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Eco-Friendly Technology for Textile Printing Using Innovative Self Printing Paste

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TARA SEEDS were subjected to mechanical crushing sieving and soaking in water followed by filtration to obtain galactomannan gum. Rheological properties of this gum were investigated before and after the gum was treated with sodium hydroxide (0. 5 to 10%).

Experience gained from this study was used to concurrently isolate eco-friendly galactomannan gum and safety natural dye from Tara seeds in one step process. Evaluation was made of the obtained self printing paste for printing cotton, wool and silk fabrics in presence and absence of different mordants. It was found that pastes of Tara gum treated with sodium hydroxide at a range of 0.5 to 2 % exhibit non-Newtonian pseudo plastic behavior, whereas the latter is converted at higher alkali concentrations to non- Newtonian Thixotropic behavior; similar to pastes prepared from the untreated gum. The colored printing paste, which was isolated from Tara seeds, could successfully be used in printing of silk, wool and cotton fabrics without any additives, but the shade was only confined to one color. It was also found that the K/S values of silk and wool are practically equal meanwhile they are higher than that of cotton. Mordants enhance printing and create different colors, depending upon their nature. For example the K/S of printed cotton samples displays the highest value with tannic acid and the lowest with alum and follows the order: tannic acid > copper sulphate > ferrous sulphate > potassium dichromate > alum ; an order which is also valid for wool and silk fabrics.

Fabrics printed by the self printing paste acquire color fastness to rubbing, to washing, and to perspiration ranging from very good to excellent, besides, resistance of the prints to alkali treatment.

Keywords: Tara gum, Self printing paste, Mordants, Cotton, Wool and Silk.

Textile printing involved in textile industry pollutes heavily the water due to unfixed color , thickening agent, and other ingredients of the printing paste which are washed off the fabric into waste -water[1,2,3], Concern for environment has, therefore, created an increasing interest in natural dyes. It is believed that natural dyes are more friendly to the environment than synthetic dyes[4], and many discussions have been made on this subject[5-8]. As a result, the coloring of textiles with dyes from plants and other natural products receive -nowadays- increasing attention[9-11].

Recently the structure of galactomannan, their applications and environmental aspects were studied[1-3,8]. It has been reported that galactomannan gums are more environmentally suitable than sodium alginate[1] . This has evoked our interest in carrying out a thorough investigation into the galactomannan gums isolated from Tara seeds. Tara seeds are composed of three components, namely, hull, endosperm and germ. They contain both eco-friendly galactomannan gum and eco-friendly natural color.

With the above in mind, current work was undertaken to isolate both the galactomannan gum and natural dye from Tara seeds simultaneously in one step process. The so isolated colored gum was evaluated as self printing paste for printing cotton, wool and silk fabrics. Printing was also carried out in presence of different mordants.

Experimental

Plant seeds

Dry clean seeds of tara were obtained from tara shrub. They were kindly supplied by EL-Khawaga Farm at EL-Khatatba, Menufia. The seeds composing of hull, endosperm, and germ were obtained from ripe pods[12]. The latter is rich in pyrogallol tannin. The gum is collected in the endosperm and composed mainly of galactomannan; the molar ratio of mannose to galactose is 3:1[12-14].

Substrates

Cotton fabric

Mill desized, scoured and bleached poplin cotton fabric (140 g/m^2) produced by Misr/ Helwan for Spinning and Weaving Company was used throughout the present work.

Natural silk fabric

Mill scoured natural silk fabric (81 g/m^2) was supplied by Hussein EL-Khatib Sons Company, Suhag, Upper Egypt .

Wool fabric

Mill scoured pure wool fabric (270 g/m^2) was supplied by Misr Company for Spinning and Weaving, Mehalla EL-Kubra, Egypt.

Chemicals

Mordants

The mordants used comprised copper sulphate, ferrous sulphate, alum, tannic acid and potassium dichromate.

