 100 % pure form have taken and samples were prepared with these oils for soaking and padding at 2kg/cm² pressure. The samples were prepared by soaking the fabric for 3 minute in the concentration range of 1% to 10% of clove oil which was prepared by aqueous emulsion of clove oil, water and an emulsifier PEG 400. Citric acid is used to keep the pH at 5 and the treated fabric is dried at 60°C for 35 minutes.

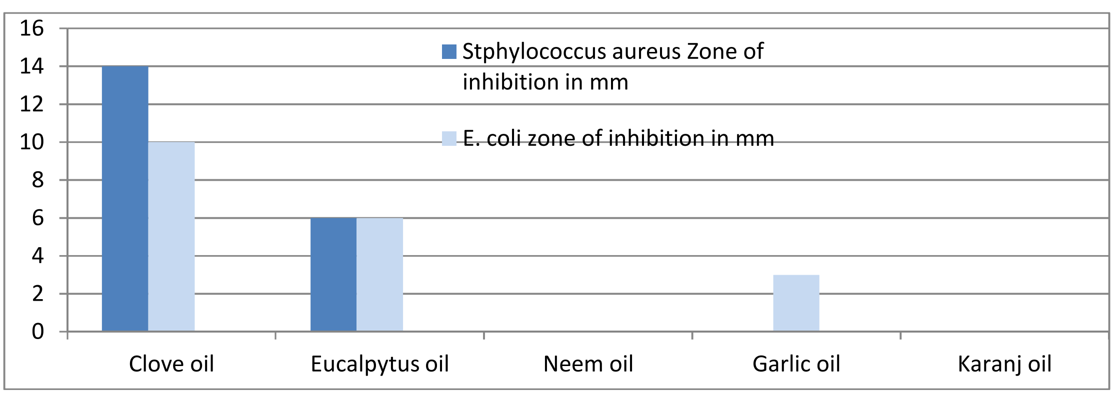
1.4. Method of antibacterial testing.

Agar diffusion test is used for this research, which include the testing method of AATCC 147-1998. It is qualitative test method and suitable for large number of samples. In this test method agar solution is prepared with nutrient and then microbial cells are inoculated. The solution is transferred into the petridish where textile samples are laid over the solution for intimate contact. The plate is incubated at 37°C for 18 to 24 hour and growth of bacteria is then examined. Zone of inhibition becomes apparent with the diffusion of antimicrobial agent in the agar plate [12].

RESULT AND DISCUSSION

TABLE 1: - Antibacterial effect of 100% concentration of essential oil treated nonwoven fabric in terms of zone of inhibition.

Sr. NO.	Essential Oil	*Staphylococcus aureus* Zone in mm.	*E coli* Zone in mm.
1.	Clove oil	14	10
2.	Eucalyptus oil	6	6
3.	Neem oil	0	0
4.	Garlic oil	0	3
5.	Karanj oil	0	0



GRAPH 1: The nonwoven fabric treated with 100% concentration of essential oil and their zone of inhibition in mm.

FIGURE.3.2 Antimicrobial effect on gram-positive Staphylococcus, the fabric was treated with 100% eucalyptus and clove oil

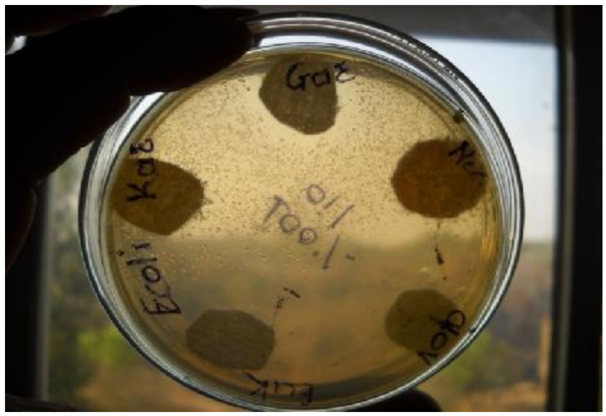
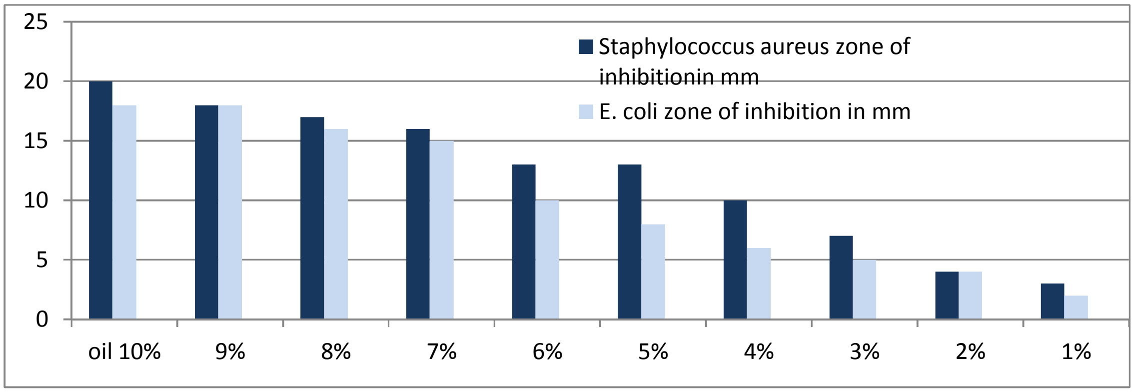


