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A comparative study of aroma retention properties of wool, silk and cotton fabric using aromatherapy essential oil

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Abstract
Nowadays textile materials have been found in application in the field of aroma therapeutic finish using essential oil. By this application pharmaceutical and environment friendly ingredients are impregnated to the fabric. The correct choice of fabric and oil must be considered before finish application. In present study wool, silk and cotton fabric were chosen and a comparative study was done to identify which fabric is better receptor of oil and aroma and retain it for longer time. Aromatherapy essential oil was applied on fabric by a selected method. An olfactometry analysis was done by judges for four weeks. Judges rate the intensity of aroma on every 5the day with each wash and again intensity of aroma was recorded. Wool fabric was found best receptor of oil and aroma after each washes and silk fabric was better than cotton fabric. A change in colour of silk fabric was also observed after treatment. The physical properties, fabric weight and thickness also increased after finish application.

Keywords: Aromatherapy, citronella oil, cotton, lemongrass oil, silk, wool

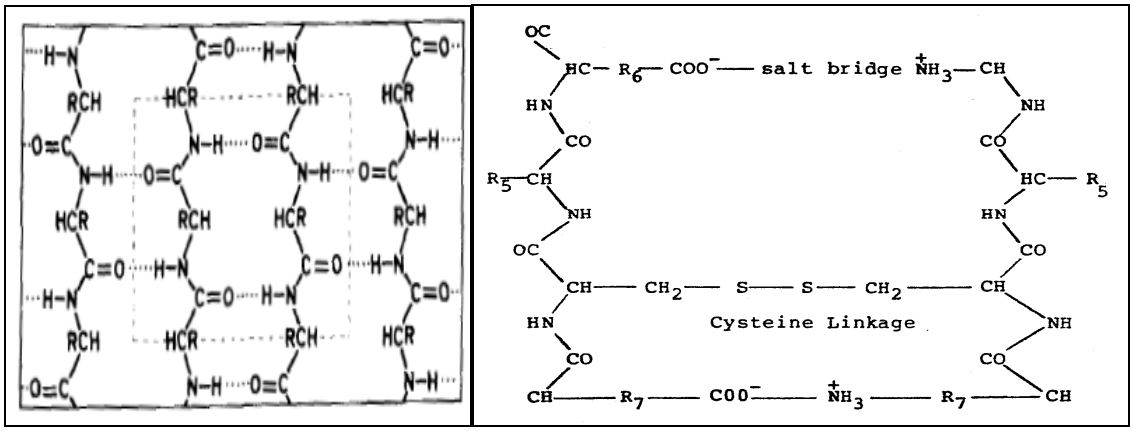
1. Introduction
Recent researches show that textiles have increased their use so far in the field of application of aroma therapeutic finish. A series of researches are aimed towards development of aroma embedded textile material for sustainability, environmental consciousness and consumer well being. An attempt has been made for finishing of textile material with herbal antimicrobial compounds (Ramchandran Rajendrakumar & Rajendren 2004) [1]. Fragrance finishing of textile material increases the value of the product by adding beneficial factor such factors affects moods of the wearer (Gilbert and Firestein. 2002) [2]. Aromatherapy is art and science of using naturally extracted aromatic plants essential oils to balance, calm, cure infections and promote the health of body and mind. The term aromatherapy was coined by late 1920s by French cosmetic chemist R.M. Gattefosse. There are some best known aromatic plants such as lavender, rosemary, jasmine, basil, sandalwood, lemongrass citronella are used for aroma therapeutic finish application. Aromatherapy textile has a diverse use like interior textiles such as sheets, quilt-covers, curtains, carpets and bed sheets and other textile materials. (Srivastava *et al*) [3] applied fragrance finish using propylene glycol by spray application and also by padding mangle where silicon softerns was used with fragrance oil solution.
The purpose of this study is to identify suitable fabric for aroma therapeutic finish. All fabrics take oil and aroma differently depending upon property and structure of the fabric. (Dr. A. J. West & Dr. K.E. Annett-Hitchcock 2014) [4] in their review article stated that there is a need to indentify which fabric absorbs oil and retains aroma for a longer time and how can the right fragrance match with the other performance aspect of fabrics. From the perspective of textile application the textile material are subjected to washing the durability of finish is the major concern issue for consumer. The other finishing process such as bleaching disizing dyeing affects the durability and effectiveness of essential oil. The fabric need to be free from other finishes before application of essential oil. The fabrics must be desized, scoured which can adversely affect the other performance perspective of fabrics.
The aroma retention property depends upon the fiber polymer system of fabric. Under present study pure wool, silk and cotton fabric were chosen to compare aroma retention property. These fabrics are so chosen because of their fiber properties which are desirable for aroma

