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Antimicrobial Fabrics Using *Conocarpus erectus* Aqueous Extract

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IN the current study, the aqueous extract of the shoots of *Conocarpus erectus* L. (Combretaceae family), was found to be rich in tannins,flavonoids and other phenolics. It showed good inhibitory activity against all tested Gram positive bacteria with zones of inhibition range from 11 to 15 mm at 2000 µg concentration. The appropriateness of wool and nylon fabrics with *Conocarpuserectus* L. extract using pigment printing technique has been discussed. The effect of different laborers as extract concentration, thickener type, pH, fixation type and mordant type has been investigated. The prints were estimated by measuring color strength (K/S) value and the overall fastness properties. The results exhibited that K/S of the prints increases with extract concentration increases from 10 to 40 ml/100 g printing paste. The highest K/S was obtained by using Meypro gum as a thickening agent. Furthermore, K/S of the fixed prints by steam-fixation for 30 min was higher than those in case of thermo-fixation. Use the mordant in the printing paste has no apparent effect on the K/S values, overall fastness properties were ranging between very good and excellent. Printed fabrics have antibacterial activity especially against Gram +ve bacteria.

Keywords: Tannin, Antimicrobial, Flavonoids, Natural fabrics.

Introduction

Addition antibacterial activity to the fabrics can be achieved by nano-metals [1-8] and natural materials [9-12].

Medicinal plants have attracted great attention as important source of bioactive products. They serve human beings as valuable components of dyes, cosmetics and pharmaceuticals. *Conocarpuserectus* L. (Combretaceae family), commonly known as buttontree or buttonwood, used in traditional medicine forefever, catarrh, diabetes, conjunctivitis, anemia and diarrhoea [13]. It was reported that the methanol extracts of the different parts of this plant exhibit High antioxidant, antibacterial and anti-cancer activities [14]. Chemically, the plant is characterized by the presence of flavonoids and other phenolics, especially tannin compounds [15].

The utilization of natural dye in the dyeing or printing has become an urgent necessity because of its natural features, sourced from natural, environmentally friendly and have no damage to the human [16]. So scientists extract these pigments from plants. Turn some scientists to use plants can have activity against bacteria growth [14].

This research aims to establish the possibility of using *Conocarpus erectusaqueous* extract as a natural dye resource in pigment-printing of wool and nylon fabrics. Also, the antibacterial activity of the extract and prints is evaluated.

Material and Methods

Materials

Dye

Conocarpus erectus extract and used as a pigment colour.

Fabrics

Mill-scoured wool fabric (100%) supplied by Misr company for spinning and weaving, Mehalla El-Kubra, Egypt.Nylon: Mill-scoured natural silk fabric supplied by Hussein M. El-Khatib Sons Co., Suhag, Egypt.

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Mordants

Aluminum-ammonium sulphate ($NH_4Al(SO_4)_2$. $12H_2O$, Copper sulphate ($CuSO_4$), Ferrous sulphate ($FeSO_4$),Potassium dichromate ($K_2Cr_2O_4$) and Tannic acid ($C_{14}H_{10}O_4$).

Thickening agent

High viscosity sodium alginate was supplied by Ceca colloid chemie, France and used at 3% concentration.

Meypro gum NP-16 (Meyhall), which is a non-ionic thickening agent based on modified plant seed gum, was used at 8% concentration.

Synthetic thichener, Daicothick was kindly supplied by Daicocompany, Cairo, Egypt and was used at 3% concentration.

Binder DB

It was kindly supplied by Daico Company, Cairo, Egypt.

Other chemicals

Urea and Diammonium phosphates were of laboratory grade chemicals.

Plant material and extraction

The shoots of *Conocarpuserectus* L. were collected from Hurghada, Egypt. The air dried and powdered plant material (500 g) was extracted exhaustively by water (1L). The aqueous extract was concentrated under reduced pressure to 500 ml. The two dimensional paper chromatography of the aqueous alcoholic extract using two solvent systems (butanol: acetic acid: water "4:1:5") and (15% acetic acid) and visualizing the spots under UV light and spraying with different spray reagents (ammonia and $FeCl_3$ reagents) revealed the presence of several flavonoids and other phenolic compounds. Also, dilute ammonia solution was added to a portion of the aqueous extract followed by addition of concentrated H_2S0_4 showed a yellow colour, indicating the presence of flavonoids [17]. 1 ml $FeCl_3$ solution was added to the aqueous acidified extract giving blue color, indicating the presence of tannins [18].

