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Utilization of Lanolin in Microwave-assisted Pigment Printing of Textiles

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PROPER utilization of wool grease which is usually discarded after scouring of raw wool fleece in many parts of the world is of prime importance from the environmental and economic point of views. In the present work, wool grease was extracted from coarse wool fleece using conventional heating or microwave irradiation. Different concentrations of lanolin was utilized as a binder in pigment printing of wool, polyester fabrics as well as polyester/wool (65/35) and polyester/cotton (65/35) blended fabrics using flat screen technique. Fixation of prints was brought about either by conventional heating or microwave irradiation. Extraction of lanolin as well as fixation of prints under the influence of microwave irradiation was carried out at different reaction parameters; Viz. concentration of reagent, reaction time and temperature, and microwave power. Colorimetric measurements; namely colour strength (K/S) and fastness properties (against washing, light, perspiration, and rubbing) were conducted. The ~~wet contact angle~~, UPF, stiffness, and air permeability of the printed fabrics were also assessed and compared to those of the corresponding samples printed in presence of commercial binder instead of lanolin.

The results of this study reveal that the colour strength and fastness properties of the fabrics printed using lanolin as a binder, whatever the adopted fixation method, is almost similar to those printed using commercial binder. Only the rubbing fastness of the printed fabrics was remarkably worse upon using lanolin as a binder in pigment printing of the said textile fabrics.

Keywords: Wool, Polyester, Blend, Fabrics, Printing, Microwave, Lanolin.

Introduction

Raw wool contains 10–35 %, of its mass, wool wax depending on the breed of sheep and the sampling area over the body of sheep. Wool grease is a major by-product of the wool-scouring. It is normally recovered from the scouring effluent used to clean the fleece prior to textile processing. The removal of grease from scour liquor is twofold advantageous process in that the grease is of commercial value and grease removal reduces the pollution load of effluent discharged from a scour plant. Industrially, purified lanolin is obtained by neutralization of the scouring effluent to eliminate free fatty acids followed by cleaning, decolorization and deodorization processes.

Lanoline exhibits anti-corrosive, nontoxicity, biodegradability and lubrication properties; and consequently it meets the requirements of some industrial applications. For instances, lanoline is used in durable corrosion-resistance paintings for iron, lubrication of metal as metal cutting oils, softening of tanned leather, spraying varnishes and oils, as well as polishing waxes and abrasives. Surprisingly, lanolin has limited applications in

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textile wet processing although it exhibits some functionalizing properties useful for textile fabrics. ~~Very~~ recently, a promising novel application of lanolin in textile wet processing was reported in which it was utilized to impart super hydrophobic effect to viscose fabrics [1]

Printing is the branch of the textile wet processing industry which is popular for most of fabrics as well as garments. Basically, printing is a form of dyeing in which the colors are applied to specified areas instead of the entire fabric. The resulting multicolored patterns have attractive and artistic effects which enhance the value of the fabrics much more than the plain dyed ones. The coloration is achieved with the incorporation of dyes or pigments in the printing paste [2].

Unlike printing with fabric affinitive dyes, in pigment printing, the colorants is fixed on the fabric surface by a binder which adheres to the fabric surface and forms a film in which the pigment is enclosed. Binders used usually in textile printing are synthetic polymers based on unsaturated organic compounds [3, 4].

Microwave heating is an alternative technique to conventional heating for fast, effective and uniform heating. Because microwave energy easily penetrates all of the particles of materials, the heating takes place instantly and uniformly [4-7], which, in turn, eliminates the problems that could occur during conventional heating [8, 9]. In coloration of textiles the use of microwave heating promotes dye exhaustion and increases the dyeing rates [10, 11].

Although there are many publications deal with utilization of microwave irradiation in the field of textile dyeing [12-16], as well as other wet processes of textiles [17-21]; its utilization in the field of textile printing is not yet fulfilled.