retention. Wool is a natural protein fibre. Wool polymer is a linear keratin polymer repeating unit of wool fibre is sulphur containing amino acid linked together with disulphide bonds. Wool fiber forms a salt linkage which attracts water molecule which enhances the hygroscopic nature of fibre. The fibre polymer system of wool hydrogen bond forms between hydrogen and nitrogen atom. It is very weak bond and breaks easily as fiber absorb water so water molecule enters easily in fiber polymer system. Wool is very absorbent fibre as it contains higher amorphous areas it is about 75-70% amorphous and 25-30% crystalline however the scaly structure of wool makes it partially water repellent but when moisture or other substances like oil & aroma once penetrate the fiber surface it get absorbed quickly and has good retention for a longer time.

Silk is also natural protein fibre. Silk is very fine regular translucent filament which is encased by a gummy substance called sericin. Silk composed of 16 amino acids these are cross linked by salt and cystine linkage as wool which enables it to absorb moisture or other substances like oil and aroma. The absorption of water molecules takes place in the amorphous regions of the silk fibre, where the water molecules compete with the free active side groups in the polymer system to form cross links with the fibroin chains. As a result, loosening of the total infrastructure takes place. Silk has a very crystalline polymer system, it is about 35-30% amorphous and 65-70% crystalline, it is less absorbent than wool but it is more absorbent than cotton however it absorbs fewer water molecules because of salt linkage.

Cotton is natural cellulosic fibre. Under microscope cotton fibre appear as very fine, regular fibre. Cotton is composed of a cuticle which contains waxy layer this layer enables the fibre to adhere tenaciously to the primary cell wall of fibre. It does not contain any salt linkage like wool and silk fibre. In the polymer system of cotton fibre hydrogen bond formed between hydrogen and oxygen atom which is stronger than hydrogen-nitrogen bond. Cotton fibre is very absorbent fibre but it has less amorphous areas than wool so moisture enters in polymer system but does not retain for longer time (Norma Hollen & Jane Saddler, Textiles) [5, 6].

Fiber polymer system of wool, silk and cotton fabric is shown in figure: 1



(a) **(b)**

Fig 1 (a) Hydrogen bond formation between two wool polymers. Dotted line indicates hydrogen bonding the formula for hydrogen bond formation is same for silk polymer. **(b) Salt linkage** between two wool polymers and formula for Salt linkage in same for silk polymer.