Preparation of printing paste

The pastes used for application of dye extract as a pigment color in printing were prepared as follows:-

Dye extract--------------------------Yg
Binder HD --------------------------70 g
Diammonium phosphate----------12.5 g
Thickener----------------------------360 g
Urea-----------------------------------40 g
Mordant ----------------------------20 g
Water ---------------------------X g

Total 1000 g

Printing technique

All the pastes were applied to the fabrics through flat screen by traditional technique

Fixation

After printing and drying, the printed goods were subjected to fixation either by steaming at 102 ^oC for 20, 30, 40 min. or thermo-fixation at 140,150 and 160 ^oC for 4 min. in mini-thermo oven (Roaches, England).

Washing

Washing process of the prints after fixation was carried out through four stages: 1)rinsing thoroughly with cold water, 2) washing with hot water, 3) soaping using 2g/l non-ionic detergent namely HosptalCV-ET at 60°C for 15 minutes, and 4) washing with hot water followed by cold water to remove the unfixed dye and finally air drying.

Testing and analysis

Color strength (K/S) and fastness

The color strength of the printed samples expressed as K/S and the overall fastness properties (washing, perspiration and rubbing) were assessed according to standard methods [19, 20].

In-vitro antimicrobial assay

Antimicrobial activity of the aqueous extract of the shoots of *Conocarpuserectus* was screened in-vitro by the agar diffusion technique according to [21]. Four different concentrations of the plant extract were prepared and individually tested against Gram positive bacteria (*Bacillussubtilis* ATCC6633, *Staphylococcusaureus* ATCC29213, *Lactobacilluscereus* ATCC14579), Gram negative bacteria (*Escherichiacoli* ATCC 25922, *Pseudomonas aeruginosa* ATCC27953) and fungi (*Candidaalbicans* ATCC 10321, *Aspergillusniger* NRC36, *Fusariumsolani* NRC15). Bacteria and yeast strains are American Type Culture Collection, and fungal isolates were obtained from the culture collection of the Department of Chemistry of Natural and Microbial Products, National Research Center, Cairo, Egypt. Filter paper discs (6 mm in diameter) saturated with the extract at the following concentrations (2000, 1000, 500 and 250 µg /5µL DMSO/disc). The drugs Thiophenicol and Treflucan were used as positive controls for antibacterial and antifungal activities, respectively at 50 µg/disc concentration. DMSO showed no inhibition zone used as a negative control. All the prepared discs were placed on the surface of each inoculated plate, at the concentrations of 1×10^6 spores^{-ml} of fungi (potato dextrose agar medium) and 1×10^8 spores^{-ml} of bacteria (nutrient agar medium). The plates incubated for 24 h at 30 ºC for bacteria and 72 h at 28 ºC for fungi. After this period, the observed inhibition zone around the disc measured in millimeters (mm) and compared with that of the controls.

Minimal inhibitory concentration (MIC) measurement

The aqueous extract of the shoots of *C. erectus* showed antimicrobial activity against Gram positive bacteria was later tested to determine the Minimal Inhibitory Concentration (MIC) for each bacterial sample, in comparison with the control drug. The lowest concentration showing inhibition zone around the disc was taken as (MIC).

Antibacterial activity of prints

Antibacterial test was quantitatively evaluated against *Escherichia coli* (Gram−ve) and *Staphylococcus aureus* (Gram+ve) bacteria. The antibacterial activity of the treated fabrics is performed as follow; squares of 1 cm of each fabric were prepared in an aseptic manner. Each square was placed in a sterile vial and the fabrics were pre-treated with 800 µl distilled water for 10 min. Tryptone soy broth (2.2 ml) was added to each vial to make a total volume of 3 ml. An aliquot (10 µl) of *S. aurous/E. coli* suspension was added to each fabric-containing vial (1.6 × 103/ml). Control broth with/without bacterial inoculation was also included. The vials were then incubated with agitation at 35◦C, 220 rpm. Aliquots of 10 µl broth were sampled at 24 h and serial dilution for the aliquots was prepared in broth. Duplicate aliquots (50 l) of the serially diluted samples were spread onto plates. The plates were incubated at 35◦C and bacterial counts were performed. The bactericidal activity was evaluated after 24 h and the reduction percentage of bacteria was calculated by the following equation:

$$R(\%) = \frac{(A-B)}{A} \times 100$$

where R = the reduction rate, A = the number of bacterial colonies from untreated fabrics, and B = the number of bacterial colonies from treated fabrics(1).

