DOI : 10.15613/sijrs/2019/v6i2/209461
ISSN (Print): 2349-8919
ISSN (Online): 2350-0999
ScieXplore: **International Journal of Research in Science,** *Vol 6(2), 44-53, July-December 2019*

Technical Textiles – Protective Clothing

P. Ramya

HOD/CDF, Nandha Arts and Science College, Erode – 638052, Tamil Nadu, India; ramskutty@gmail.com

Abstract

Increasing global competition in textiles has created many challenges for textile researchers and industrialists. The rapid growth in technical textiles and their end-uses has generated many opportunities for the application of innovative finishers. The population explosion and the environmental pollution in recent years have forced researchers to find new health and hygiene related products for the wellbeing of mankind. The threats caused by microbes are numerous and the problem is aggravated even more in tropical and subtropical regions. Pathogenic microorganisms transfer infectious diseases and cause lung related disorders. Today, much is talked about 'prevention is better than cure' using natural and artificial wearing suitable clothing. Recently, there has been upsurge interest in apparel technology all over the world for much demanding functionality of the products like wrinkle resistance, water repelling, fade resistance and resistance to microbial invasion. Among these, development of antimicrobial textile finish is highly indispensable and relevant since garments are in direct contact with human body. This paper deals with the application of natural oils and their antimicrobial property.

Keywords: Pretreatments, Uptake of oil, oil retention

1. Introduction

Infectious diseases remain an important cause of morbidity and mortality in developing and developed nations (Lewis et al., 2006). They account for approximately one half of all deaths in tropical countries of which bacterial infections seems to be the most prevalent. There is therefore a need for continuous search for new, effective and affordable antimicrobial agents (Cowan, 1999)[3]. In recent times, there has been renewed interest on plants as sources of antimicrobial agents due to their use historically and the fact that a good portion of the world's population, particularly in developing countries, rely on plants for the treatment of infectious and non-infectious diseases. Antiseptic properties of plant volatile oils have been recognized since antiquity (Dorman et al., 1999)[2]. The discovery and development of antibiotics have led to a dramatic improvement in the ability to treat infectious diseases and is among the major advances of the 20th century.

Today, much is talked about 'prevention is better than cure' using natural and artificial wearing suitable clothing. Oils form an integral part in textile manufacture. They are used to facilitate processing in spinning, winding, knitting and texturing. Application of oil is very common in wool and jute fibre spinning. During 1940-1950, nylon spin finishes consisted of sulphated vegetable oil. Oil is obtained from nature and finds application in health products, lubricants and as an aid in processing of jute and polyester textured yarns. The use of the natural oil is quite widespread in view of the fact that it confers antimicrobial effect.

This paper deals with the effect of pretreatment on the uptake of clove oil in cotton, viscose and polyester fabric with varied count. The effect of pressure and concentration in the uptake of clove oil is also dealt in cotton fabric. The amount of oil retained by cotton fabric is also studied. The main objective of this paper is to study the effect of concentration and pressure of the padding mangle on the uptake of natural oils and retention in cotton fabric.

2. Review of Literature

The natural variants possess more potential for investigation because of following reasons:

1. Eco-friendly
2. Least toxicity
3. Suitability for next-to-skin innerwear
4. Vast scope of research to counteract microbe's resistant development towards antimicrobial finishes
5. Safe handling.

"The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with antimicrobial properties.

Microorganisms cause problems with textile raw materials and processing chemicals, wet processes in the mills, roll or bulk goods in storage, finished goods in storage and transport and goods as they are used by the consumer. This can be extremely critical to a clean room operator, a medical facility, or a food processing facility, or it can be an annoyance and aesthetic problem to the athlete or normal consumers. The economic impact of microbial contamination is significant and the consumer interests and demands for protection are at an all time high.

Antibacterial fabrics are important not only in medical applications but also in terms of daily life usage. The application of antimicrobial finishes to textiles can prevent bacterial growth on textiles. Antibacterial textile production has become increasingly prominent for hygienic and medical applications. The antimicrobial agents can be antibiotics, formaldehyde, heavy metal ions (silver, copper) quaternary ammonium salts with long hydrocarbon chains, phenol and oxidizing agents such as chlorine (Goldsmith et al.,1954), chloramines, hydrogen peroxide, ozone (Gouda, 2006). Antimicrobial Finish is important for general textiles and high performance applications where the chance of microbial growth is high.

