Factors Affecting Release of Microencapsulated Essential Oils from Finished Silk Fabric for Automotive and Home Textile Products

Phussadee Lim and Jantip Setthayanond

ABSTRACT--- Performance and properties of home and automotive textiles are greatly influenced by heat and light. In this research, the effect of heat and light was studied on aroma finished silk fabrics. Lemon and eucalyptus oil microcapsules were applied on silk in the presence of acrylic binding agent. Effect of binder concentrations on the fabric's properties was reported. By exposure to heat treatments at 50,70 and 90 oC for 24 hours, lemon and eucalyptus oil were apparently lost from the finished fabrics. In addition, UV light is another factor causing a strong effect on durability of lemon and eucalyptus oil microcapsules on silk fabrics, about 40% oil reduction was observed. This study suggests that heat and UV light can pose a considerably effect on stability and durability of aroma finishes on silk fabrics. These factors may shorten the service-life time of aroma finished silk to a significant extent if the fabrics are used in home and automotive textile products.

Keywords - Silk, oil microcapsules, heat treatment, UV, home textiles, automotive textiles

INTRODUCTION

Market of non-apparel textile products has grown continuously. Non-apparel textiles include home textiles, automotive textiles, geotextiles and also textiles for other specific-purposes. Due to different usage purposes, each particular type of non-apparel textiles requires different textile materials and production techniques to attain final desirable properties. For home and automotive textiles, apart from their performance properties, they can be more value added by enhancing aesthetic properties regarding their application e.g. hand-feeling, aroma properties, etc.

Silk fiber is employed for high-end textile products. For home textiles, silk is produced into draperies, included in furniture and also bedding products. Silk can also be used as decorative fabrics in automotive textiles. Aroma finishing with plant essential oils or fragances indulge users with relaxing and therapeutic scent of the surrounding atmosphere and some of which also impart special properties on textiles, eg. anti-mosquito textiles from microencapsulated citronella oil (Specos, Garcia et al. 2010). Aroma finishes are typically perfumes and herbal essential oils being a core, microencapsulated with a shell material by various techniques (Rodrigues, Fernandes et al. 2008, Rodrigues, Martins et al. 2009, Miró Specos, Escobar et al. 2010, Bône, Vautrin et al. 2011, Martins, Barreiro et al. 2014, Asbahani, Miladi et al. 2015). Release mechanism of oil microcapsules is typically by mechanical action exerted to break microcapsules and the scent is then released. However, there are several other factors that can influence release of aroma oils from microcapsules and also affect how long this aroma oil will last on textiles. Heat and light are external factors that may affect to some extent on aroma finishing durability and it is crucial to take such factors into account, in particular for home and automotive textiles that are frequently exposed to heat and light during their service life.

PROBLEM STATEMENT

Durability of aroma oil finishing on textiles depends on several factors. Apart from the factors regarding materials and processes used for microcapsule fabrication and finishing condition, the durability of aroma oil microcapsules on textiles is as well influenced by external factors in which textiles encounter during their uses. For textiles like home and automotive textiles, aroma finishing that is applied to impart aroma feature to these textiles, can greatly be manipulated by heat and light, giving rise to poorer durability of aroma finishing. To date, there is no research reported about the influence of these external factors on aroma oil finishing before.

THE AIM OF RESEARCH

This research was conducted to investigate the effect of heat and ultraviolet (UV) light on the durability of two essential oil microcapsules viz. lemon and eucalyptus oils treated on silk fabrics. Heat and light are vital factors influencing the properties of silk fabrics that are to be used for home and automotive textiles.

METHOD OF RESEARCH

Materials

Plain woven silk fabric with the weight of 61.76 g/m^2 was degummed before use. Microencapsulated lemon oil and Eucalyptus (with melamine-formaldehyde shell) and acrylic binder were purchased from Ratchada Chemicals, Co. Ltd., Thailand. Wetting agent used were Starpon 4488. All chemicals used were in analytical grade.

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Methods

1. Effect of acrylic binders on finishing

The silk fabrics were finished with two microencapsulated oils viz. lemon and eucalyptus oils by pad-dry-cure process. The fabrics were immersed in the solutions containing 30 g/l oil microcapsules at various concentrations of acrylic binder (10, 20, 30 and 50 g/l) for 10 minutes. After that, the fabrics were squeezed through the pad mangle at 80% wet pick up and then dried and subsequently cured at 120°C for 0.5 minutes and 160°C for 2 minutes, respectively. Fabric whiteness was assessed with a Macbeth Color7000 spectrophotometer. Bending lengths of the fabric both in warp and weft directions were measured with Fixed angle flexometer according to BS 3356 standard and flexural rigidity (G) of fabrics were calculated from equation 1.

$$G = 0.1MC^3 \quad (1)$$

Where M is fabric mass per unit area (g/m^2) and C is bending length of fabric (cm).

