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Durable aroma finish on cotton using microencapsulation technology

L. BHATT*, S. S. J. SINGH AND N. M. ROSE

Department of Textile and Apparel designing, CCS Haryana Agricultural University, Hisar-125004

**E-mail : bhatt19latika@gmail.com*

ABSTRACT : Aroma finish was imparted onto the fabric using microencapsulation technology and its durability was accessed. Cotton fabric was padded with microcapsule gel and the washing durability and retention of aroma were checked. The curing temperature and time was optimised as 80°C for 60 sec. The samples retained aroma till 30 wash cycles and as the number of wash cycles increased the intensity of aroma decreased. Such durable wellness finishes will also benefit the agriculture sector as it will ensure increased cultivation of aromatic plants and enhanced rate of essential oil extraction. Aroma finish will add value to cotton so the cultivation, production and export of cotton will also boost.

Key words : Aroma, cotton, essential oil, microencapsulation, pad dry cure, wash durability, wellness

The addition of fragrances to textiles has been carried out for many years in the form of fabric conditioners in the wash and tumble drying process but the effect was short lived. To achieve durable aroma finish on textiles has been a long time dream for textile chemists. As fragrances are volatile so they evaporate away and do not stay for long periods and are not resistant to wash. Therefore microencapsulation was found to be a solution to this problem. Microencapsulation can effectively control the release rate of fragrance compounds and essential oils as required which ensures the storage life of volatile substance (Slavica *et al.*, 2005).

Microencapsulation is a technique to prepare microcapsules, small particles that contain an active agent or core material surrounded by coating or shell of limited permeability (Benita, 1996). Microencapsulation is an innovation wherein active material is enveloped in a coating or capsule which protects it from external environment. Release of aroma is by diffusion of the fragrance through the capsule wall and rupture of the capsules (Nelson, 2002). These capsules can be applied to fabric through simple pad-dry sequence. During wear, simple mechanical rubbing of fabric gradually ruptures the membrane releasing active agent for therapeutic, energy boosting, stress busting, moisturising or deodorising effects.

Garments act as second skin so they are the excellent media to transfer the therapeutic effect of aromas to the human body and provide wellness effect through aromatherapy. Cotton is the most preferred fabic in India. As close friends of humans, textiles can make aromatherapy easy wherever they are needed. Various products such as fibres, fabrics, non fabrics and garments can be chosen to enjoy the pharmaceutical and emotional effects of aroma oil treated fabrics. The uses of aroma finished textile are diverse. Interior textiles such as sheets, quilt-covers, curtains, carpets and bed-gowns are suitable for the attachment of lavender, camomile, citrus or cinnamon microcapsules, which are good for hypogenesis and eliminating fatigue..

MATERIALS AND METHODS

Selection of material : For core material, out of four essential oil one was selected keeping in mind the aroma and therapeutic properties of the essential oils with the help of a self

structured preferential choice index with two parameters *i.e.* aroma of the oil and its therapeutic effects and was subjected to 20 experts. A natural gum was used as wall material and the complex coacervation technique was used for the preparation of microcapsules and pad dry cure technique for the application onto the substrate.

Preparation of microcapsule gel: The basic recipe referred is as follows (Teli *et al.*, 2005). 12 g of gelatin was accurately weighed and dissolved in 25 ml of warm water and was stirred with high speed stirrer for 10 min. 4 g of core material was added to the solution at 40ºC. 12 g of gum acacia was weighed accurately and dissolved with 25 ml warm water separately. The gum acacia solution was added to the gelatin solution and the temperature of the solution was maintained at 40ºC. The pH of the solution was decreased to 4.5. The solution was stirred at high speed for some time and the temperature was lowered to 5ºC for gel formation. Then pH was increased to 8.5 to form microcapsules. 1 ml of alcoholic formalin (17%) was added to the formed capsules for stabilization

Standardization of temperature and time of curing : The padding process was standardized for the curing time and temperature was also optimised for 70, 80 and 90ºC and 30, 60 and 90sec, respectively. The cotton fabric sample was immersed in the padding solution containing microcapsules, binder and softener in a ration 50:15:1 with 110-120 expression using pneumatic padding mangle, squeezed and cured at the optimised temperature for few minutes (Sukumar and Lakshmikantha, 2009 and Thilagavathi *et.al.,* 2006).