Results and Discussion

Conocarpuserectus extract was found by the phytochemical investigation to be rich with flavonoids, tannins and other phenolics. The antimicrobial potential of *Conocarpuserectus* extract was presented in Tables 1 and 2. Results revealed that the extract showed good inhibitory activity against all tested Gram positive bacteria with zones of inhibition range from 11 to 15 mm at 2000 µg concentration and the inhibitory effect decreased directly with decreasing the extract concentration. The minimum inhibitory concentrations (MIC) of the extract against *B. subtilis* ATCC6633, *S. aureus* ATCC29213 and *L. cereus* ATCC14579 were 500, 500 and 250µg respectively, in comparison with the positive control drug. The degree of susceptibility of the tested Gram positive bacteria to the extract can be arranged as the following order *L. cereus* > *S. aureus*> *B. subtilis.* Results also indicated that, the plant extract did not show any anti-microbial activity against Gram negative bacteria and fungi.

Effect of dye extract concentration

Figure 1 showed the effect of dye extract concentration (10-50%) on color strength of the printed wool and nylon fabrics (K/S), the printing process was carried out in presence of synthetic thickener in printing paste at pH 7 and steam fixation.

From Fig. 1 it is clear that color strength value of printed wool and nylon samples increases until 9.84 and 5.02 respectively by increasing dye extract concentration at pigment printing paste up to 40%, after this concentration K/S value decrease. This behavior may be due to a) hydrogen bond formation between phenolic compounds hydroxyl group in *Conocarpuserectus* extract and amino and amido groups of wool and nylon molecule, b) combination between anionic and cationic groups in tannins compounds in *C.erectus* extract and protein molecule in the fabrics, c) interaction between any quinine groups in present tannins and any suitable reactive groups in the proteins which exist in fibre molecule and d) dye quantity in the extract increases by increasing dye extract concentration until 40% followed by increasing in the migrated dye to the printed surface after fixation, by increasing dye extract concentration to 50% the printing paste viscosity decreases and the quantity of printing paste attached with the fabric surface will be reduced.

TABLE 1. Antimicrobial activity of plant extract through agar diffusion method.

Entry	Different conc (µg /5µL DMSO/disc)	Inhibition zone diameter (IZD) (mm)							
		Gram positive bacteria			Gram negative bacteria		Fungi		
		B. subtilis **ATCC 6633**	***S. aureus*** **ATCC 29213**	***L. cereus*** **ATCC 14579**	***E. coli*** **ATCC 25922**	***P.aeruginosa*** **ATCC 27953**	***C.albicans*** **ATCC 10321**	***A.niger*** **NRC 36**	***F.solani*** **NRC15**
Plant extract	2000	11	12	15	N.A.	N.A.	N.A.	N.A.	N.A.
	1000	8	9	11	N.A.	N.A.	N.A.	N.A.	N.A.
	500	7	8	9	N.A.	N.A.	N.A.	N.A.	N.A.
	250	N.A	N.A	7	N.A.	N.A.	N.A.	N.A.	N.A.
Thiophenicol	50	20	15	17	10	9	N.A.	N.A.	N.A.
Treflucan	50	N.A.	N.A.	N.A.	N.A.	N.A.	8	13	11

N.A.: No activity (absence of susceptibility).

TABLE 2. Minimal inhibitory concentration of plant extract against Gram positive bacteria.

Entry	Inhibition zone diameter (IZD)(mm)							
	Gram positive bacteria			Gram negative bacteria		Fungi		
	B. subtilis **ATCC 6633**	***S. aureus*** **ATCC 29213**	***L. cereus*** **ATCC 14579**	***E. coli*** **ATCC 25922**	***P.aeruginosa*** **ATCC 27953**	***C. albicans*** **ATCC 10321**	***A.niger*** **NRC 36**	***F.solani*** **NR C15**
Plant extract	500	500	250	-	-	-	-	-
Thiophenicol	6.25	6.25	3.13	25	25	-	-	-

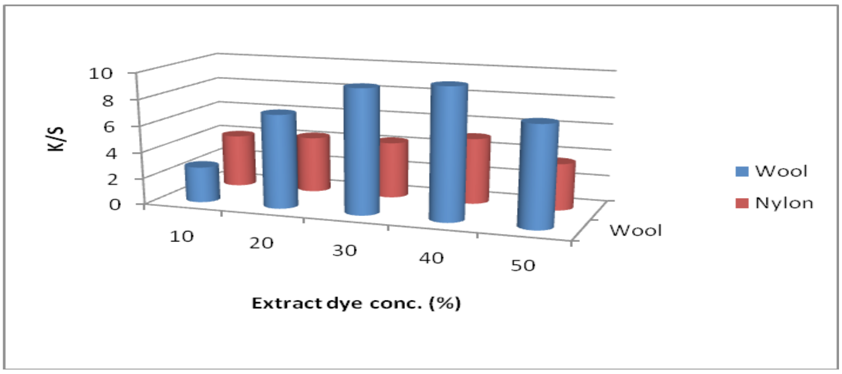


Fig.1. K/S dependence on dye extract concentration.