Antimicrobials fabrics gained significant importance due to their wide acceptance as surgical apparels, baby clothing and undergarments.

Following are the major requirement for an effective antimicrobial finish:

1. Durability to washing, dry cleaning and hot pressing
2. Selective activity to undesirable microbes
3. It should not produce harmful effects to the manufacture, user and the environment
4. It should compile with the statutory requirements of regulating agencies
5. Compatibility with the chemical processes
6. Easy method of application
7. No deterioration of fabric quality
8. Resistant to the body fluids
9. Resistant to disinfectant/sterilization
10. Quick acting and effective in killing or inhibiting the growth of a broad spectrum of microbes
11. Non-selective and non-mutable to pathogens
12. Fast to repeated laundering, dry cleaning and exposure to light
13. Safe and comfortable to wear (No irritation to skin)
14. Minimal environmental impact
15. Compatible with other finishing agents
16. Low cost

Antimicrobial treatment for textile materials in necessary to fulfill the following objectives:

1. To avoid cross infection by pathogenic microorganisms.
2. To control the infestation by microbes
3. To arrest metabolism in microbes in order to reduce the formation of odour.
4. To safeguard the textile products from staining, discoloration and quality deterioration

3. Materials

3.1 Fabric Particulars

The fabrics were woven with 60Ne, 50Ne, 40Ne counts of Cotton, Viscose, and Polyester on a loom with the following reed, pick density, GSM and thickness. Table 1-3 gives details of the yarns which have been

Table 1. Properties of yarns 60 Ne, 50 Ne, 40 Ne

Sl. No.	Yarn Count (Ne)	Tenacity (g/tex)	Elongation (%)	U.CV (%)	Hairiness
1.	40	18.70	3.30	9.43	4.67
2.	50	20.51	3.64	10.16	3.62
3.	60	21.80	3.10	10.90	3.85

Table 2. Count of yarn used for fabric construction

Sl. No.	Count of yarn	Fabric
1.	40Ne	Cotton, Viscose
2.	50Ne	Cotton, Viscose, Polyester
3.	60Ne	Cotton, Viscose

Table 3. Woven fabric Particulars

Sl. No.	Fabric	Count	GSM	Thickness (mm)	Ends (cm)	Pick (cm)
1.	Cotton	60x40	64	0.25	29.16	19.16
2.	Cotton	60x50	60	0.26	28.33	20
3.	Cotton	60x60	60	0.28	31.66	23.33
4.	Viscose	60x40	76	0.24	33.33	19.16
5.	Viscose	60x50	80	0.26	35	21.66
6.	Viscose	60x60	80	0.28	33.33	26.66
7.	Polyester	60x50	16	0.11	51.66	32.5

used for weaving the Cotton, Viscose and Polyester fabrics.

3.2 Chemicals and Standards used in Different Experiments

Chemicals were obtained from commercial sources and were of analar grade. Table 4 gives the details of the chemicals used for various test.

Table 4. Chemicals used in the current research work

Sl. No.	Chemicals	Experiment
1.	Nutrient agar medium	Antibacterial testing
2.	ENISO 20645	Antibacterial testing (qualitative testing)
3.	Sodium Chloride	Dyeing of cotton viscose
4.	Sodium Hydroxide	Scouring
5.	Turkey red oil	Desizing
6.	Sodium carbonate	Scouring, bleaching, dyeing
7.	Sodium silicate	Bleaching
8.	Reactive dyes	Dyeing of cotton and viscose
9.	Disperse dyes	Dyeing of polyesters
10.	Acetic acid	Disperse dyeing
11.	Hydrogen peroxide	Bleaching

4. Methods

The following methods were used in the present study.

4.1 Enzyme Desizing

The desizing bath was prepared using 1:20 liquor ratio with required quantity of malt enzyme (Diaster). The fabric was immersed for 60-120 min at 40 to 50 °C. Acetic acid was added to maintain the pH value at 6 to 7.5. The fabric was then removed and given hot and cold wash and then dried.