The resultant fabric obtained after each padding and curing process was analyzed under e-scope to ensure the presence of microcapsules in the fabric structure optimum proportion was selected on the basis of wash durability, bending length and flexural rigidity.

Assessment of microencapsulated fabrics for wash durability : Wash durability test was carried out. Treated fabric was cut into sample size 10.4 cm. A soap solution was prepared using 5g of soap in 1 l of distilled water.. Each fabric sample was placed in a separate container and soap solution was added to each container maintaining M:L ratio 1:50. These specimens were treated for 45 minutes at 50 ± 2° C. After removing fabric specimen from laundrometer after 5, 10, 15, 20, 25 and 30 wash cycles it was rinsed twice in cold water and then in running tap water for 10 min and squeezed. The finished specimen was dried in air at a temperature not exceeding 60 ºC. These samples were further used for microscopic analysis and to check the retention and intensity of aroma.

Retention of aroma after wash: The treated and washed samples evaluated against aroma retention by 20 experts through survey technique using olfactory analysis. The aroma assessment was based on Lewis's procedure (Lewis, 2003). A portion of each fabric was removed after 5, 10, 15, 20, 25 and 30 wash cycles, tested for the presence of fragrance by the experts. The washed samples were evaluated within 24 hr after washing. The samples were hung on a clothesline in a room for 1 h to stabilize the evaporation of fragrance prior to being judged. To get fair judgement the experts were not allowed to enter the stabilizing room and samples were brought to the experts. To detect odor, a specimen was put on a desk and the expert used a fingernail to scratch "X" on the specimen to rupture some capsules and smell the swatch. The size of "X" was about 3x3 cm. The response were recorded as 'Yes' or 'No'. If the aroma was judged to be present by majority of experts, the condition was noted as passing.

Intensity of aroma after wash: The treated samples and washed samples were evaluated qualitatively for intensity of aroma at different number of wash cycle. Change in amount of aroma was assessed by sensory evaluation of 20 respondents with the help of self structured criteria

RESULTS AND DISCUSSION

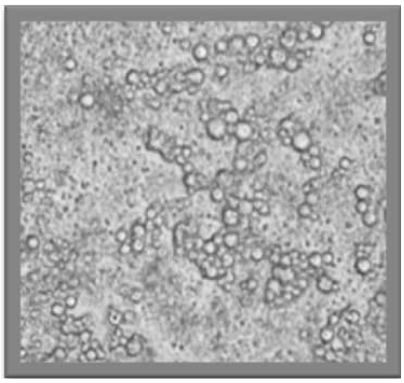
Selection of essential oil : Four aroma oils were got evaluated by 20 respondents on the basis of aroma of the oil and its therapeutic effects using a preferential choice index. The data related to preferences of respondents regarding the essential oils is presented in Table 1.

It is thus concluded that the most preferred essential oil was lemongrass oil which was used for further experimental work (Table 1)

Table 1. Preferences of the respondents for essential oil for microencapsulation

Essential oil	Parameters		Average mean score	Rank
	Aroma	Therapeutic effect		
	W.M.S			
Basil oil	3	3.36	3.18	II
Lemongrass oil	3.48	3.6	3.54	**I**
Orange oil	3.04	2.68	2.86	III
Tea tree oil	2.52	3.2	2.86	III

WMS – Weighted mean score



Microscopic image of lemon grass oil microcapsules

Preparation of microcapsules : The prepared microcapsules were analysed under inverted microscope and it was found that the formed microcapsules were uniform in size and had sharp walls.

Optimization of curing temperature : The optimum curing temperature was 80°C. At higher temperature the wash durability decreased. Shiqui *et al.,* (2006) observed that thermal treatment can give contradictory effects on washing durability of fragrance finished fabrics. Higher temperature and longer curing time usually increases fastness of capsules on textiles with decreased aroma inside the capsules because higher the temperature of curing, more the vitalization of fragrance.

Optimization of curing time : The curing time was optimized at 60 seconds as best results were obtained in terms of presence of microcapsules on fabric, washing fastnesss, bending length and flexural rigidity. Treated fabrics if exposed to high temperature for longer curing time may result in rupturing of wall and decrease in the number of microcapsules. Monllor *et al.,* (2009) revealed that stronger curing conditions increase binder reaction and improve fixation of capsule but fragrance is volatile so it could not withstand strong curing conditions hence they should not be subjected to high temperature and longer curing time (Table 2).

