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Sensory evaluation of cotton fabric treated with peppermint oil

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Abstract

The finishing of cotton fabric with natural essential oils has attracted attention as a sustainable technique to enhance textile functionality. This study evaluates the application of peppermint oil on cotton fabric to determine its impact on sensory qualities. Cotton samples were treated with numerous concentrations of peppermint oil and different methods of application. The samples were assessed by thirty experts under different parameters. The treated samples as compared to the untreated samples showed greater outcomes in appearance, lustre, texture, and aroma. This eco-friendly approach has potential for usage in medical textiles, sporting, and home furnishings, coinciding with the growing demand for sustainable and multipurpose fabrics.

Keywords: Peppermint oil, application, cotton fabric, aroma, appearance, texture, lustre, whiteness index

1. Introduction

Beyond traditional mechanical and chemical treatments, textile finishing now uses practical, sustainable methods that improve fabric performance while reducing environmental impact. Essential oils have drawn a lot of interest among natural finishing agents because of their consumer appeal, eco-friendliness, and bioactive qualities. *Mentha piperita* is the source of peppermint oil, which is highly prized for its cooling, deodorizing, and antibacterial properties, making it a promising option for functional textile applications.

One of the most popular natural fabrics is cotton, which is valued for its comfort, softness, and breathability. However, finishing treatments are frequently required due to its vulnerability to microbiological development, odor retention, and lack of intrinsic functional qualities. Despite their effectiveness, traditional chemical finishes can be harmful to the environment and human health because of their limited biodegradability and lingering toxicity. On the other hand, natural finishes like peppermint oil provide a safer and more environmentally responsible option, which is in line with the rising demand for eco-friendly fabrics in the home furnishings, athletic, and medical industries.

Incorporating peppermint oil into cotton fabric improves wearer comfort by adding a cooling sensation and refreshing aroma in addition to strengthening antibacterial resistance. Additionally, medicinal substances like menthol and menthone found in peppermint oil are known to prevent bacterial growth and offer therapeutic advantages. A thorough analysis of the general appearance, lustre, texture,

and aroma intensity of cotton fabric coated with peppermint oil is necessary to evaluate its acceptability by the consumers.

With an emphasis on factors including sensory qualities, this study attempts to explore the effects of peppermint oil finishing on cotton fabric. The project aims to establish peppermint oil finishing as a practical, sustainable technique for creating multipurpose textiles by examining the trade-off between functional enhancements and fabric comfort. It is anticipated that the results will help improve green textile technologies and facilitate the creation of textiles that satisfy environmental regulations and consumer demands.

2. Methodology

Application of peppermint oil on cotton fabric Different methods like direct, microencapsulation, resin cross linking and combination of microencapsulation and resin cross linking methods were used for applying peppermint oil into the cotton fabric. All the parameters required for the application of the oil through all the four methods were standardized and pad dry cure process was employed to apply the oil treatment to the fabric.

The following methods were used to effectively fix essential oil onto the fabric surface- Microencapsulation technique: The phase separation, complex coacervation method was chosen among several microencapsulation techniques, including solvent evaporation, polymerization, spray drying, and pan coating, because it is compatible with laboratory resources and has demonstrated effectiveness in prior

research. This technique used gelatin as a stabilizer, gum acacia as the wall material, and essential oils as the core material. Oppositely charged molecules successfully encased the oil droplets in a protective layer when the pH and temperature were regulated. The technique is appropriate for textile applications due to its benefits, which include high payload, the use of food-grade ingredients, processing at room temperature, and affordability.

Direct method: To improve binding and durability, essential oils were directly applied to the fabric using citric acid as a cross-linking agent.

Resin cross-linking technique: Oils were mixed with a resin cross-linking agent and applied to the textiles using an appropriate catalyst.

Combination method: The textiles were finished using the chemical method of resin cross-linking and the physio-chemical process of microencapsulation. It was employed to improve the endurance of the treatment.

Assessment of the treated fabric

Both the treated and control (untreated) fabric samples were sensory evaluated for lustre, texture, aroma, and appearance. Thirty experts from the Department of Apparel and Textile Science, IC College of Community Science, CCSHAU, Hisar, Haryana, evaluated treated fabric samples using a three-point quantum scale. The weighted mean scores were then calculated by summing the individual ratings.