Desizing

Enzyme	-	2%
Turkey red Oil	-	0.5%
Time	-	2 Hrs.
MLR	-	1:20
pH	-	5.5 -7
Temperature	-	50°C followed by
Hot Wash	→	Cold Wash

4.2 Scouring

The scouring bath was prepared with 2% sodium hydroxide, 2% sodium carbonate an 1% sodium silicate, 1% wetting agent with liquor ratio 1:20. The bath was stirred well and the temperature was raised to boil. The wetted, squeezed cotton material was entered into the bath and taken out after 3 hours. The fabric was then removed, washed with cold water and dried.

Scouring

Sodium hydroxide	-	2%
Sodium carbonate	-	2%
Wetting agent	-	1%
MLR	-	1:20
Temperature	-	Boiling
Time	-	3 hours

↓

Hot Wash → Cold Wash → To neutralize

↓

Acetic acid (1%)

4.3 Bleaching

The bleaching bath was prepared with the required amount of hydrogen peroxide, sodium silicate and wetting agent using 1:20 material to liquor ratio. The bleaching bath is well stirred. The pH of the bath was adjusted to 10.5 to 11.0 by adding sodium carbonate. Raise the temperature to 50°C. The well scoured fabric was entered into this bath. After 10 minutes the temperature was raised to 85°C and the bleaching process was continued for 2 hrs. Finally the fabric was removed and washed well.

Bleaching

H_2O_2	-	2%
Sodium Silicate	-	2%
Sodium carbonate	-	1%
Wetting agent	-	1%
MLR	-	1:20
Temperature	-	85°C

Hot Wash → Cold Wash followed by Complete drying

4.4 Dyeing of Cotton and Viscose

4.4.1 Selection of Dye

Reactive dyes were used to dye the bleached cotton and viscose fabrics.

4.4.2 Selection of Colour

The dye powder reactive Blue M2R was selected for dyeing process.

4.4.3 Method of Dyeing

The dye bath was prepared with MLR 1:20 with the required quantity of dye solution. The material was entered at room temperature. After 15 minutes, the dissolved common salt or Glauber's salt was added in three portions and dyed for another 30 minutes. Then fixing agent sodium carbonate was added and dyeing was continued for another 30 minutes.

After Treatment

The dyed material was neutralized with acetic acid and was treated with neutral soap at the boil for 5 minutes and washed free from soap with hot, then with cold water.

Dyeing

Shade	-	1.5%
Material Liquor ratio	-	1:20
Sodium Chloride	-	20gms/ liter
Sodium carbonate	-	15gms/liter.
Time	-	1 hour

Cold Wash → Acetic Acid → Soaping → Hot wash
5 cc/lr (To neutral)

Hot wash ↓ Cold Wash → Complete drying

4.4.4 Dyeing of Polyester

The Polyester fabric was dyed using disperse dyes.

Shade	-	2%
MLR	-	1:30
Wetting agent	-	1g/lr
Dispersing agent	-	1g/ lr
Carrier	-	5g/lr
Acetic acid	-	1g/lr
Temperature	-	Boil
Time	-	2 hours

The dye bath was set with 1g/lr wetting agent, 1g/lr dispersing agent and 3g/lr carrier at 40°C. The fabric was worked in the bath for 15 minutes. The dispersed dye (dye pasted with wetting and dispersing agent) was then added and the temperature was raised to boil with 30 minutes. The pH of the bath was maintained at 6.5 by adding acetic acid (1g/lr) for the activation of phenol. The dyeing was continued at boil for 2 hours.

4.5 Method of Application of Oil

Ten essential oils in 100% pure form namely Neem oil, Aloevera oil, Eucalyptus oil, Mustard oil, Sandalwood oil, Olive oil, Sesame oil, Dry ginger oil, Karpurathy oil and Clove oil were taken and samples were prepared with these oils for soaking and padding at 2kg/cm^2 pressure.