The surface morphology of silk was monitored with Jeol JSM-6480LV scanning electron microscope (SEM) at 10 kV.

2. Effect of heat on durability of finished microcapsules on silk

Silk fabrics finished with lemon and eucalyptus oil microcapsules at 10 g/l in the presence of 20 g/l acrylic binder were heat treated at 50, 70 and 90°C for 24 hours. The untreated and heat-treated fabrics (0.15g) were extracted with ethanol in the presence of 25 stainless steel balls in a dyeing pot. Extraction was carried out in Starlet Daelim infrared dyeing machine at 35°C for 2 hours in order to quantify the amount of oils present on the fabrics. Absorbances of the extracted solutions were determined with a Specord 250 UV/vis spectrophotometer at 268 and 315 nm for eucalyptus and lemon oils, respectively. Amounts of lemon and eucalyptus oils were calculated from standard curves plotted between the concentrations and absorbance values of lemon and eucalyptus oil solutions in ethanol.

3. Effect of UV light on durability of finished microcapsules on silk

Silk fabrics finished with lemon and eucalyptus oil microcapsules at 10 g/l in the presence of 20 g/l acrylic binder were UV irradiated at wavelength of 365 nm. The fabrics were hung vertically towards dual arranged UV lamp and distance between the fabric and the UV lamp was set at 10 cm. The experiment was conducted in a light box for 4, 8, 24 and 48 hours. UV-exposed fabrics (0.15g) after each exposure times were extracted to determine the amount of lemon and eucalyptus oils remained on the fabrics using the same procedure as mentioned in the previous section. Amounts of lemon and eucalyptus oils were then calculated from the standard curves of the oils in ethanol.

RESULTS AND DISCUSSION

1. Effect of acrylic binder

By applying microcapsules of lemon and eucalyptus oils onto silk, acrylic binder is normally employed to assist fiber binding. Acrylic binder caused no deteriorated effect to fabric whiteness (Figure 1) while flexural rigidity values indicated that the fabrics were stiffer when acrylic binder was applied in warp direction while a little reduction in stiffness was observed in weft direction (Figure 2). With increasing acrylic binder concentrations, a slight increase in fabric stiffness was detected. SEM result showed an attachment of lemon oil microcapsules on silk. Capability to bind the microcapsules onto the fiber surface seemed depending on concentration of acrylic binders. Microcapsules could greater adhere on silk when more acrylic binder was used. The result showed that at least 20 g/l acrylic was needed for the finishing, but too high concentration applied (50 g/l) appeared to cause an adverse effect to the microcapsules as seen in Figure 3.

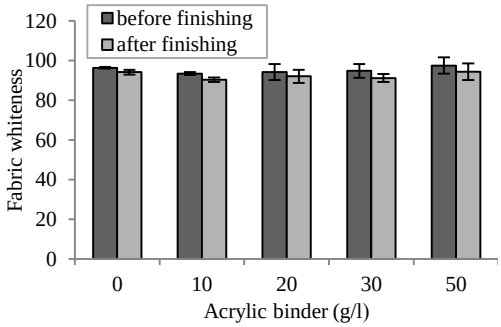

Figure 1. Whiteness of silk fabrics before and after lemon oil microcapsule finishing

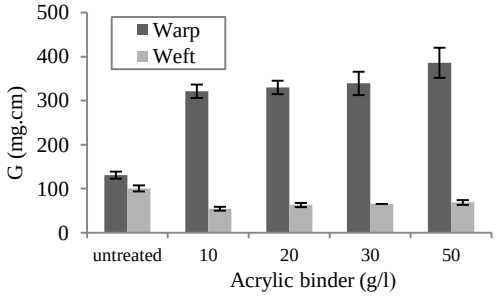

Figure 2. Flexural rigidity of silk fabrics treated with lemon oil microcapsule at various acylic binder concentrations

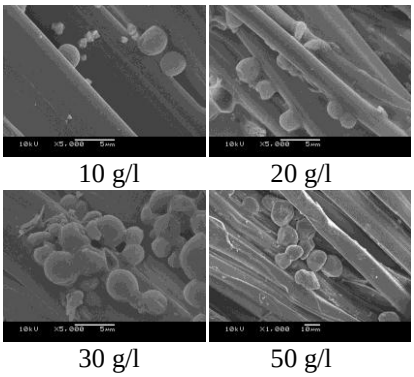

Figure 3. SEM images of silk fabrics finished with lemon oil microcapsules at various acrylic binder concentrations.