- 1. Appearance:** Appearance refers to the overall visual impression of the fabric, how it looks to the eyes. It was assessed under excellent, good, and fair category.
- 2. Texture:** The tactile characteristic of a fabric's surface is known as texture. It establishes the fabric's feel or hand. It was evaluated under soft and smooth, rough, and coarse category.
- 3. Lustre:** A fabric's ability to shine by reflecting light is referred to as its lustre. It was assessed under high, medium and low category.
- 4. Aroma:** In textiles, aroma or odour evaluation refers to assessing the smell of a fabric. The aim is to determine the fabric's ability to absorb, retain, or release scents and to understand how this may affect the wearer's experience. The intensity of the aroma or odour was evaluated and categorized as strong, moderate, or mild.

Color change: The whiteness and yellowness of the treated and controlled fabrics was measured using a reflectance spectrophotometer using the ASTM-C1510 standard test method. The X, Y, Z, and whiteness index values and yellowness index values were calculated at 10 degrees observer with D65 illuminant.

Statistical analysis

Using the appropriate statistical methods, data for fabric samples treated with peppermint oil were tabulated and calculated.

Mean: By adding together all the observations and dividing that total by the number of observations in the set, the arithmetic mean was determined. The study computed a mean for the fabrics' preliminary, performance, and comfort characteristics.

$$\text{Arithmetic Mean} = \Sigma X / n$$

Where,

X = sum of all the observations,

N = total number of observations

Weighted Mean Score: WMS quantify the data on the strength of the treated fabric samples following washing, abrasion, ironing, and sun-drying, as well as the data on the general appearance, texture, and lustre of treated fabrics, were quantified using weighted mean scores (WMS). This formula was used to calculate it:

$$\text{Weighted mean score} = \frac{\text{Total weighted scores}}{\text{Number of respondents}}$$

3. Results and Discussion

The peppermint oil was applied to cotton fabric using all four application methods under optimized conditions identified through experimental analysis. The treated samples were passed through the rollers of a pneumatic padding mangle at 2 kg/cm² pressure and then dried and cured at the optimum temperature and time, which resulted in favourable performance and comfort characteristics.

The effectiveness of the pad-dry-cure method was supported by earlier findings. Teli and Chavan (2015)^[2] applied citronella oil microcapsules to cotton fabric using padding, while Bhatt *et al.* (2016)^[1] and Kumari *et al.* (2018)^[3] used the same method to apply lemongrass and other essential oils, respectively. These prior studies validate the suitability of the technique for ensuring even application and durable finishes.

The results related to the sensory evaluation of the treated fabric in terms of appearance, texture, lustre, and intensity of aroma are illustrated in Tables 1 to 4. The results for the whiteness and yellowness index are presented in Table 5.

Appearance of treated fabrics

The data in Table 1 depicts the results for appearance of fabrics treated with peppermint oil using different treatment methods.

Table 1: Effect of mosquito repellent treatment on appearance

Treatment method	Appearance (WMS)
	Peppermint oil
Control sample	1.16
Direct	2.66
Microencapsulation	2.00
Resin cross-linking	2.50
Combination	2.00

2.4 - 3= Excellent, 1.7 - 2.4= Good, 1 - 1.7= Fair
WMS= Weighted Mean Score

As observed from the data in Table 1, untreated fabric (control) scored 1.16, indicating a fair appearance. Direct application of peppermint oil scored the highest (2.66), categorized as excellent. Microencapsulation and combination treatments resulted in good appearance (2.00 WMS). Resin cross-linking achieved a higher score (2.50) with treated cotton fabric, making it excellent.

Texture of treated fabrics

The information in the Table 2 illustrates the texture of fabrics treated with peppermint oil using different treatment methods.