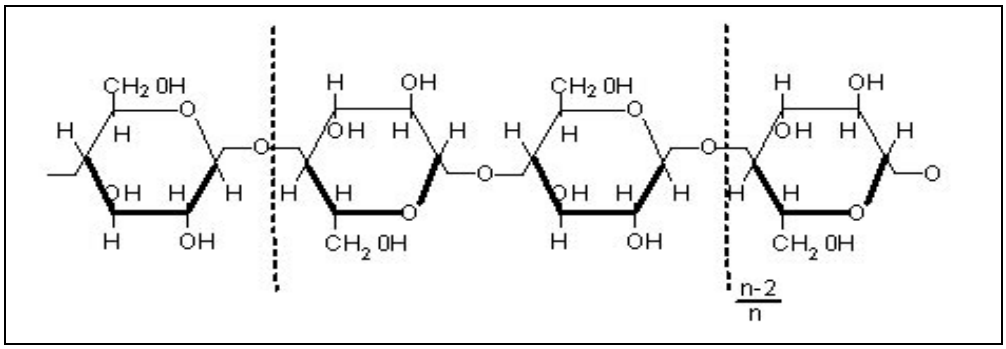


Fig 1: (c) Chemical formula of cellulose polymer

Under the present study two essential oil i. e. lemongrass (*Cymbopogon flexuous)* and citronella (*Cymbopogon winterianus)*. Lemongrass is a medicinal plant whose leaves are widely used for many applications for aromatherapy. The essential oil is good source of a citral active compound, which is a basic raw material for synthesis of β-ionone used for synthesis of a number of useful aromatic compounds and vitamin A lemongrass is thus used as a main substitute for cod liver oil (Hebbalkar 1992) [7]**.** There are some therapeutic and emotional effects of lemongrass oil such as it is used for treating digestive tract spasms, stomach-ache, high blood pressure, convulsions, vomiting, cough, and antioxidant and as mosquito repellent (Satyabrata & K A Geetha Floriculture (Ornamental, Medicinal & Aromatic Crops) [8]. The essence of oil can impart medicinal effect separate from the aroma but more often they are intertwined (Bachbauer & Jirovet z, 1994) [9]. Nowadays herbal drugs are prescribed widely even when their biologically active compounds are unknown because of their effectiveness, minimal side effects in clinical experience and relatively low cost (Valiathan, 1998) [10]. Citronella oil is one of major essential oil. It is used extensively as source of important perfumery chemicals like

citronellal geraniol etc. Citronella essential oil is rich in citronellal, citronellol & geraniol (Katiyar *et al*. 2011) [11]. There are some therapeutic and emotional effects of citronella oil such as it is used as antibacterial, anti-inflammatory and most importantly as mosquito repellent.

2. Materials and methods

The fabrics used in the present study were pure wool, pure silk and pure cotton. All preliminary processes such as desizing scouring and bleaching were done prior to finish application. All these process removes the impurities and enhance the ability for proper impregnation of finishing solution to the fabric. The weight of wool fabric was 1.630 gm, which was twill weave with a 18 × 9 (ends × pics per inch), silk fabric weight was 0.32 gm plain weave with a 52 × 66 (ends × pics per inch), & cotton fabric weight was 0.4 gm was also plain weave with a 112 × 92 (ends × pics per inch). Aromatherapy oil i. e. citronella essential oil and lemongrass essential oil were used for finish application. Codification of treated variant samples is shown in table 1.

Table 1: Codification of treated variant samples

Wool fabric sample treated with citronella oil	WC
Wool fabric sample treated with lemongrass	WL
Silk fabric sample treated with citronella oil	SC
Silk fabric sample treated with lemongrass	SL
Cotton fabric sample treated with citronella oil	CC
Cotton fabric sample treated with lemongrass	CL

2.1 Preparation of solution

Firstly 80% of ethyl alcohol was prepared. After that the essential oil was mixed with ethyl alcohol using stirrer for proper mixing of oil and alcohol and varying concentration of 10% 20%, 30%, 40%, & 50% was prepared.

2.2 Application on textile fabric

Immersion method was used for application of essential oil**.** All fabrics were kept immersed in the given solution of varied oil concentration 10% 20%, 30%, 40%, & 50% for 24 hours then squeezed dried and cured.

2.3 Olfactometry analysis

An olfactometry analysis of aroma present in fabrics treated with aromatherapy oils combined with ethyl alcohol was done for four weeks by panel of 5 healthy judges. Over a period of four weeks judges smelled the sample every 5th day. The rating scale used was ordinal scale, 5 being very strong aroma and 0 for no aroma and for proper identification of fragrance coffee beans were used to sniff between smelling of samples. During the period the fabric samples were washed 6 times and air dried at ambient conditions and after each wash the specimen's average intensity of aroma recorded.

Table 3: Average fragrance intensity rating by judges with respect to time intervals and different concentration treated with Citronella oil + Ethyl alcohol and Lemongrass + Ethyl alcohol