In this paper, lanolin was proposed as a binder in pigment printing of polyester, wool as well as polyester/wool and polyester/cotton blended fabrics. Saving energy during coloration of textile fabrics will be brought about by using microwave irradiation in fixation of pigment printed fabrics instead of the conventional thermo-fixation technique.

Experimental

Materials

Scoured light-weight merino wool fabric and polyester fabric as well as polyester/wool (65/35) and polyester/cotton (65/35) blended fabrics were purchased from Misr Company for Spinning and Weaving, Egypt. The fabrics were further treated with a solution containing 2 g/L nonionic detergent (Hostapal® CV-Clariant) at 60ºC for 30 minutes. The fabrics were then thoroughly rinsed with tap water and air-dried at room temperature.

The pigment Orange 34 and a high viscosity synthetic thickener DIACO The synthetic thickener Daicothick was supplied by Daico Company, Cairo, Egypt, and was used at 3% concentration. Printofix Binder MTB was kindly supplied by Clariant.

Lanolin (purified wool wax) was extracted in our labs from Egyptian wool fleece and used in this study as a binder in the printing paste. Urea and di-ammonium phosphate were of laboratory grade chemicals.

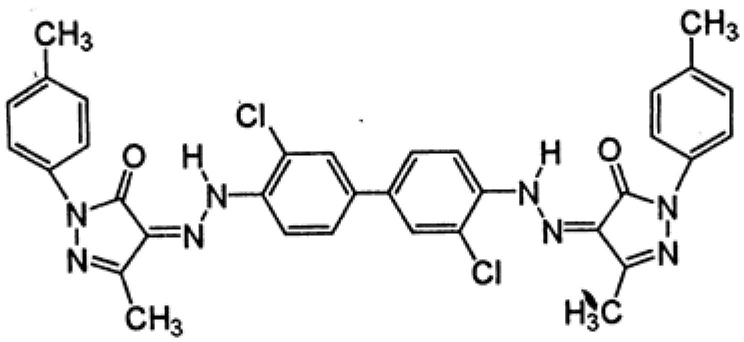

Fig. 1. Structural formula of Pigment Orange 34 .

Methods

Extraction of wool wax

Conventional method

Wool was scoured within an aqueous solution of sodium carbonate (2 gm/l) for 1 h at the boil. The boiled water containing grease was then centrifuged for 15 min at 8500 rpm to get rid of excess dusty materials. The obtained wet material was boiled to evaporate residual water and separate wool wax.

Microwave-assisted method

Wool wax was extracted from raw wool fleece inside microwave oven using different concentrations of sodium carbonate (0.25 - 2.0 g/L) at different temperatures (40-80°C) for different periods of time (5-45 min). The obtained wet material was boiled to evaporate residual water and separate wool wax.

Printing of fabrics

Preparation of the printing paste

The printing pastes were prepared according to the formulation given in Table 1. Ammonia, urea, diammonium hydrogen phosphate and lanolin as a binder were mixed with water. The thickener (Daicothick) was then introduced and the paste was stirred using a high shear mixer for 10 min to allow full viscosity to develop. The pigment (Pigment Orange 34) was then added to the mixture with stirring using a high shear mixer for 15 min.

TABLE 1. Formulation of the printing paste.

Components	Weight (in grams)
1- Diammonium hydrogen phosphate	1.0
2- Lanolin (binder)	(2-4-6-8)
3- Thickener (Daicothick)	3
5- Urea	4
6- Pigment	5
7- water	(85-83-81-79)
Total	100 g

The printing paste was prepared also in presence of the commercial binder Printofix Binder MTB (2 %, wlv).

Printing technique

Each printing paste was applied separately to wool, polyester, polyester/cotton and wool/polyester blend fabrics using flat screen printing method.

Fixation

The printed fabrics were dried at room temperature, and then subjected to thermo-fixation at 120, 140, and 160 °C for 1, 2, 4, and 6 min in a thermostatic oven (Mathis, Switzerland), or in a microwave oven at different power level (60 - 90 watt) and different time (2, 4, and 6 min). The fixation of the printed fabrics was carried out within a covered as well as uncovered container.