Effect of thickening agent used type

To study the effect of type of thickening agent used on the color strength of printed wool and nylon fabrics must be different printing pastes prepared with different thickeners as synthetic thickener based on acrylate, sodium alginate and lastly Meypro gum at dye extract concentration 40% and pH 7.0. The printed samples dried at ambient temperature followed by steam fixation. The resulted data appear in Fig. 2.

It is display from Fig. 2 that K/S value of the printed fabrics exceeded in case sodium alginate and Meypro gum than those in case synthetic thickener regardless fabric type used. The highest value of K/S of printed wool and nylon fabrics was obtained with Meypro gum as thickener; K/S value followed the order as follow :

Meypro gum > sodium alginate > synthetic thickener. This behavior may be attributed to Meypro gum paste stability to the printing conditions, printing components and steam fixation conditions.

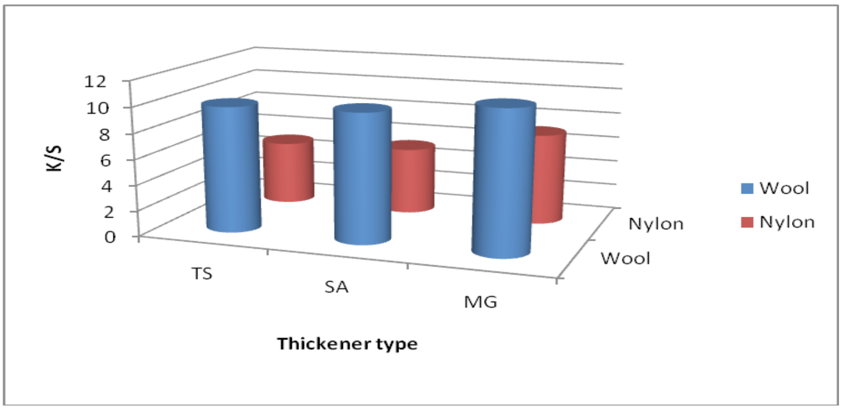
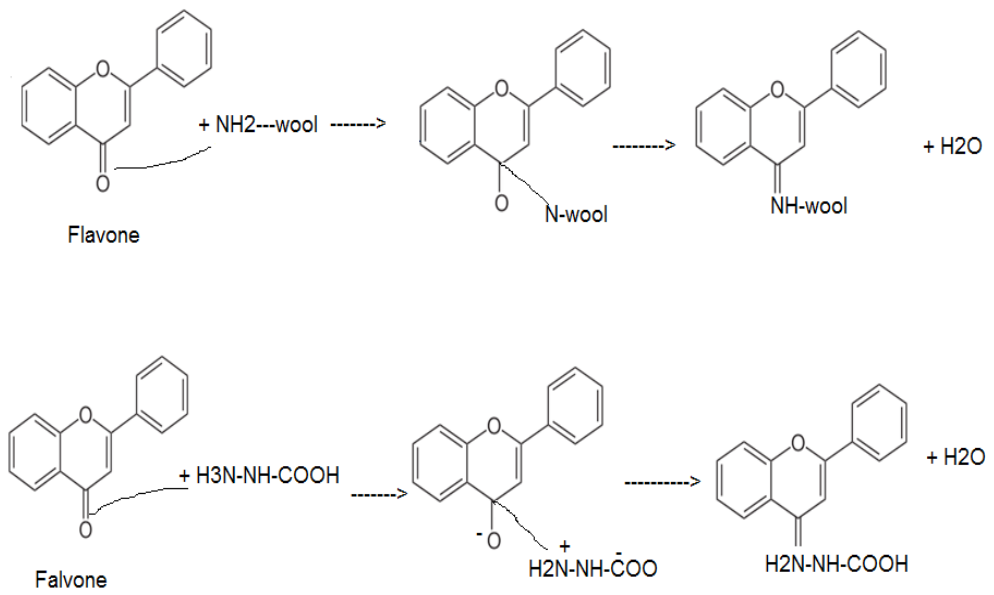