Evaluation day	Oil concentration	Citronella			Lemongrass		
		WC	SC	CC	WL	SL	CL
1 (no wash)	10%	5.00	5.00	4.8	5.00	5.00	4.8
	20%	5.00	5.00	4.8	5.00	5.00	4.8
	30%	5.00	5.00	4.8	5.00	5.00	4.8
	40%	5.00	5.00	4.8	5.00	5.00	4.8
	50%	5.00	5.00	4.8	5.00	5.00	4.8
5 (1wash)	10%	4.8	4.6	3.2	4.6	4.4	3.00
	20%	4.8	4.6	3.2	4.6	4.4	3.00
	30%	4.8	4.6	3.2	4.6	4.4	3.00
	40%	4.8	4.6	3.2	4.6	4.4	3.00
	50%	4.8	4.6	3.2	4.6	4.4	3.00
10 (2wash)	10%	4.6	4.2	2.8	4.4	4.00	2.2
	20%	4.6	4.2	2.8	4.4	4.00	2.2
	30%	4.6	4.2	2.8	4.4	4.00	2.2
	40%	4.6	4.2	2.8	4.4	4.00	2.2
	50%	4.6	4.2	2.8	4.4	4.00	2.2
15 (3wash)	10%	4.2	4.00	2.2	4.2	3.8	1.2
	20%	4.2	4.00	2.2	4.2	3.8	1.2
	30%	4.2	4.00	2.2	4.2	3.8	1.2
	40%	4.2	4.00	2.2	4.2	3.8	1.2
	50%	4.2	4.00	2.2	4.2	3.8	1.2
20 (4wash)	10%	4.00	3.8	1.8	4.00	3.2	1.00
	20%	4.00	3.8	1.8	4.00	3.2	1.00
	30%	4.00	3.8	1.8	4.00	3.2	1.00
	40%	4.00	3.8	1.8	4.00	3.2	1.00
	50%	4.00	3.8	1.8	4.00	3.2	1.00
25 (5wash)	10%	3.8	3.4	0.8	3.6	3.00	0.6
	20%	3.8	3.4	0.8	3.6	3.00	0.6
	30%	3.8	3.4	0.8	3.6	3.00	0.6
	40%	3.8	3.4	0.8	3.6	3.00	0.6
	50%	3.8	3.4	0.8	3.6	3.00	0.6
30 (6wash)	10%	3.6	3.00	0.4	3.2	2.8	0.2
	20%	3.6	3.00	0.4	3.2	2.8	0.2
	30%	3.6	3.00	0.4	3.2	2.8	0.2
	40%	3.6	3.00	0.4	3.2	2.8	0.2
	50%	3.6	3.00	0.4	3.2	2.8	0.2

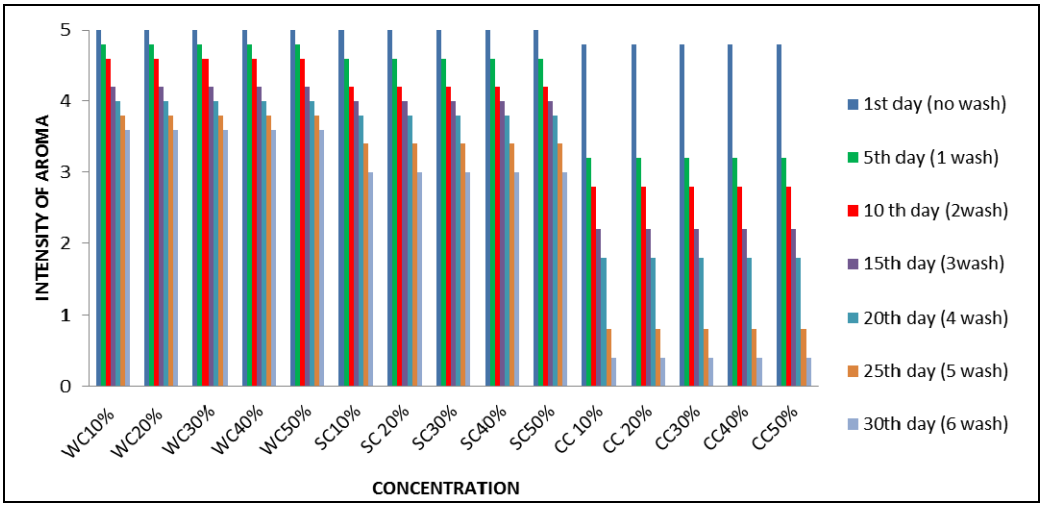


Fig 2: graph showing Average fragrance intensity rating by judges with respect to time intervals and different concentration treated with Citronella oil + Ethyl alcohol