Table 2: Effect of mosquito repellent treatment on texture

Treatment method	Texture (WMS)
	Peppermint oil
Control sample	2.20
Direct	2.66
Microencapsulation	1.60
Resin cross-linking	2.50
Combination	1.50

2.3 - 3= Soft and smooth, 1.7 - 2.3= Rough, 1 - 1.7= Coarse
WMS= Weighted Mean Score

Untreated fabric (control) scored 2.20 for peppermint oil, indicated a rough texture. Direct application produced the softest texture, scoring 2.66 with peppermint oil making it soft and smooth. Resin cross-linking also resulted in a soft texture, with a score of 2.50. Microencapsulation and combination treatments yielded the lowest scores, falling into the coarse category.

Lustre of treated fabrics

The data in the Table 3 presents the lustre of fabrics treated with peppermint oil using different treatment methods.

Table 3: Effect of mosquito repellent treatment on lustre

Treatment method	Lustre (WMS)
	Peppermint oil
Control sample	1.00
Direct	2.26
Microencapsulation	2.13
Resin cross-linking	2.00
Combination	2.00

2.4 - 3= High, 1.7 - 2.4= Medium, 1 - 1.7= Low
WMS= Weighted Mean Score

It is evident from the table 3 that untreated fabric (control) scored 1.00, indicating low lustre. Direct application resulted in the highest lustre, scoring 2.26 with peppermint oil, falling into the medium category. Microencapsulation showed a slight improvement, with a score of 2.13 with peppermint oil, maintaining medium lustre. Resin cross-linking and combination treatments produced similar results, scoring 2.00, also classified as medium lustre.

Intensity of aroma of treated fabrics

The data in the Table 4 presents the intensity of aroma in fabrics treated with peppermint oil using different treatment methods.

Table 4: Effect of mosquito repellent treatment on intensity of aroma

Treatment method	Intensity of aroma (WMS)
	Peppermint oil
Control sample	1.00
Direct	2.33
Microencapsulation	2.03
Resin cross-linking	2.36
Combination	1.96

2.4 - 3= Strong, 1.7 - 2.4= Moderate, 1 - 1.7= Mild
WMS= Weighted Mean Score

As speculated from Table 4, untreated fabric (control) scored 1.00, meaning mild or no aroma is present. Resin cross-linking produced the strongest aroma, scoring 2.36 with peppermint oil, categorized as strong. Direct application also resulted in a noticeable aroma, with scores of 2.33 showing moderate intensity of aroma. Microencapsulation retained a moderate aroma, with scores of 2.03. Combination treatments lead to a weaker aroma, scoring 1.96 with peppermint oil, keeping them in the moderate range.

The general aesthetic and tactile properties of the peppermint oil-treated fabrics varied with the method of application. Overall, fabrics treated using the direct and

resin cross-linking methods demonstrated superior visual and tactile appeal, often being rated as “excellent” in appearance. In contrast, those treated via microencapsulation and combination methods were rated as only “good”. This may be attributed to the interaction between the gum in the microcapsule gel and the cotton substrate, possibly creating uneven surface effects that influenced visual perception.

The texture of the control (untreated) fabric was noted to be rough, whereas direct and resin cross-linked treatments yielded a noticeably smoother and softer handle. The combination and microencapsulation methods, however, resulted in a coarser texture, likely due to the increased surface friction caused by the deposition of oils and auxiliary materials during treatment. This finding underscores the impact of treatment mode on the sensorial comfort of textiles.

Regarding lustre, all treated fabrics exhibited medium lustre, an improvement over the low lustre observed in the untreated fabric. This enhancement may be linked to the deposition of oil-based materials, which possibly smoothed the fibre surfaces, improving light reflectance.

In terms of aroma intensity, the control sample exhibited negligible fragrance. Notably, resin cross-linked fabrics retained the strongest aroma, likely due to the embedding of oils within the resin matrix, allowing for sustained release over time. Fabrics treated via other methods showed moderate aroma intensity. This supports the hypothesis that the method of application significantly affects both the intensity and longevity of olfactory properties. These results align with prior research by Vasugi *et al.* (2010) ^[4] and Rani (2014) ^[6], who similarly observed improved surface characteristics and stronger aroma retention with direct and resin cross-linking applications of herbal treatments.

Color change in the treated fabric samples

The data in the Table 5 presents the whiteness index and yellowness index of cotton fabric treated with peppermint oil using different treatment methods.