Fig.2. Type of thickener effect on K/S of printed fabrics.
(TS: synthetic thickener, SA: sodium alginate, MG: Meypro gum)

Effect of pH of printing paste

Use of natural dye in printing or dying like synthetic dye, so study the effect of printing paste pH (alkaline, neutral and acidic) was wanted and effective in case natural dye. Figure 3 shows the influence of pigment printing pH (3, 5, 7, 9 and 11) on K/S of printed wool and nylon fabrics. The printing paste consists of 40 % concentration of dye extract and Meypro gum as a thickener. The printed goods fixed by steam fixation.

From the data of Fig. 3 it was concluded that color strength (K/S) significant increase with printing paste pH increase. By increasing pH, dye quantity that transferred to the fabric surface increase, so color depth became more powerful. In acidic pH color depth value was low and increase significantly by increasing pH from 3 to 9, after pH 9 no further increase. The obtained results may be due to the structure feature of fibers and dye, at low pH positive charge was formed on colorant which repulsed with positive charge that on fiber surface. On the other hand, at pH higher than 7 negative charges are formed on wool and nylon fibers which formed ionic bond with colorant. Mechanism of reaction between fiber and dye may be distinguished as follow :



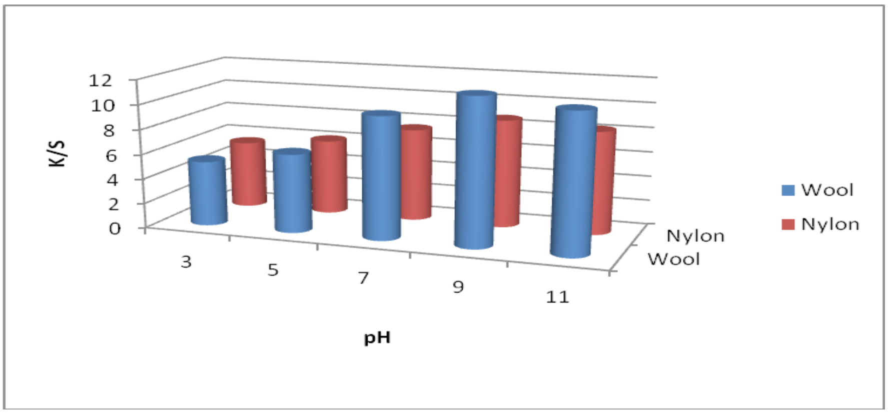


Fig.3. effect of printing recipe pH on printed fabrics K/S.

Effect of fixation technique

Figure 4 illustrates the effect of fixation technique on K/S of printed wool and nylon fabrics. The printed paste thickened by Meypro gum which contains 40% of dye extract was prepared, and pH adjusted at 9. The printed samples were then dried at room temperature followed by fixation through using two methods, thermo-fixation at 140,150 and 160^{0}C for 4 min., and steaming at 100^{0}C for 20, 30 and 40 min.

It is seen from results that, a) as generally the color strength (K/S) of printed fabrics which fixed by steaming was significantly higher than those fixed with thermo-fixation process regardless fabric type. This probably due to water vapor condensation on the printed samples surface which leads to more penetration for dye molecules inside the fabric and hence K/S increases, b) K/S of the printed fabrics depends on time of steaming, C) the highest value of k/S(11.78 and 7.61) is obtained at 30 min. of steam-fixation for printed wool and nylon fabrics respectively, and D) K/S of the printed samples relies on thermo-fixation temperatureand the highest value of samples (7.96 and 6.85) were achieved at 150^{0}C for printed wool as well as nylon separately.