2. Effect of heat

When aroma finishing is applied for home and automotive textiles, effect of heat is taken into account especially automotive textiles that have a large chance to heat exposure. Heat generated inside vehicles such as cars, could be as high as 70°C in tropical countries like Thailand and even worse in summer time. In this study, the results obtained in Table 1 shows the effect of heat on microcapsules's durability as a function of heat treatment temperatures. With increasing temperature, microcapsules applied on silk both lemon and eucalyptus were destroyed. Amount of the oils decreased with increasing temperature as seen in Figure 4. Only 24 hours of heat exposure, more than 10% oil is lost when the fabrics were heated to 70°C and higher loss was observed for the case of 90°C. The results informed a significant effect of heat on stability and durability of the lemon and eucalyptus oils microcapsules on silk.

Table 1. Amount of extracted lemon and eucalyptus oils on silk heat treated at 50, 70 and 90 °C for 24 hours

Temperature (°C)	Amont of extracted oil (g/g fabric)	
	Lemon	Eucalyptus
untreated	0.696±0.011	0.282±0.010
50	0.623±0.028	0.271±0.004
70	0.511±0.009	0.244±0.020
90	0.481±0.012	0.164±0.020

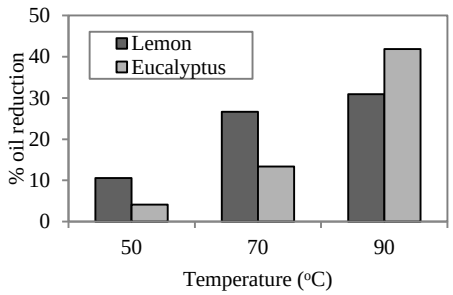

Figure 4. Percentage oil reduction as a result of heat treatment

3. Effect of UV light

Light is another factor influencing properties and performance of home and automotive textiles. UV containing in sun light or other artificial light sources could have harmful effect to the oil microcapsules applied on silk. Amount of oils extracted from silk fabrics was found to decrease with increasing UV irradiation time (Table 2). Only 48 hour irradiation could reduce lemon and eucalyptus oils on the fabrics for about 40%, indicating a strong effect of UV on durability of the finishes on silk fabrics.

From this study, it suggests that heat and UV irradiation have a considerably effect on stability and durability of aroma finishes on silk fabrics. These factors could shorten the service life of aroma finished silk to a relatively high extents. The oil lost may be caused by microcapsules destruction and/or higher volatilization of the oil from the fabrics, leading to a significant loss of the finishes from the fabrics.

Table 2. Amount of extracted lemon and eucalyptus oils on silk after UV irradiated for 4, 8, 24 and 48 hours

Irradiation time (hr)	Amont of extracted oil (g/g fabric)	
	Lemon	Eucalyptus
0	0.512±0.011	0.217±0.010
4	0.496±0.018	0.213±0.002
8	0.444±0.017	0.154±0.009
24	0.384±0.018	0.151±0.012
48	0.291±0.011	0.133±0.004

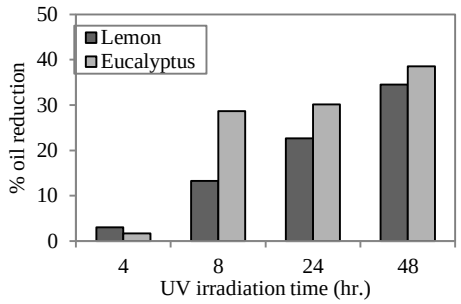

Figure 5. Percentage oil reduction as a result of UV irradiation

CONCLUSION

Microcapsules of lemon and eucalyptus oils were finished on silk fabrics with varying acrylic binder concentrations. Acrylic binder have no deteriorated effect on silk whiteness but did make the fabrics stiffer. The degree of microcapsule adherent on silk seems to increase with concentration of acrylic binders but too high amount is not recommended. Heat and UV light can cause a serious effect on stability and durability of the lemon and eucalyptus oil microcapsules on silk, an apparent loss of oil being observed. This study infers that the service-life time of aroma finishes applied onto silk fabrics that to be used for home and automotive textiles, may be shortened to a significant extent by heat and UV exposure.

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