Retention of aroma : Aroma was retained in the fabric till 30 wash cycles. This can be attributed to the fact that the wall of the microcapsules provide covering to the oil thus protecting it from outside environment and providing it a controlled release to give it a longer life (Table 3). Sukumar and Laxmikantha (2009) also revealed that aroma finish retained till 25 wash cycles. Shah and Goel (2010) also pointed

Table 2. Optimization of curing temperature

Temperature(°C)	Parameters					Rank
	Wash durability (wash cycles)	Bending length (cm)		Average bending length (cm)	Flexural rigidity (mg-cm)	
		Warp	Weft			
70	20	2.92	1.98	2.45	29.48	II
80	25	2.93	2.0	2.46	29.88	**I**
90	10	2.88	1.97	2.42	28.96	III

Table 3. Optimization of curing time

Temperature(°C)	Parameters					Rank
	Wash durability (wash cycles)	Bending length (cm)		Average bending length (cm)	Flexural rigidity (mg-cm)	
		Warp	Weft			
30	15	2.90	1.98	2.44	29.28	II
60	25	2.93	2.0	2.46	29.98	**I**
90	15	2.95	2.1	2.52	31.59	III

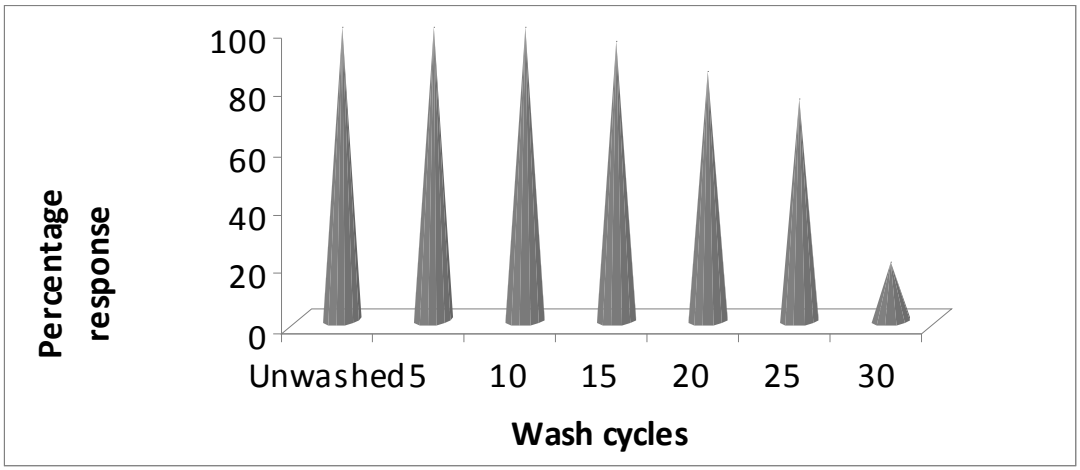


Fig. 1. Retention of aroma in microencapsulated fabrics after wash

that aoma was retained till 30 cycles of wash, rub and abrasion.

Intensity of aroma : It was observed that as the number of wash cycles increased the intensity of decreased as with each wash few microcapsules gets washed away (Table 4). Wang *et al.,* (2005) observed that after washing the fragrance release rates decreased and the results of sensorial evaluation showed that performance of the fabric lasted 25 cycles of wash and the intensity gradually decreased with increase in the number of washes.

Table 4. Retention of aroma in microencapsulated fabrics after wash

Wash cycles	Unwashed	5	10	15	20	25	30
Retention of aromaF (%)	20 (100)	20 (100)	20 (100)	19(95)	17(85)	15(75)	4(20)

Table 5. Intensity of aroma in microencapsulated fabrics after wash

Wash cycles	Intensity of aroma (WMS)	Rank
Unwashed	4.35	**I**
5	4.2	II
10	3.7	III
15	2.95	IV
20	2.5	V
25	2.3	VI
30	1.2	VII

4.2 – 5 = Very strong, 3.4 - 4.2= Strong, 2.6 - 3.4 = Moderate, 1.8 - 2.6= Mild and 1 - 1.8 = Faint

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