FIGURE 3.3: Antimicrobial effect on gram-negative E. coli, the fabric was treated with 100% concentration of oil.

Table 1 and graph 1 indicate the antimicrobial property of five oils as Clove, garlic, Karanj, Eucalyptus and Neem oil. Figure 3.2 shows antibacterial effect of clove and eucalyptus oil on the agar plate as clear zone for staphylococcus aureus and figure 3.2 shows the antibacterial influence on gram negative microorganism E. coli. When antibacterial property of five oils when compared it has been observed that clove oil has shown good antibacterial property e.g. 14 mm for staphylococcus aurous and 10 mm for E. coli as against 6 mm clear zone for both the microorganism of eucalyptus oil. Garlic oil has shown only 3 mm zone of inhibition for gram-negative E. coli. Neem and Karanj oils have not shown antibacterial property when compared with the above oils. The reason may be due to the presence of Eugenol (70 to 90%) which is an active antimicrobial ingredient (phytochemicals) where as in eucalyptus oil phytochemicals is 1,8 cineol, a volatile compound which varies according to plant species. Garlic oil due to presence of volatile allicin (max 30%) shows their antibacterial property on E. coli. Neem and Karanj oil which are having Nimbidin (1.2 to 1.6 %) and Karanjin (1.25 %), which is very small in quantity and hence shows no significance effect of antimicrobial property. The good antimicrobial property of clove oil may be due to another reason of being good diffusion property in the agar plate when compared with the rest of the oils.

TABLE -2 Antibacterial effect of clove oil at various concentrations on nonwoven.

Sr. NO.	Concentration of clove oil	Staphylococcus aureus Zone in mm.	E coli Zone in mm.
1.	10%	20	18
2.	9%	18	18
3.	8%	17	16
4.	7%	16	15
5.	6%	13	10
6.	5%	13	8
7.	4%	10	6
8.	3%	7	5
9.	2%	4	4
10.	1%	3	2



GRAPH 2: Antibacterial effect of clove oil finished nonwoven sample against both the microorganism at the concentration of 10 to 1%.