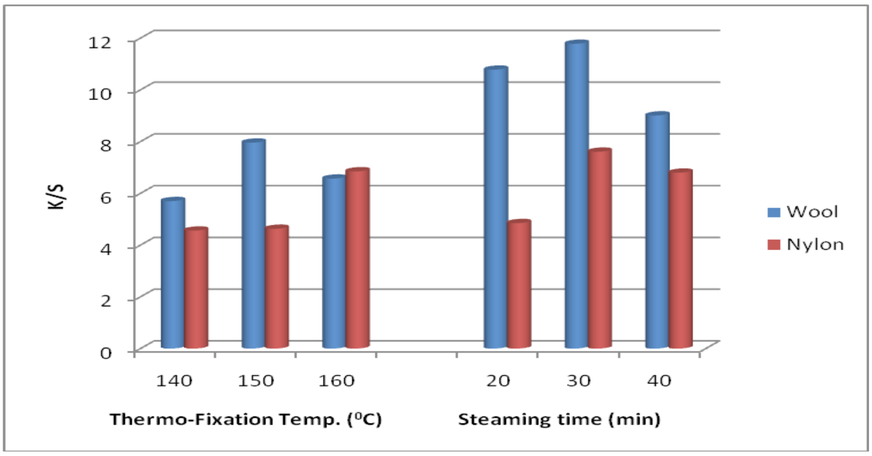


Fig.4. Dependence of K/S on fixation type.

Effect of fabric type

Figure 5 shows the effect of fabric used type on K/S of pigment printed fabric. The printing paste contains 40% concentration of extract dye;Meypro gum as thickening agent, pH of the printing paste is 9 and the printed fabric fixed by steaming for 30 min.

It is obvious that K/S value of the printed woolen fabrics is higher than printed nylon fabric. This may be due to number of active centers on wool fabric surface more than on nylon fabric surface.

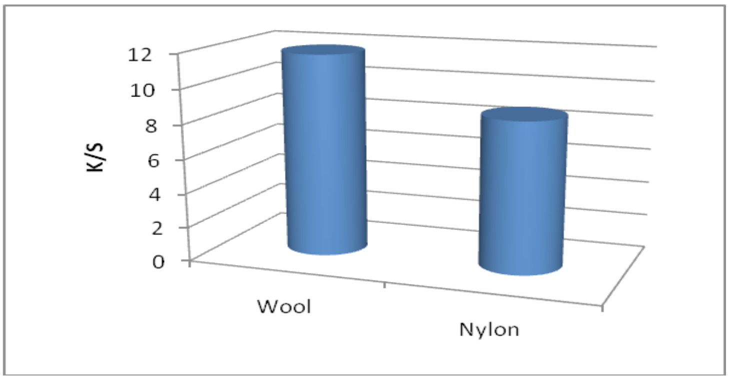


Fig. 5. dependence of printed fabrics K/S on fabric type.

Effect of Mordant type

In the previous work, scientists have been reported that using of mordants with natural dyes in dyeing and printing process has some advantages or lead to improve fastness properties of the fabrics [22].

To study the effect of mordanting with different mordants as Aluminum-ammonium sulphate (M1), Copper sulphate (M3), Ferrous sulphate (M4), Potassium dichromate (M5) and Tannic acid (M2) on the K/S of the printed samples, printing paste was prepared by using Meypro gum 600 g/kg as a thickener , Dye extract concentration 400 ml/kg , Binder HD 100 g, diammonium phosphate 12.5 g/kg, urea40 g/kg and mordant 20g/kg pH of printing paste adjusted at 9. Resulted samples were subjected to steam-fixation at 100 ^{0}C for 30 min.

Table 3 shows that, increasing for K/S of the printed mordanted wool, Nylon fabrics in presence of Aluminum-ammonium sulphate and Tannic acid as a mordant, and vice versa in case of other mordants. The K/S values follow the order: Aluminum-ammonium sulphate > Tannic acid > Cupper sulphate > Ferrous sulphate > potassium bicarbonate .Highest k/S in presence of aluminum salt as a mordant may be lies to formation weak coordinate bonds between mordant anddye by lifting free groups in dye molecule which react with fiber [22]. In case tannic acid as a mordant the enhancement in K/S of printed protein fabrics could be referred to formation of hydrogen bond between free amino and amido groups of proteins and phenolic hydroxyl groups of *Conocarpuserectus* extract, on the other hand formation ionic bond between cationic groups on the protein molecule and anionic groups of the tannins [23].

TABLE 3. Dependence of colour strength, colour data of dried and steamed printed fabrics on used mordants.