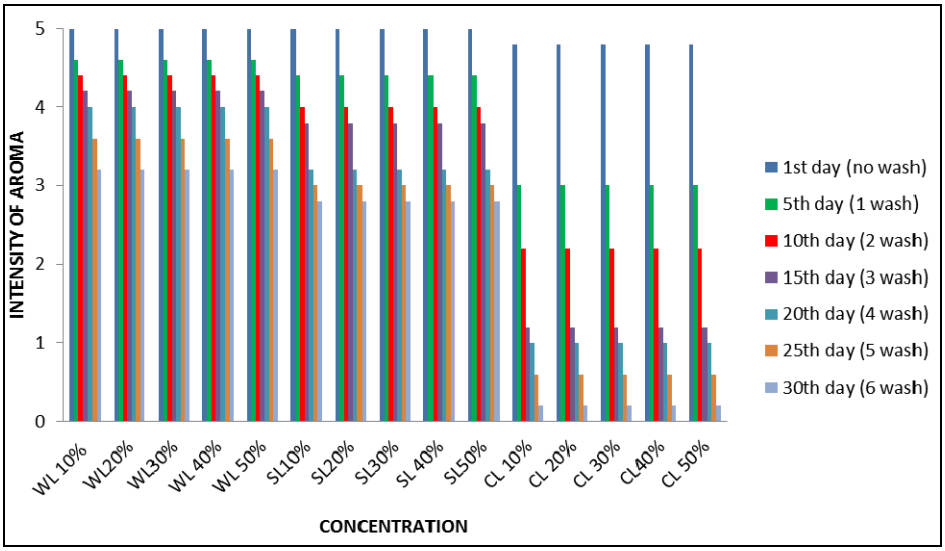


Fig 3: graph showing Average fragrance intensity rating by judges with respect to time intervals Lemongrass + Ethyl alcohol

3. Result and discussion

The treated fabrics were tested for physical properties such as weight thickness and change in color to determine significant changes in the test fabrics after treated with test solution which is shown in table 2. The fabric weight was recorded for controlled and treated sample and it was found that wool fabric increases its weight compare to silk and cotton fabric for both the oils. Silk fabric weight was recorded more compare to cotton fabric. It is clear from table 2 that wool fabric absorbed more oil in comparison to silk and cotton, which was thought to due to the fiber polymer system of wool. Silk absorbed more oil in comparison to cotton fabric. Increase in thickness of wool fabric was also noticed and it was found more compare to silk and cotton. Change in color of silk fabric was also observed after treatment with compare to controlled sample. Aroma durability of treated fabrics is shown in table 3. In most cases judges rated the intensity of aroma very similarly. The rating points for wool fabric treated with both essential oil and for each concentration are higher than that for silk and cotton fabrics and the rating for silk fabric is higher than cotton fabric. This phenomenon is attributed to the properties of fiber polymer system of wool and silk, which causes it to hold more aromatherapy essential oil and also its fragrance for a longer period of time. It is also can be seen from the table 3 that intensity of aroma remains same by increasing percentage of concentration of solution. So it can be concluded that 10% concentrations have as much intensity of aroma as 50% concentration. This makes cost effective use of essential oil because we cannot use much quantity of oil.

Table 2: changes in physical properties of fabric

Type of fabric	Type of sample	Fabric weight(gm)	Fabric thickness (mm)
WC	Controlled	1.63	0.84
	Treated	2	0.92
WL	Controlled	1.63	0.84
	Treated	0.95	0.90
SC	Controlled	0.32	0.44
	Treated	0.75	0.52
SL	Controlled	0.32	0.44
	Treated	0.40	0.50
CC	Controlled	0.4	0.21
	Treated	0.5	0.23
CL	Controlled	0.4	0.21
	Treated	0.3	0.22

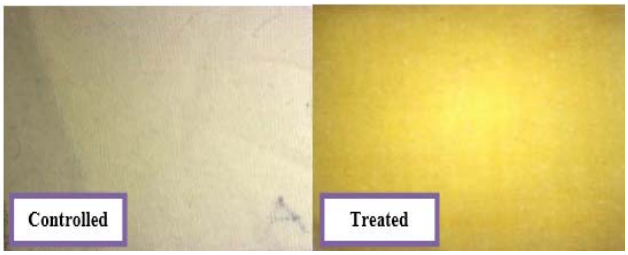


Fig 4: color change in silk fabric.

4. Conclusion

In present study a comparative study was done to identify which fabric is better receptor of oil and aroma. Pure wool, silk and cotton fabrics were chosen for the study. All three fabric sample were treated with essential oils and an evaluation of durability of aroma intensity was done for four weeks by panel of judges and for individual sample of different oil concentration (10%, 20%, 30%, 40% & 50%). The fragrance lasted through at least for four weeks and after 6 washes after the application: however they continued to provide aroma even after the last evaluation. It was also found that concentration of oil does not affect the intensity of aroma of all samples. The physical properties of treated fabric samples was also changed compared to controlled sample. By this comparative study it was found that wool fabric shows best receptor of oil and aroma compare to silk and cotton and silk fabric was better than cotton which was thought to be due to properties of fiber polymer system. Wool and silk fabric has good aroma retention compare to cotton therefore wool and silk fabrics are better suitable for aroma therapeutic finish application.

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