Washing

After printing and fixation via microwave irradiation or thermo-fixation, the printed fabrics were subjected to washing through 3 stages as follows: (a) rinsing thoroughly with cold and warm water, (b) washing with a solution containing 2 g/L Hosptapal CV-ET for 15 min at 60°C, and (c) rinsing with warm and cold water to remove the unfixed dye and finally air-drying.

Evaluation of printed fabric

Color measurements

The colour strength of the printed fabrics was assessed by reflectance method, which is performed on Ultra-scan PRO spectrophotometer (Hunter Lab, USA) under illuminant D65, 10° standard observer. The colour strength (K/S) in visible region of the spectrum (400–700 nm) was calculated based on *Kubelkae–Munk* equation shown below:

$$\frac{K}{S} = \frac{(1-R)^2}{2R}$$

Where, (K) is adsorption coefficient, (R) is reflectance of dyed sample and (S) is scattering coefficient. In terms of CIE Lab values (L*, a*, b*) and colour strength (K/S)

Fastness properties

Colour fastness of the prints to washing, perspiration and light was evaluated. Wash fastness (ISO 105-C02 (1989) was evaluated using the visual ISO Gray Scale for both colour change (AATCC Evaluation Procedure (EP 1- similar to ISO 105-A02) and colour staining (AATCC EP 2- same as ISO 105-A03). Light fastness (Xenon arc) was evaluated using ISO 105-B02.

Measurement of ultraviolet protection factor

The ultraviolet protection factor (UPF) was automatically calculated according to Australia/New Zealand standard AS/NZS-4399:1996 method employing UPF calculation system of UV/Vis spectrophotometer as reported in the standard AATCC Test Method 183:2010-UVA Transmittance.

Fabric stiffness

The bending stiffness of treated as well as untreated fabrics was assessed according to the British Standard method 3356:1961 using Shirley stiffness tester.

Air permeability

Air permeability of the fabrics was measured on FX 3300 air permeability tester (TEXTEST AG, Switzerland) at a pressure of 100Pa according to ASTM D737.

Results and Discussion

Traditional printing of textile fabrics

The colour strength (K/S) of wool and polyester fabrics as well as polyester/cotton and polyester/wool blended fabrics printed with Orange 34 pigment in presence of 8 g lanolin as a binder was determined spectro-photometrically. All samples were printed then fixed at different temperatures (120, 140, and 160 °C) for different periods of time (1, 2, 4, and 6 min).

Effect of fixation time and temperature

The effect of fixation temperature and time on the colour intensity (K/S) of printed fabrics was tabulated in Table 2. Meticulous investigation of the date of this table 2 clarifies the following:

- Increasing the fixation time of the printed wool fabrics from 1 to 2 min resulted in an increase in the K/S value of the prints irrespective to the fixation temperature. At 120 and 140 °C, further increase in the fixation time to 4 and 6 min led to decrease in the K/S of the printed samples, presumably due to bleeding of the pigment from the printed fabric. Maximum K/S value was obtained upon fixation of the printed wool fabrics for 2 min at 160 °C. It seems that the maximum efficiency of lanolin as a binder is attained at such temperature and enables it to fortify the bonding of the pigment to wool fabrics.

- Similar trend was observed in case of polyester/wool printed fabrics.

- In case of polyester fabrics, fixation of the prints at 120 °C resulted in decreasing in the K/S value of the printed samples. This implies that the pigment was not linked properly to the fabric by the used binder. Fixation of the prints on polyester fabrics at higher temperatures (140 and 160 °C) for 2 min led to increasing the K/S of the printed fabrics. Further increase in the fixation time caused migration of the pigment from the fabric.

- At all fixation temperature and time, fixation of the printed polyester/cotton fabrics resulted in decease in the K/S value of the printed fabrics.

Effect of lanoline concentration

The effect of lanolin concentration within the printing paste on the colour intensity of the printed fabrics was studied and summarized in Table 3. We can conclude from this table that, in all printed fabrics, as the amounts of lanolin in the printing past increase from 2 % up to 6%, the K/S of the printed fabrics increases. Further increase in the amount of lanolin to 8% has no appreciable effect on the colour intensity of the printed fabrics. These results imply that lanolin is an effective candidate for usage as a binder in pigment printing of different textiles.