Other chemicals

Sodium hydroxide and sodium carbonate were of laboratory grade chemicals. Commercial ethyl alcohol (95%) and non-ionic detergent namely Hostapal CV-ET were of technical grade chemicals.

Methods

Separation of the gum from the seeds

The galactomannan gum was separated from Tara seeds, by subjecting the dry clean seeds first to mechanical crushing then to sieving in order to separate the germ from the hull and endosperm. The hull and endosperm were soaked in cold distilled water for 24 hr to swell the gum, which is the main constituent of the endosperm. Such swelling results in a viscous mass associated with insoluble components.

The viscous mass was separated from the other insoluble components of the hull and endosperm via filtration through a mucilein fabric followed by precipitation with commercial ethyl alcohol (95 %) and finally air dried.

Isolation of a self printing paste

The hull of Tara gum contains natural dark brown colour. Several trials were carried out to isolate this natural colour along with the dissolved gum with a view to obtain a self printing paste.

Trials have disclosed that the color can be isolated from the hull of the seeds by a dilute sodium hydroxide solution. The latter is also able to affect isolation of gum from the remaining parts of the seeds after removal of the germ. Hence the experimental procedure adopted in the present work to isolate a self printing paste - based on galactomannan gum and natural dye - could be summarized as follows:

The seeds were crushed mechanically and sieved to remove the germ as mentioned above. The hull and endosperm were then soaked in 1 % sodium hydroxide solution and left overnight to yield a colored viscous mass. The latter was purified through separation from other insoluble components of hull and endosperm by filtration using a muslin fabric. The purified colored viscous mass so obtained was used as self printing paste for printing cotton, wool and natural silk fabrics without any other additives.

Printing

Screen printing of cotton, wool and silk fabrics was carried out using the self printing paste. The so printed fabrics were then subjected to the following operations.

- *Fixation*

  Prints were fixed on the fabrics by steaming at 100^{o}C for 15 min.

- *Washing*

The fixed printed fabrics were thoroughly washed with cold running water followed by washing at 50^{o}C with a solution containing Hostapal CV-ET (2 g/l) and sodium carbonate (3 g/l) for 15 min , then washed with water at 45^{o} C for 5 min and finally rinsed with cold water and air dried.

Analysis and measurements

Determination of the rheological properties[15]

The rheological properties of the printing pastes were measured using Rheomat-15 Zurick, Switzerland at 25°C and the apparent viscosity (η) at various rates of shear was calculated from the shearing stress (Z) and rates of shear (D) as follows:

$$\eta = Z / D$$

Fastnesss properties[16,17]

The color strength, expressed as K/S and the overall fastness properties (washing, perspiration and crocking) were assessed according to the standard methods.

Results and Discussion

Effect of sodium hydroxide concentration on rheological properties of gum paste isolated from Tara seeds

Development of eco-friendly products and technologies in textile printing has been the subject of several recent investigations[1,11,18]. This is, as already mentioned, because of the heavy pollution load conferred on the wastewater by unfixed colour, thickening agent and other ingredients of the printing paste which are washed off the fabric into the wastewater.

The current investigation is carried out as an integral part of the aforementioned investigations. Hence, the research was designed to establish conditions under which colored natural thickener could be isolated from Tara seeds. The colored thickener or in a more strict scientific sense, galactomannan gum along with natural color, could be obtained from the crushed Tara seeds only when sodium hydroxide solution was used for swelling, dissolution and isolation of the gum. For this reason, the effect of different concentrations of sodium hydroxide on the rheological behaviour of galactomannan gum isolated by making use of water was studied. This was done in order to discover the most appropriate sodium hydroxide concentration to be used in preparation of the colored paste.