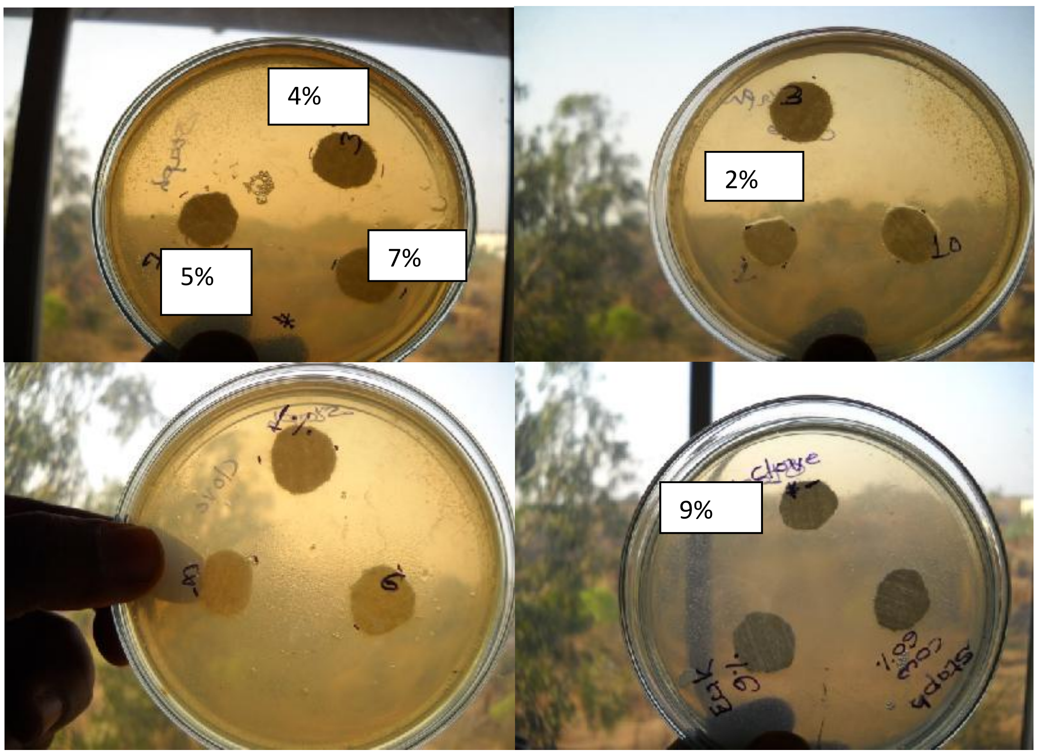


FIGURE 3.4 Antibacterial effect of clove oil finished nonwoven sample against E. coli

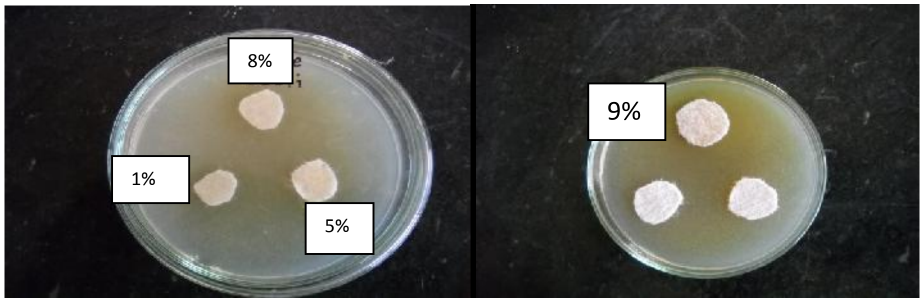
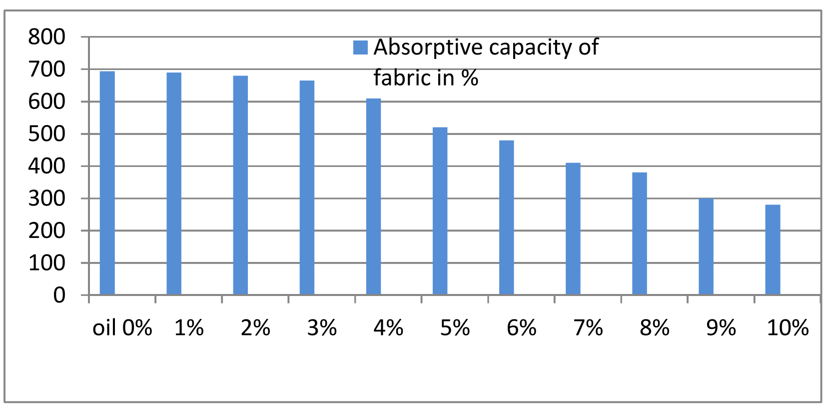


FIGURE.3.5 Antibacterial effect of clove oil finished nonwoven sample against staphylococcus aureus

Table 2, graph 2, figure 3.4 and 3.5 clearly indicates that as the concentration of clove oil increases the zone of inhibition increases. This is because of presence of higher amount of eugenol as antibacterial component of clove oil with increasing concentration. The zone of inhibition of both the microorganism gram positive staphylococcus aureus and gram negative E. coli has represented with table 2 and statically in graph 2.

TABLE 3: Influence of clove oil at various concentration on nonwoven.

Sr. No.	Clove oil concentration in %	Water absorptive capacity in %
1.	0%	694%
2.	1%	690%
3.	2%	680%
4.	3%	665%
5.	4%	610%
6.	5%	520%
7.	6%	480%
8.	7%	410%
9.	8%	380%
10.	9%	300%
11.	10%	280%



GRAPH 3: Influence of oil finishing on water absorptive capacity of viscose nonwoven

Table 3 and Graph 3 clearly indicates that as clove oil concentration increases from 1 % to 10% the water absorptive capacity of nonwoven fabric goes down from 694% to 280%. This may be due to the increase in viscosity and oil content with increasing concentration from 1% to 10 %. Oil being hydrophobic in nature and content of oil at 10%, the viscose nonwoven shows minimum absorptive capacity.

2. CONCLUSION

From the results and discussion the clove oil treated nonwoven fabric even at low concentration of 1% gives very good antibacterial property. Viscose nonwoven, treated with clove oil can have numerous applications in medical textile such as wipes, wound care bandage, bed sheet, pillow cover, surgical absorptive composite and others. Viscose is a biodegradable material and their disposability reduces the chance of cross infection.

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