The oils were finished by dip dry method to three different types of fabric such as cotton, viscose rayon and polyester with varied count. The oil was applied on to the fabric in grey state and after every pretreatment such as desizing, scouring, bleaching and dyeing for cotton, after dyeing for viscose and polyester. Each oil-coated fabric was then tested for its antimicrobial activity.

Based on the results, clove oil was selected for application of oil on cotton, viscose and polyester fabric with various pretreatment. Clove oil with varied concentration and varied pressure of mangle was applied on cotton fabric. The samples were prepared by soaking the fabric for 3 minute in the concentration range of 1%, 3%, 5%, 10%, 15% of clove oil which was prepared by aqueous emulsion of clove oil, water and an emulsifier

PEG 400. Citric acid was used to keep the pH at 5 and the treated fabric was dried at 60˚C for 35 minutes. The wick ability of polyester and viscose fabrics in clove oil was also found.

4.5.1 Standardization of Finishing Conditions using Padding Mangle

The finishing conditions of the clove oil on to the fabric were standardized by varying different pressures and concentrations of oil. The fabric sample immersed in the oil was passed through a padding mangle run at a speed of 20, 30, 40 rpm/min and a mangle pressure of 4.54 kg, 6.81 kg, 9.09 kg, 11.36 kg, 13.6 kg. The padded fabric was air-dried and then cured for 3 min at 140˚C.

4.6 Uptake of Oil

To find the uptake of oil in the fabric the initial weight of the fabric and the weight of fabric after oil application was found. The percentage of uptake of oil was calculated as follows:

$$\frac{\text{Final weight - Inital weight}}{\text{Initial weight}} \times 100$$

4.7 Tests for Oil Retention

To determine oil retention of an oil sorbent sample, the sample (5×5 cm^2) was placed in 150 ml of oil for 15 min. The sorbent was then removed and vertically hung, where upon the absorbed oil begin to drip from the sorbent. The weight of the material is measured after 15, 30, 60, 120, 300 and 1800s of drainage. The amount of oil retained is determined as the difference between the weight of the wet material after drainage and the initial weight of the material. (Praba Karan et al., 2010)[1]

5. Results and Discussion

5.1 Effect of Pretreatment on the Uptake of Clove Oil in Cotton, Viscose and Polyester Fabrics

Figure 1 shows that following pretreatments such as desizing, scouring, bleaching and dyeing for cotton fabrics have led to a significant increase in the uptake of oil. By far, the bleaching treatment has resulted in an appreciable increase in uptake of oil. The reasons attributed to this phenomenon are removal of the wax and improvement the absorbency of the cotton fibres. There is no consistency in the relationship between count and uptake of oil, though in the grey state, it is noticed that as the count increases the oil uptake decreases which is to be expected.

In respect of viscose (Figure 2) after dyeing the uptake of oil shows a significant increase. Also in the dyed state, it is apparent that the fabric made with 40s shows an appreciable increase in the uptake of oil in comparison to the other counts.

With regard to polyester fabrics (Figure 3), again following dyeing treatment the uptake of oil has registered an increase. This is, doubtless due to an increase in the size of pores which are created during dyeing.

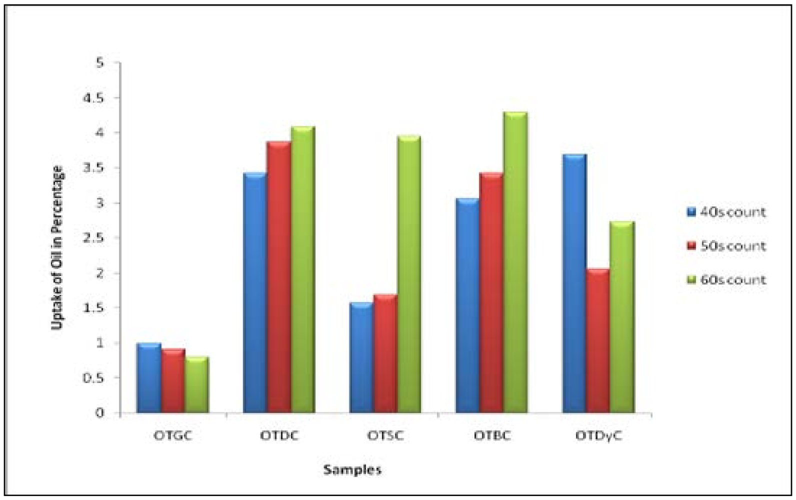

Figure 1. Effect of pretreatment on the Uptake of clove oil in cotton fabrics.