With the above in mind, pure uncolored gum was isolated from crushed Tara seeds as described in the experimental section. Pastes containing 3% of the isolated gum were treated with different concentrations of sodium hydroxide ranging from 0.5 to 10 % at room temperature for 2 hr and their rheological properties were measured at 25° C using Rheomat – 15, Figure 1 and 2 illustrate the rheograms obtained with freshly prepared pastes as well as pastes stored for 24 hr before the measurement.

Figure 1 depicts that all the examined pastes are characterized by non-Newtonian behaviour since the relation between shearing stress and rate of shear is not linear. However, addition of sodium hydroxide has a remarkable effect on the rheological properties of tara glactomannan gum. As evident, character and location of the rheogram depend on the concentration of sodium hydroxide.

Paste samples treated with low concentrations of sodium hydroxide within the range of 0.5 – 2% are characterized by a non-Newtonian pseudoplastic behaviour as the up and down rheograms are coincident. Increasing the concentration more than 2 % gives rise to non-Newtonian thixotropic behaviour where the up and down curves are not coincident. It is further seen that increasing the concentration of sodium hydroxide from 0.0 to 2% shifts the rheograms regularly near to the rate of shear axis. This implies that the apparent viscosity of the gum decreases as the concentration of sodium hydroxide increases; a matter which is more clearly represented in Table 1. For example, at a rate of shear of 2.927 sec^{-1} the apparent viscosity of the untreated paste amounts to 542.5 poise. This is against apparent viscosity values of 458.5, 374.2, and 319.9 poise for paste samples treated with 0.5 %, 1 % and 2 % sodium hydroxide, respectively .

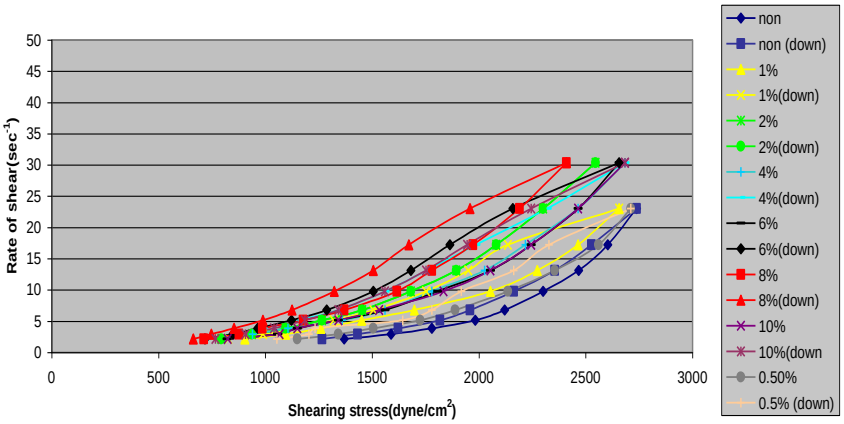

Fig.1. Effect of concentration of sodium hydroxide on the reheological properties of gum freshly prepared (concentration of the gum was 2%).

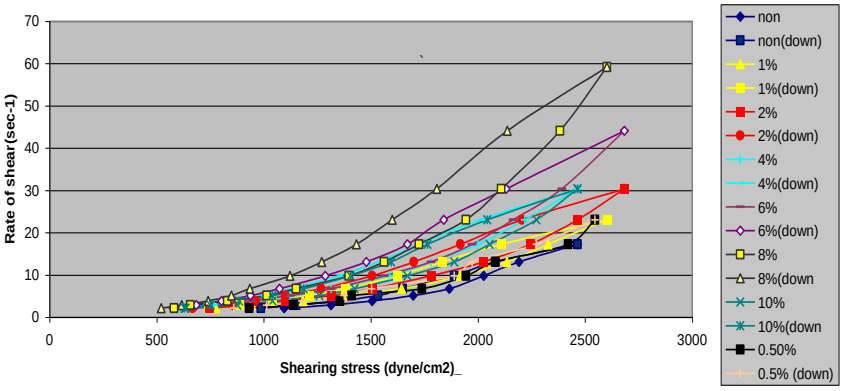

Fig.2. Effect of sodium hydroxide concentration on the reheological properties of the gum afterstoring for 24 hr.