Fabric type	Mordant type	K/S	L*	a*	b*	ΔE
Wool	0	11.78	59.64	11.68	15.67	0
	M1	12.13	46.96	3.81	11.52	35.08
	M2	11.1.	41.64	4.05	15.15	40.77
	M3	9.96	44.03	4.74	17.68	38.77
	M4	7.74	43.44	5.41	6.15	38.26
	M5	6.57	54.11	4.81	9.70	28.11
Nylon	0	8.73	50.21	9.82	9.42	0
	M1	9.16	41.29	4.85	16.85	41.52
	M2	10.81	43.75	5.36	16.83	39.72
	M3	5.14	61.72	5.13	9.26	20.56
	M4	3.39	63.57	3.10	4.13	22.56
	M5	5.29	53.72	5.33	20.34	30.58

Colour data (L*, a*, b* and ΔE) in Table 3 revealed that, L* values of the printed and mordanted, with aluminum salt and tannic acid, fabrics decreased than those in case of unmordanted fabrics. This means that the dark shade is achieved and accepted with k/S values. A decrease of a* and b* values mean a less reddish and yellowish shade respectively. The higher ΔE values were obtained in case of using aluminum salt and tannic acid. The auxochromic groups (OH and COOH) in phenolic compounds in *Conocarpuserectus* extract were able to complex compounds formation, depending on these group number suitable for forming complexes with mordant metal ions and combined with the fabric via hydrogen bonding.

From Table 4 results, it can be noticed that K/S and colour data values of investigated fabrics which printed by the printing paste, with all its ingredients after storing for three days, marginally increase as a result printing paste stability for storing and may be no reaction between active groups in the extract and printing paste ingredients.

TABLE 4. Dependence of color strength, colour data of dried and steamed printed fabrics on used mordants after storing.

Fabric type	Mordant type	K/S	L*	a*	b*	ΔE
Wool	0	11.78	59.64	11.68	15.67	0
	M1	12.02	52.59	4.55	17.33	30.48
	M2	11.06	41.34	3.12	13.08	40.43
	M3	10.10	61.02	3.86	8.41	15.13
	M4	7.84	40.15	3.55	6.14	41.30
	M5	6.67	51.53	3.66	17.88	31.50
Nylon	0	8.73	50.21	9.82	9.42	0
	M1	9.01	55.84	3.75	8.00	25.95
	M2	10.21	57.23	3.28	6.64	24.58
	M3	5.01	51.53	4.23	25.46	34.86
	M4	3.99	53.39	2.17	4.59	31.19
	M5	5.31	57.25	4.17	12.48	33.11

Table 5 represented the overall fastness properties of the printed fabrics with optimum conditions (Meypro gum 60 %, extract concentration 40%, with and without mordant, pH 9). All prints fixed by steaming for 30 min. at 100 ^{o}C. It is clear that all fastness properties of the mordanted and non-mordanted prints were between very good and excellent. After storing for printing paste no significant effect on overall fastness properties as it is evident in Table 6.

TABLE 5. Effect of used mordants on overall fastness properties of dried and steamed printed fabrics.

Fabric type	Mordant type	Washing fastness		Rubbing fastness		Perspiration fastness			
						Acidic		Alkaline	
		Alt	St	dry	wet	Alt	St	Alt	St
Wool	0	4-5	4-5	4-5	4	4-5	4-5	4-5	4
	M1	4-5	4-5	4	3-4	4-5	4-5	4-5	4
	M2	4-5	4-5	4	3	4-5	4-5	4-5	4
	M3	4-5	4-5	4	3	4-5	4-5	4-5	4
	M4	4-5	4-5	4-5	3	4-5	4-5	4-5	4
	M5	4-5	4-5	4-5	4	4-5	4-5	4-5	4
Nylon	0	4-5	4-5	4	4	4-5	4-5	4-5	4
	M1	4-5	4-5	4-5	4	4-5	4-5	4-5	4
	M2	4-5	4-5	4	3	4-5	4-5	4-5	4
	M3	4-5	4-5	4-5	4	4-5	4-5	4-5	4
	M4	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4
	M5	4-5	4-5	4-5	4	4-5	4-5	4-5	4

Alt: Alteration , St: Staining on cotton.

TABLE 6. Effect of used mordants on overall fastness properties and color strength of dried and steamed printed fabrics after storing.

Fabric type	Mordant type	K/S	Washing fastness		Rubbing fastness		Perspiration fastness			
							Acidic		Alkaline	
			Alt	St	dry	wet	Alt	St	Alt	St
Wool	0	11.78	4-5	4-5	4-5	4	4-5	4-5	4-5	4
	M1	12.02	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4
	M2	11.06	4-5	4-5	3-4	3	4-5	4-5	4-5	4
	M3	10.10	4-5	4-5	4	4	4-5	4-5	4-5	4
	M4	7.84	4-5	4-5	4	3	4-5	4-5	4-5	4
	M5	6.67	4-5	4-5	4	3	4-5	4-5	4-5	4
Nylon	0	8.73	4-5	4-5	4	4	4-5	4-5	4-5	4
	M1	9.01	4-5	4-5	4-5	4	4-5	4-5	4-5	4
	M2	10.21	4-5	4-5	4	3	4-5	4-5	4-5	4
	M3	5.01	4-5	4-5	4-5	4	4-5	4-5	4-5	4
	M4	3.99	4-5	4-5	4	3	4-5	4-5	4-5	4
	M5	5.31	4-5	4-5	4	4	3-4	4-5	4-5	4