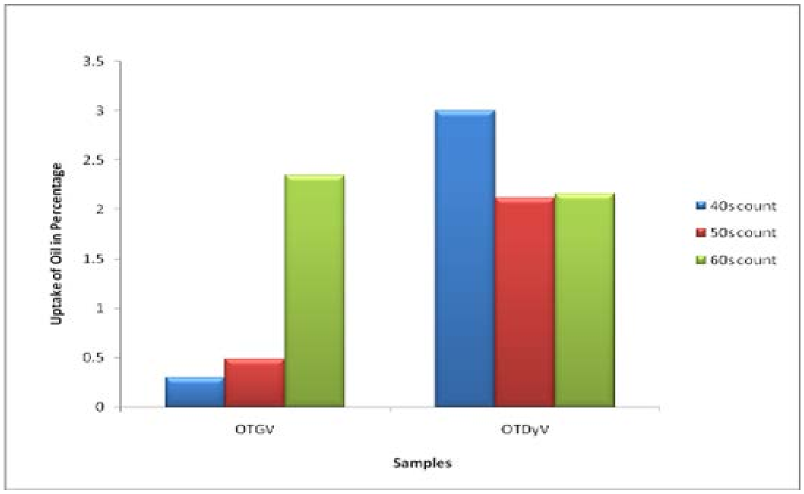

Figure 2. Effect of pretreatment on the Uptake of clove oil in viscose fabrics.

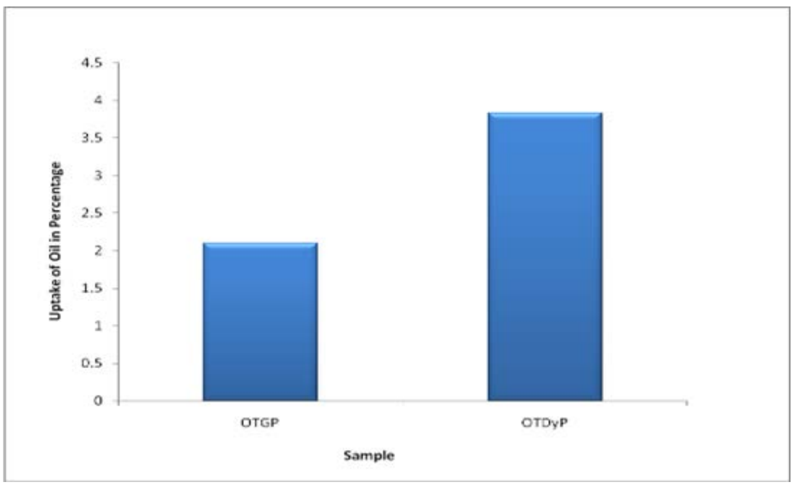

Figure 3. Effect of pretreatment on the Uptake of clove oil in polyester fabrics.

5.2 Effect of pressure on the Uptake of Clove oil in Cotton Fabrics

Figure 4 shows an increase in pressure has not shown any consistent trend although it can be stated that 15% concentration the uptake is the highest recorded. It is also interesting to note that a pressure of 6.81 kgs seems to be the optimum pressure at 15% concentration of oil.

5.3 Effect of Concentration on the Uptake of Clove Oil in Cotton Fabric

As it is to be expected, Figure 5 shows that at a concentration of 15% of oil maximum uptake of oil has occurred. Here also the trend between the pressure and the uptake of oil appears to be erratic. With the exception of the uptake of oil with 1% concentration where there is a clear trend between oil uptake and concentration. In no other case is any other relation noticed.