TABLE 1. Effect of concentration of sodium hydroxide on the apparent viscosity of Tara gum at various rates of shear for freshly prepared paste*.

Rate of shear (sec^{-1})	Apparent viscosity in poise of the pastes containing sodium hydroxide at NaOH concentration of :							
	0.00%	**0.5%**	**1%**	**2%**	**4%**	**6%**	**8%**	**10%**
2.18	628.0	527.5	414.5	364.2	331.6	376.8	326.6	378.0
2.927	542.5	458.4	374.2	319.9	320.9	380.3	299.3	430.3
3.851	462.1	391.0	327.1	284.4	287.2	298.6	256.0	298.6
5.139	385.7	335.7	282.4	246.1	264.6	261.1	229.1	261.1
6.779	307.8	278.7	250.4	214.5	230.2	230.2	201.9	226.2
9.771	235.4	218.6	210.2	172.1	182.1	184.9	165.3	187.7
13.12	188.0	179.5	173.2	144.4	154.4	156.5	135.6	156.5
17.26	155.9	150.7	142.8	120.6	128.5	130.1	114.2	130.1
23.03	118.9	117.7	115.3	99.9	107.0	107.0	95.1	107.0
30.38				83.8	88.3	87.4	79.3	88.3
44.1							38.8	

* The concentration of the gum was 3%.

Besides, treatment of the tara freshly prepared gum with higher concentrations of sodium hydroxide, *i.e.* 4%, results in marginal increment in apparent viscosity; the latter increases from 319.9 poise to 320.9 poise upon increasing the sodium hydroxide concentration from 2 % to 4 %. Similar situation is encountered when the said tara gum was treated with 6 % or 10 % sodium hydroxide. With gum prepared with 8 % sodium hydroxide, on the other hand, the apparent viscosity exhibits the lowest values within the range studied.

The transformation of the rheological properties of tara glactomannan gum from thixotropic into pseudoplastic by treatment with relatively low concentration of sodium hydroxide (0.5%, 1 % or 2%) calls for increased solubility of the gelatinized swelled gum in dilute sodium hydroxide solution. Once this is the case, the swelled gum dissolves and converts into homogenous paste which can rebuild its structure immediately after the applied force is removed; this characteristic is the property of pseudoplastic pastes. Higher concentrations of sodium hydroxide (4% to 10%) – beside increasing the solubility–seem to cause molecular degradation of the gum most probably through cleavage of the mannose main chain in the glactomannan. As a result , the gum becomes structurally inhomogeneous; that is, short chains are present along with long chains. Such inhomogeneity brings about a state of a paste which is not able of immediate rebuilding of its structure after removal of the applied force, thereby exhibiting thixotropic behaviour.

Figure 2 shows the rheograms of both the native and alkali treated tara glactomannan gum after being stored for 24 hr. As evident, all the pastes are characterized by non-Newtonian thixotropic behaviour since the up and down flow curves are not coincident. Only rheogram of paste treated with 0.5% sodium hydroxide solution displays almost pseudoplastic behaviour. At any event, however, the thixotropic characterestics of tara gum pastes observed after storing could be interpreted in terms of inhomogeneity of the molecular masses brought about by degradation of mannose chains during storing. It is likely that the gum undergoes hydrolytic molecular cleavage of mannose chain and hence decreases the apparent viscosity at any given shear rate. The effect of storing can be best realized by comparing Tables 1 and 2.

TABLE 2. Effect of concentration of sodium hydroxide on the apparent viscosity of Tara gum at various rates of shear after storing the gum for 24 hr*.