Comfort attributes

The effect of presence of lanolin as a binder in the pigment printing paste of the said fabrics on some of their comfort attributes was studied. Results of this investigation, summarized in Table 4, elucidate that there is no deterioration in the comfort attributes of the printed fabrics; namely air permeability and UPF. The fabrics stiffness of the printed fabrics is comparable to that of the corresponding fabrics printed in presence of commercial binder.

Microwave-assisted printing

Microwave irradiation was used in fixation of prints on wool, polyester, wool/polyester, and polyester/cotton fabrics. The effect of fixation time inside microwave oven on the colour intensity (K/S) of the printed fabrics was monitored. Results of this investigation are summarized in Table 5.

Data of this table clarifies that in most cases, the colour strength of the printed fabrics upon fixation of the prints inside uncovered container is significantly higher than the corresponding microwave-fixed printed samples in a covered container. The highest K/S values were obtained upon fixation of the printed samples for 6 min inside the covered container, and 4 min for the uncovered ones.

Table 6 shows the effect of microwave power on the K/S values of printed fabrics which were fixed inside microwave in an uncovered container. Date of this table shows that the appropriate microwave power for fixation of printed fabrics is 80 %.

TABLE 2. Effect of fixation time and temperature on K/S value of wool and polyester fabrics as well as polyester/cotton and polyester/wool blended fabrics printed with pigment Orange 34.

Temperature/sample	K/S of the printed fabric after fixation time of			
120°C	**1**	**2m**	**4m**	**6m**
Wool	20.22	32.10	29.8	29.1
Polyester	19.22	17.99	16.50	12.33
Polyester/Cotton	19.17	12.77	12.19	11.46
Polyester/wool	22.20	32.42	31.44	28.40
140°C	**1**	**2m**	**4m**	**6m**
Wool	20.22	33.72	27.63	27.51
Polyester	19.22	27.01	23.53	23.48
Polyester/Cotton	19.17	15.90	12.91	11.43
Polyester/wool	22.22	31.61	31.26	28.69
160°C	**1**	**2m**	**4m**	**6m**
Wool	20.22	36.33	33.50	33.10
Polyester	19.22	32.58	30.22	28.49
Polyester/Cotton	19.17	18.76	16.93	16.52
Polyester/wool	22.22	33.44	33.90	35.20

(Condition: 10 g/L lanolin as a binder- 2g/L pigment, 1.50 g/L thickener, 2g/L urea, and 0.25g/L diammonium hydrogen phosphate).

TABLE 3. Effect of lanolin concentration in the printing paste on the colour intensity of printed wool and polyester fabrics as well as polyester/wool and polyester/cotton blended fabrics on (fixation conditions: 160°C, for 2 min).

Lanolin concentration (%)	(K/S) of the printed fabric [a]			
	Wool	**Polyester**	**Polyester/wool**	**Polyester/cotton**
1	13.23	22.84	22.12	15.30
2	18.93	24.02	21.48	17.69
4	27.23	32.23	26.50	15.79
6	27.16	32.21	25.97	18.04

a: The K/S values of samples printed in presence of commercial binder for wool, polyester, polyester/wool, and polyester/cotton blended fabrics are 10.23, 20.84, 20.12, and 10.30; respectively.