5.4 Oil Retention Test with Clove Oil (Table 5)

It is noticed from Figure 6 that the retention of oil in cotton fabrics appears to be the maximum 0.30 gm in comparison

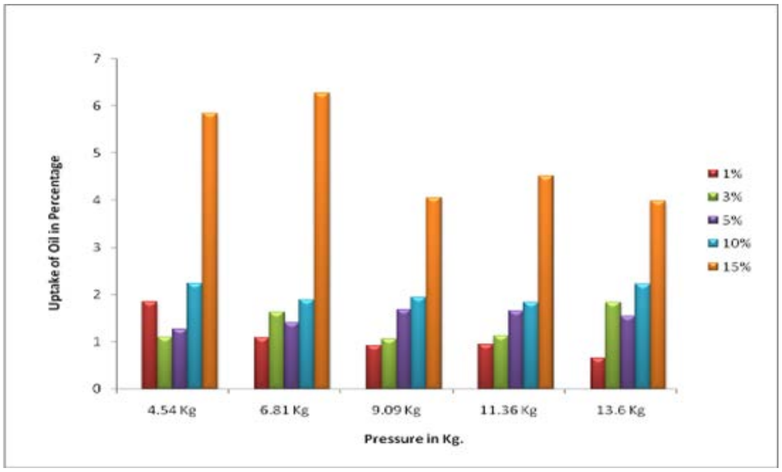

Figure 4. Effect of pressure on the Uptake of clove oil in cotton fabrics.

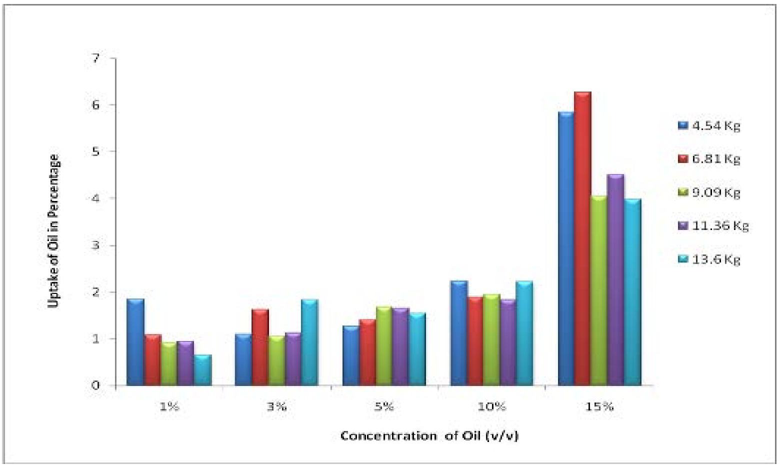

Figure 5. Effect of concentration on the uptake of clove oil in cotton fabric.

Table 5. Oil retention test with clove oil

Fabric	Initial weight (g)	Weight of Oil treated sample (g)	Weight of oil treated sample						Amount of Oil retained (Final weight – Initial weight)
			After 15 Sec (g)	After 30 Sec (g)	After 60 Sec (g)	After 120 Sec (g)	After 300 Sec (g)	After 1800 Sec (g)	
Cotton	0.15	0.5	0.50	0.50	0.5	0.5	0.5	0.45	0.30
Viscose	0.15	0.30	0.30	0.30	0.30	0.30	0.29	0.26	0.11
Polyester	0.16	0.41	0.39	0.35	0.30	0.25	0.23	0.19	0.03

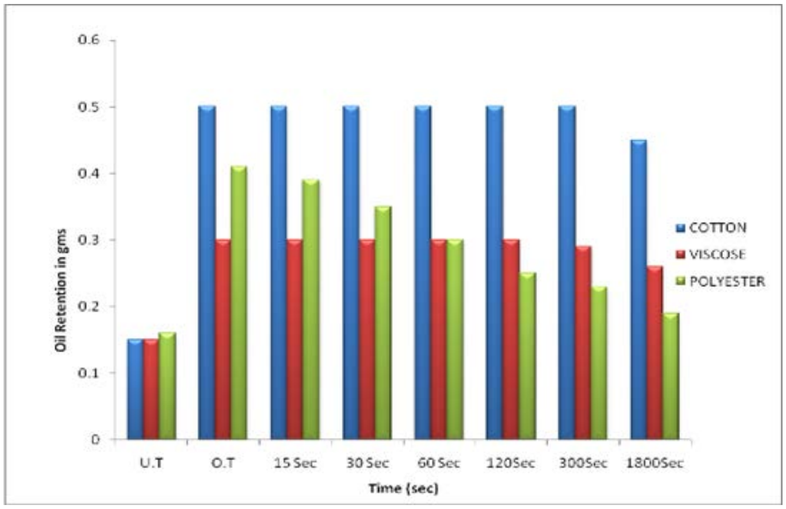

Figure 6. Oil retention test with clove oil.