Rate of shear (sec^{-1})	Apparent viscosity in poise of the pastes containing sodium hydroxide at a concentration of :							
	0.00%	**0.50%**	**1%**	**2%**	**4%**	**6%**	**8%**	**10%**
2.18	502.39	427.03	355.44	341.62	280.08	293.89	266.27	291.39
2.93	449.01	388.20	321.79	318.05	261.92	278.76	224.50	299.34
3.85	391.04	351.94	307.15	285.82	243.16	244.58	215.43	270.17
5.14	330.33	274.39	266.39	255.74	218.44	218.44	197.13	245.08
6.78	266.57	256.47	242.34	222.14	193.87	193.87	169.64	210.03
9.77	207.36	198.95	196.15	182.14	162.53	159.72	142.87	170.93
13.12	166.95	158.60	162.78	154.43	135.65	135.65	118.95	144.00
17.26	142.77	140.23	134.84	130.08	115.80	114.23	99.94	118.97
23.03			112.94	107.00	96.30	93.92	84.41	98.68
30.38				88.32	81.11	76.61	69.40	81.11
44.10						60.84	54.01	
59.22							43.92	

* The concentration of the gum was 3%.

Printing

Experience gained from the aforementioned study concerning the effect of sodium hydroxide concentration on the rheological properties of glactomannan gum isolated from the Tara seeds was used to isolate the same gum along with the natural colored associated therewith. That is, self colored paste could be isolated from Tara seeds using the proper concentration of sodium hydroxide with which no profound changes in the gum occur.

Considering the above, an economic eco-friendly printing paste containing a natural dye and galactomannan gum could be obtained from Tara seeds and used as self-colored paste. The latter was used in printing wool, silk and cotton fabrics without any additives- as per screen printing. Colour fixation of the prints was effected at 100° C for 15 min by making use of steam. After being washed as described in the experimental section, the prints were assessed for colour strength, expressed as K/S, and overall colour fastness properties. The results obtained are given in Table 3.

TABLE 3. Color strength values and overall fastness properties of natural fabrics printed using self printing paste isolated from Tara gum.

Fabric printed	K/S	Washing fastness		Rubbing fastness		Perspiration fastness			
		Alt.	St.	Dry	Wet	Acidic		Alkaline	
						Alt.	St.	Alt.	St.
Cotton	0.55	4-5	4-5	4-5	4	4	4	4-5	4-5
Silk	0.74	4-5	4-5	4	4	4-5	4-5	4-5	4-5
Wool	0.65	4-5	4-5	4	4	4-5	4-5	4-5	4-5

It is clear (Table 3) that, silk and wool fabrics display higher K\S values than cotton fabric. This is rather expected since tara is rich in pyrogallol tannic[12]. It has been reported[19] , that tannins present in natural dyes are high molecular weight compounds containing phenolic hydroxyl groups which enable them to form effective crosslinks between proteins such as silk and wool, where they form three types of bonds, namely.

(a) Hydrogen bond which is formed between phenolic hydroxyl groups of tannins and the free amino and amides groups of the proteins.
(b) Ionic bond it is formed between suitable charged anionic groups of the tannin and cationic groups on the protein.
(c) Covalent bond it is formed by interaction of any quinone or semi quinone group present in tannic with any suitable reactive groups in the protein.

However in case of cellulosics, exemplified by cotton, the tannins could form only two types of bonds as follows:

(a) Hydrogen bond which is formed between phenolic hydroxyl groups of tannins and the hydroxyl groups of cellulose.
(b) Covalent bond which may be formed by the interaction of quinone or semi quinone groups present in tannins with suitable functional groups in the cellulose.

Results of the overall colour fastness properties (Table 3) indicate that the colour fastness to rubbing, to washing or to perspiration obtained with the self colored paste on silk, wool and cotton ranges from good to excellent.

Based on the foregoing, it may be concluded that the colored (printing) paste isolated from Tara seeds could successfully be applied – without any type of additives – to silk, wool and cotton fabrics. Nevertheless, the shade is only confined to one colour. For this reason, mordants are employed to achieve different colours. Thus different mordants are undertaken and applied to the fabrics before printing or post to printing or incorporated in the self printing paste. Having done this, the fabrics are evaluated for K\S and overall fastness properties as detailed below.