TABLE 4. Effect of lanolin concentration as a binder in pigment printing of wool and polyester fabrics as well as polyester/wool and polyester/cotton blended fabrics in presence of lanoline as a thickener on some of its comfort attributes

Fabric	1 % lanoline			2% lanoline			4% lanoline			6% lanoline		
	AP[(a)]	UPF	Stiffness	AP[(a)]	UPF	Stiffness	AP[(a)]	UPF	Stiffness	AP[(a)]	UPF	Stiffness
Wool	55.1	730.7	1317 mg	55.1	2318.5	1317 mg	52.7	2185.8	1157 mg	54.3	458.9	2314 mg
Polyester	50.0	18.9	356 mg	340	18	373.8 mg	115	36.6	267 mg	125	37	124.6 mg
Polyester/ wool	80.9	66.7	1246 mg	43.5	372.1	1477.4 mg	36.8	38.9	1495.2 mg	38.2	44.3	1637.6 mg
Polyester/ cotton	72.9	78	445 mg	43.4	21.7	445 mg	46.2	28.7	462.8 mg	45.5	127	445 mg

(a) AP: Air permeability

Air permeability of printed wool, PET, PET/wool and PET/cotton with the commercial binder are 52.1, 46.0, 77.9, and 70.9; UPF of printed wool, PET, PET/wool and PET/cotton with the commercial binder are 700.7, 10.9, 60.7, and 70; Stiffness of printed wool, PET, PET/wool and PET/cotton with the commercial binder are 1229, 346, 1146, and 425; respectively.

TABLE 5. Effect of fixation time on the colour strength of microwave-fixed printed fabrics (microwave power level: 90)

Sample	Colour strength (K/S)					
	Covered inside MW for			Un-Covered inside MW for		
	2 min	4 min	6 min	2 min	4 min	6 min
	PET/Wool					
Before washing	24.5	26.82	27.65	24.27	28.44	27.82
After washing	21.68	21.13	23.14	23.84	24.83	23.34
	PET/Cotton					
Before washing	18.59	21.39	22.60	20.0	21.93	21.29
After washing	13.14	14.48	16.48	13.51	16.68	15.40
	Wool					
Before washing	25.62	28.39	29.47	28.01	29.12	29.01
After washing	22.17	23.03	26.97	26.47	28.37	28.47
	PET					
Before washing	19.12	20.51	21.02	21.10	24.08	22.14
After washing	14.31	14.72	19.09	15.21	18.38	14.27

TABLE 6. Effect of MW power level on the colour strength of microwave-fixed printed fabrics (4 min, uncovered).

Fixation time (min)	Colour strength K/S at a power level			
	60 %	70 %	80 %	90 %
	PET/Wool			
Before washing	24.10	27.75	29.44	28.44
After washing	21.61	24.72	25.80	24.83
	PET/Cotton			
Before washing	21.00	21.08	23.32	21.93
After washing	13.14	16.09	17.38	16.68
	Wool			
Before washing	28.42	28.76	30.82	29.12
After washing	27.09	27.84	28.89	28.37
	PET			
Before washing	21.37	22.54	24.31	24.08
After washing	15.32	16.40	19.28	18.38

The effect of the amount of lanolin (as a binder) within the printing paste on the colour intensity of the printed fabrics was studied and the results of this study were tabulated in Table 7. Data of this table implies that only in case of PET and PET/wool printed fabrics, as the concentration of lanolin increases (up to 6 %), the colour strength of the printed fabrics increases. The optimum concentration of lanolin within the printing paste was found to be 2% and 4% in case of PET/cotton and wool printed fabrics; respectively.

Lanolin versus commercial binder

To evaluate the efficiency of lanolin as a binder for pigment printing of textile fabrics, we compare the colour intensity of the printed fabrics in presence of lanolin as a binder to that obtained in case of using commercial binder; namely Printofix Binder MTB. Results of this study were, tabulated in Table 8, prove that lanolin can be used as a binder in pigment printing of textile fabrics with comparable efficiency to that of commercial binder.

Fastness properties

To assign their durability, the fastness properties of the printed fabrics towards washing, perspiration, and light were assessed. Results of this investigation, which is summarized in Table 9, reveal the following:

- The light fastness of the printed wool fabrics is excellent, the fastness of the same fabrics to perspiration is very good and that against washing is satisfactory. It is observed also that the fastness properties of the woolen fabrics printed in presence of 6 % lanolin is lower than those fabrics printed in presence of 1, 2, and 4 % lanolin.
- Similar trend was observed in case of printed wool/PET fabrics.
- The light fastness of the printed PET fabrics is adequate, fair towards perspiration and not satisfactory against washing.
- The trend is even worse in case of PET/cotton printed fabrics.
- Similar results were obtained in case of using the conventional method of thermo-fixation for the printed fabrics.