to either viscose or polyester. Polyester fabric, as is to be expected, retains less oil due to its hydrophobic nature. Surprisingly, Viscose fabric retains less oil in comparison to cotton and the reasons are not clear.

On the basis of the amount of oil retained by the fabrics, it is clear that cotton has the ability to take more oil than that of polyester fabrics.

6. Conclusion

There is no area where oils are not used in textiles. In processing of jute and wool fibres various types of oils are used. They are also used to improve the knit ability of yarns. Application of lubricant in the form of oils is an important activity and without oil, the textured yarns cannot be processed. Separation of oil from water is an area which constitutes the major problem in chemical engineering. Oils such as clove oil and sandalwood oil provide aroma to fabrics which is liked by many consumers. Massaging by oil gives relief in some muscular problems. Fish oil is used for medicinal purposes and coconut oil is used for treating wounds. Most of the oils possess therapeutic value which finds application.

This paper reports the effects of natural oils on the properties of cotton, viscose and polyester fabrics in depth. The findings are as follows:

1. Pretreatments are having a significant effect on uptake of oil.
2. Uptake of oil was dependent on concentration, pressure of padding mangle and the type of material.
3. Concentration of oil and pressure with which it is applied has a significant effect in oil uptake.
4. The uptake of oil was found to be high in cotton fabrics in comparison to viscose and polyester fabrics. Cotton Fabric has more retention than either viscose or polyester.

7. Reference

1. Praba Karan C, Rengasamy RS, Dipayan Das. Oil spill cleanup by structured fibre assembly. *Indian Journal of Fibre and Textile Research*. 2011; 36:190-200.
2. Dorman HJD, Deans SG. Antimicrobial agents from plants, antibacterial activity of plant volatile oils. *Journal of Applied Microbiology*. 1999; 88(2):308-316. https://sfamjournals.onlinelibrary.wiley.com/doi/full/10.1046/j.1365-2672.2000.00969.x.
3. Cowan MM. Plant products as antimicrobial agents. Clinical Microbiology Reviews. *Journal of Clinical Microbiology*. 1999; 12(4):564-582. http://cmr.asm.org/cgi/content/full/12/4/564.
4. Viuda- Martos M, Ruiz-Navajas Y, Fernandez-Lopez J, Perez-Alvarez J. A chemical composition of the essential oils

obtained from some spices widely used in Mediterranean Region. *Acta Chimica Slovenica*. 2007; 54:921-926. https://www.researchgate.net/publication/237066907_Chemical_Composition_of_the_Essential_Oils_Obtained_From_Some_Spices_Widely_Used_in_Mediterranean_Region.
5. Wang CX, Chen L. Aromachology and its Application in the Textile Field. *Fibres & Textiles in Eastern Europe*. 2005; 13(6):54. http://www.fibtex.lodz.pl/2005/6/41.pdf.
6. Lewis K. 2012. Antibiotics: recover the lost art of drug discovery. Nature 485, 439–440. (10.1038/485439a)
7. https://indiantextilejournal.com/articles/fadetails.asp?id=507
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5481322/
9. https://pubmed.ncbi.nlm.nih.gov/17044310/
10. Gouda, M. (2006). Enhancing flame-resistance and anti-bacterial properties of cotton fabric. Journal of Industrial Textiles, 36(2): 167–177.
11. Goldsmith, M. T., Latlief, M. A., Friedl, J. L., and Stuart, L. S. (1954). Adsorption of available chlorine and quaternary by cotton and wool fabrics from disinfecting solutions. Journal of Applied and Microbiology, 2(6): 360–364.