Alt: Alteration , St: Staining on cotton

Finally, from the above results it can be consummated that *Conocarpuserectus* extract can be applied successfully as a natural dye without mordants in pigment- printing technique with suitable fixation conditions, because it has compounds as tannins and flavonides which played mordant role.

Antibacterial Activity of Printed Fabrics

Table 7 shows the antibacterial properties (bacterial reduction) of printed fabrics with *Conocarpus* erectus extract. This evaluation applies to untreated/treated fabrics. Results of Table 6 show that, regardless of the *Conocarpuserectus* extract concentration, the reduction of bacterial colonies was positive for *E. coli* and negative for *S.aureus*. By increasing the extract concentration in the printing paste, bacterial reduction percent increase. This trend agrees with tables 1and 2 results. After washing no significant decrease in reduction percent of *E.coli* as a result of the presence of thebinder into the printing paste.

TABLE 7. Antibacterial activity of printed fabrics towards Gram +ve and Gram –ve bacteria.

Extract con. (g/kg)	Reduction percent (%)			
	Before washing		After washing	
	E.coli	*S. aureus*	*E.coli*	*S. aureus*
10	20	--	17	--
20	30	--	26	--
30	40	--	37	--
40	60	--	55	--
50	75	--	71	--

Conclusion

The *Conocarpuserectus* extract has antibacterial activity particularly Gram +ve bacteria. The potentiality of utilizing extract of *C. erectus* plant in pigment printing technique as a dye resource has been studied. Previous tests have proved that it (extract) gave good results in pigment printing, Mypro gum was the most suitable thickening agent in terms of the depth of color values. The results also revealed that steam-fixation at 100 ^{o}C for 30 min. was more efficient and gave higher K/S value than thermo-fixation. Printing in presence of mordant is not much better than the printing in the absence of mordant. The prints overall fastness properties ranged from very good to excellent. Bacterial reduction percent of the printed fabrics for *E.coli* increased by increasing extract concentration.

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أقمشة مضادة لنمو البكتيريا باستخدام مستخلص نبات الكونوكاربس إركتس

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في هذا البحث اهتم المؤلف بدراسة ومعرفة مدى قابلية استخدام مستخلص نبات الكونوكاربس اركتس كمادة مضادة لنمو البكتيريا وبالتالي يتم استخدامه في انتاج أقمشة مطبوعة مقاومة للبكتيريا. أوضحت النتائج أن هذا المستخلص مضاد لنمو البكتيريا موجبة الجرام. تم استخدام هذا المستخلص في طباعة البجمنت لأقمشة الصوف والنايلون كمكون من مكونات عجينة الطباعة , تم دراسة مدى تأثيره على خواص الثبات للأقمشة تحت البحث مثل الثبات للغسيل- الثبات للعرق بنوعيه- الثبات للإحتكاك وعمق اللون. وتم دراسة تأثير العوامل المؤثرة على خواص عجينة الطباعة مثل تركيز المستخلص- نوع المتخن- درجة حموضة الوسط -نوع التحميص ونوع المثبت وذلك من خلال قياس عمق اللون للأقمشة المطبوعة. أظهرت النتائج أن أنسب الظروف لعملية الطباعة ومحتويات عجينة الطباعة كالتالي: تركيز المستخلص ٤٠٠ ملم/كيلو من عحينة الطباعة ، نـــوع المتخن ميبروجم ، الومونيوم آمونيوم سلفات ٢٠ جم/ كيلو كمثبت ، درجة حموضة الوسط ٩ وأخيرا تم استخدام التحميص الحراري في عملية التحميص. تم الطباعة أيضا في عدم وجود مثبت في عجينة الطباعة وبينت النتائج أن عدم وجود مثبت أعطى نتائج قريبة جدا من في حالة وجود مثبت. وتم عمل اختبار مقاومة نمو البكتيريا للأقمشة المطبوعة بعجينة طباعة تحتوي على تركيزات مختلفة من المستخلص وبينت النتائج ان الأقمشة لها مقاومة جيدة لنمو البكتيريا موجبة الجرام.