Fabric characteristics

The effect of adding lanolin as a binder in the printing paste for pigment printing of textile fabrics on some of their inherent properties; namely air permeability, ultraviolet protection factor (UPF), and stiffness was evaluated. Results of these analyses, summarized in Table 10 elucidate the following:

- The air permeability of wool fabric printed in presence of different amounts of lanolin as a binder is remarkably lower than that of unprinted wool.
- On the other hand, the air permeability of PET, PET/wool, and PET/cotton printed fabrics are higher than the corresponding unprinted samples.
- The UPF of all printed fabrics are higher than the respective unprinted samples. Moreover, the printed fabrics are stiffer than the unprinted ones.

TABLE 7. Effect of concentration of lanolin on the colour strength of printed fabrics fixed inside microwave oven (microwave power 80 %, fixation time 4 min, uncovered).

Fabric	Colour strength (K/S)			
	1 % lanolin	2 % lanolin	4 % lanolin	6 % lanolin
Wool	26.12	25.90	27.46	27.17
Polyester	10.78	12.06	13.25	14.3
Polyester/wool	21.34	21.55	21.95	25.14
Polyester/cotton	12.37	13.83	10.43	11.56

TABLE 8. Lanolin versus commercial binder (Printofix Binder MTB) in pigment printing of textile fabrics (Fixation inside MW in an uncovered vessel for 4 min at 80 % power).

Sample	Colour strength K/S	
	Lanolin	Commercial binder
PET/wool (6 % lanolin)	25.14	27.2
PET/cotton (2 % lanolin)	13.83	14.10
Wool (4 % lanolin)	27.46	29.1
PET (6 % lanolin)	14.35	15.7

TABLE 9. Fastness properties of microwave-fixed prints (using different lanolin concentrations as a binder) towards washing, perspiration, and light.

Lanoline Conc. %	Washing fastness		Perspiration				Light fastness
			Acidic		Alkaline		
	Staining	Alteration	Staining	Alteration	Staining	Alteration	
			Wool				
1	4	4	4	4	5	4-5	6-7
2	4	4	4	3-4	4	3	6
4	4	4	4	4	4	4	6-7
6	3	3	3	3-4	3	3	6
			Polyester/Wool				
1	3-4	3-4	4	4	4-5	4-5	6-7
2	3-4	3-4	2-3	3-4	4	3-4	6
4	3-4	3-4	2-3	3-4	4	3-4	6
6	3	2-3	3	3-4	3-4	2-3	5-6
			Polyester				
1	2-3	3	3	3	3-4	3	4-5
2	2-3	3	2-3	3	3	3	4-5
4	2-3	3	2-3	3	3	3	4
6	2-3	2-3	2-3	3	3	2-3	3-4
			Polyester/Cotton				
1	2-3	2-3	2-3	2-3	2-3	3	4
2	2-3	2-3	3	2-3	3	2-3	3-4
4	2-3	2-3	3	2-3	3	2-3	3-4
6	2-3	2-3	2	2-3	3	2-3	2-3

Fixation condition: normal thermo fixation: at 160□C for 2 min, while in MW irradiation at power level 80 for 4 min.

TABLE 10. Effect of pigment printing of textile fabrics using lanolin as a binder on some of their properties (fixation in microwave at a power level 80 for 4 min).