Table 5: Color change in the mosquito repellent treated fabric sample

Treatment method		Whiteness index				Yellowness index			
		Tristimulus values			Whiteness index value	Tristimulus values			Yellowness index value
		X	Y	Z		X	Y	Z	
Control sample		56.22	59.93	66.77	74.35	58.31	59.67	74.33	-7.22
Peppermint oil	Direct	49.13	52.19	52.42	44.50	50.79	52.32	57.86	6.75
	Microencapsulation	45.46	48.16	46.89	36.28	47.01	48.37	51.80	10.62
	Resin cross- linking	50.01	53.09	53.31	45.06	51.69	53.23	58.84	6.87
	Combination	48.80	51.79	50.91	40.85	50.46	51.97	56.23	9.33

The untreated sample had a whiteness index of 74.35 (high whiteness) and yellowness index was found to be -7.22 (very low yellowing). Direct treatment method caused a considerable decrease in whiteness (44.50) and an increase in yellowness (6.75) with peppermint oil. In microencapsulation there was greatest whiteness loss (36.28) with highest yellowing (10.62) with peppermint oil. Resin cross-linking maintained better whiteness (45.06) and moderate yellowing (6.87) with peppermint oil. Combination treatment showed a drop in whiteness (40.85) with noticeable yellowing (9.33) with peppermint oil treated fabric.

It can be concluded that microencapsulation resulted in the greatest yellowing and lowest whiteness, resin cross-linking maintained better whiteness with moderate yellowing, combination treatments significantly increased yellowness, and direct application had variable effects but still contributed to noticeable yellowing in cotton fabric treated with peppermint oil.

The application of oil treatments led to observable color changes in the treated fabrics, most notably a decline in whiteness index and an increase in yellowness index, as compared to the control sample. These shifts suggest mild discoloration, which may result from multiple factors, including the interaction of oils with fabric, oxidation during drying, or retention of natural pigments post-scouring. The thermal sensitivity of cotton during drying may also contribute, as high drying temperatures can induce yellowing.

These findings are consistent with those reported by Cheng *et al.* (2010)^[5], Rani (2014)^[6], and Rana (2016)^[7], who all documented decreased whiteness values in fabrics treated with essential oils and plant extracts, particularly when applied via methods involving heat or resin matrices. While these changes are relatively mild, they remain important when considering the aesthetic expectations for end-use textiles.

4. Conclusion

Direct application of peppermint oil gave best results for appearance of the treated fabric. While the control (untreated) samples had a rough texture, samples treated with direct and resin cross-linking methods were soft and smooth. In contrast, microencapsulation and combination treatments resulted in a coarser texture. All treated fabrics exhibited medium lustre compared to low lustre of untreated fabric. Aroma intensity was low in control samples, strong in resin cross-linked samples, and moderate in those treated by the other methods. The whiteness index decreased and the yellowness index increased in treated samples compared to the control fabric sample. Overall, the treated fabrics were well appreciated by the experts.

References

1. Bhatt L, Singh SSJ, Rose NM. Durable aroma finish on cotton using microencapsulation technology. *J Cotton Res Dev.* 2016;30(1):156-60.
2. Teli MD, Chavan PP. Encapsulation of aroma and its application on cotton to impart mosquito repellency. *Asian Dyer.* 2015;12(3):45-9.
3. Kumari P, Rose NM, Singh SSJ. Microencapsulation: Use of geranium oil for aroma finishing of woven cotton fabric. *Indian J Health Wellbeing.* 2018;9(3):45-53.
4. Vasugi RN, Prabha R, Kanimozhi M. Effect of mosquito repellent finish on cotton fabric. *Textile Mag.* 2010;21(7):85-90.
5. Cheng SY, Yuen CWM, Kan CW, Cheuk KKL, Tang JCO. Systematic characterization of cosmetic textiles. *Text Res J.* 2010;80(6):524-36.
6. Rani P. Development of aroma treated fabrics using essential oils. Hisar (Haryana): CCS Haryana Agricultural University, Department of Textile and Apparel Designing; 2014.
7. Rana M. Development of mosquito repellent fabrics using plant extracts. Hisar (Haryana): CCS Haryana Agricultural University, Department of Textile and Apparel Designing; 2016.