Fabric	Air permeability $cm^3/cm^2/S$				UPF				Stiffness (mg)			
	2 min	4 min	6 min	8 min	2 min	4 min	6 min	8 min	2 min	4 min	6 min	8 min
Wool(a)	50.5	49.2	50.8	54.3	303.8	519.0	497.2	176.1	1655	1602	1673	1495
PET(b)	67.9	128	109	110	13.4	13.8	14.3	15.0	374	356	374	249
PET/wool(c)	58.3	52.9	52.1	51.1	27.7	46.8	35.2	42.0	1602	1352	1655	1797
PET/cotton(d)	51.1	53.5	58.8	58.2	24.4	26.5	24.4	16.8	427	409	427	445

(a) The air permeability, UPF, and stiffness of untreated wool fabrics are 69.7, 223.8, and 1122.4, respectively.
(b) The air permeability, UPF, and stiffness of untreated PET fabrics are 57.9, 6.6, and 298.8, respectively.
(c) The air permeability, UPF, and stiffness of untreated PET/wool fabrics are 32.3, 12.7, and 908, respectively.
(d) The air permeability, UPF, and stiffness of untreated PET/cotton fabrics are 30.1, 12.4, and 336.3, respectively.

Conclusion

In this work, we introduce wool wax (lanolin) as a possible candidate in textile pigment printing, and hence enhance its added value. Lanolin was successfully used as a binder in pigment printing of wool, polyester, polyester/wool and polyester/cotton fabrics with adequate colour strength and fastness properties if compared with a commercial binder.

Compared to the respective conventional methods, utilization of microwave irradiation in extraction of wool wax from raw wool fleece as well as in fixation of prints on some textile fabrics would lead to saving material, time and energy used in these processes and consequently would result in a reduction in the total cost.

The comfort attributes of the fabrics printed in presence of lanolin as a binder is satisfactory and match with those of the corresponding fabrics printed in presence of commercial fabrics.

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إستغلال اللانولين في طباعة المنسوجات بصبغات البيجمنت بمساعدة أشعة الميكروويف

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إن الاستخدام الأمثل لشحم الصوف، الذي يتم التخلص منه عادة في معظم انحاء العالم بعد عمليات غسيل الصوف الخام، له أهمية قصوى من الناحية البيئية والاقتصادية. لذا يهدف هذا العمل إلى إستخلاص شحم الصوف من الصوف الخام باستخدام طرق تسخين محتلفة (التسخين التقليدي، وبأستخدام أشعة الميكروويف). ولدراسة تأثير هذه الطرق المختلفة في التسخين، تم استخدام تركيزات مختلفة من اللانولين كمادة ربط في طباعة الأقمشه المختلفة مثل الصوف، والبولي إستر بالآضافة الي مخلوط من بولي إستر/صوف (٣٥/٦٥) وبولي إستر/قطن (٣٥/٦٥) باستخدام تقنية الشاشة الحريرية. كما تم عمل تثبيت للأقمشة المطبوعة بإستخدام التسخين التقليدي أو بأشعة الميكروويف. كما تمت دراسة تأثير العوامل المختلفة علي عملية استخلاص اللانولين وكذلك تثبيت كل الأقمشة المطبوعة تحت تأثير إشعة الميكروويف مثل التركيز، زمن التفاعل، درجة حرارة التفاعل وقدرة الميكروويف. كما تم عمل القياسات اللونية مثل شدة نفاذية الضوء (K/S) وخواص الثبات (ضد الغسيل، الضوء، العرق، والاحتكاك). كما تم تقييم زاوية التلامس الرطبة، ودرجة الحماية من الأشعة فوق البنفسجية، الصلابة، ونفاذية الهواء للأقمشة المطبوعة ومقارنتها مع العينات المطبوعة بأستخدام مادة ربط تجارية بدلاً من اللانولين.

وقد أظهرت نتائج هذه الدراسة أن درجة شدة وثبات اللون للأقمشة المطبوعة بإستخدام اللانولين كمادة ربط تشبه تلك الأقمشة المطبوعة في وجود مادة ربط تجارية وذلك سواء عند تثبيت الطباعة بالطريقة التقليدية أو بإستخدام أشعة الميكروويف. ويستثنى من ذلك درجة ثبات اللون ضد الإحتكاك للأقمشة الطبوعة في وجود اللانولين والتي تعتبر أسوأ من تلك الأقمشة المطبوعة في وجود مادة البربط التجارية.