Use of mordants

According to previous reports[10,11],, mordants are often used along with natural dyes to perform: (a) fix the dyestuff, (b) obtain a full colour range, (c) keep natural dye from fading, (d) improve the overall fastness properties, and/or (e) brighten, deepen or dull the colour. Taking this into consideration in addition to the need of having different colours out of the self one-colour printing paste under investigation, tannic acid, alum, ferrous sulphate, copper sulphate, and potassium dichromate were used as mordants in printing silk, wool and cotton fabrics using the self printing paste isolated from Tara seeds. These mordants were harnessed as per the following three different methods.

Application of mordant prior to printing

Samples of silk, wool or cotton fabric were padded with 1 and 2 % aqueous solutions of the mordant to a wet pick up of 100 %, followed by drying at room temperature. The so mordanted fabric samples were screen printed using the self printing paste and the prints were realized through drying, steaming and washing as described in the experimental section. The colour strength (K/S) and the overall fastness properties of the fabric samples printed using the self printing paste aided by the said different mordants are given in Table 4.

TABLE 4. Color strength (K/S) of cotton , wool and silk fabrics printed using the self–printing paste in presence of mordant when the latter was applied prior to, during and after affecting the prints.

Mordant Used / Application of mordant		Colour Strength (K/S)								
		Prior to Printing			During Printing			Post Printing		
		Cotton	Wool	Silk	Cotton	Wool	Silk	Cotton	Wool	Silk
None		0.55	0.65	0.74	0.55	0.65	0.74	0.55	0.65	0.74
Copper Sulfate	1%	1.34	1.65	1.78						
	2%	1.45	1.61	1.96				1.57	1.69	1.69
Potassium dichromate	1%	0.88	1.39	1.59						
	2%	1.30	1.61	1.47	0.68	0.84	1.61	1.44	1.87	1.85
Alum.	1%	0.93	1.67	1.25						
	2%	0.87	1.86	1.18	0.77	0.82	0.93	2.15	1.84	2.52
Tannic Acid	1%	1.73	1.43	2.54						
	2%	2.40	2.08	3.48	0.59	1.23	0.94	2.37	2.60	2.64
Ferrous Sulfate	1%	1.05	1.03	1.45					1.45	
	2%	1.34	1.05	1.05	0.29	0.86	0.41	1.18	0.72	0.80

Results of colour strength, expressed as K/S values, shown in Table 4, make it evident that the colour strength of printed fabric samples relies on: (a) nature of the printed fabric, (b) nature of mordant and (c) concentration of the mordant. For most of the mordants used, printed silk and wool samples acquire higher K/S values than cotton samples, for reasons cited elsewhere in this work. They follow the order :silk > wool > cotton, irrespective of nature and concentration of the mordant.

However, nature and concentration of the mordant determine the magnitude and shade of the prints. Moreover, the K/S values are higher in presence than in absence of the mordant.

In case of cotton fabric, for example, the K/S of printed samples displays the highest value with tannic acid and then lowest with allum, and follows the order tannic acid > copper sulphate > ferrous sulphate > potassium dichromate > alum. This order is also valid for silk and wool printed samples.

Differences in K/S values observed with the different mordanting materials could be interpreted in terms of differences among these mordants with respect to their interactions with both the natural dye of the self printing paste and the fibre substance of the fabric. It is logical that the colour strength (and even the shade) of the prints would be a manifestation of such interactions; the latter seems to govern fixation, colour range, brightness, … etc of the prints as already stated.

The effect of mordant concentration is to enhance the color strength of the prints (Table 4). As evident K/S values obtained with 2 % mordant are higher than those for 1 % mordant, regardless of the fabric used. This, indeed, supports the postulation that interactions between the natural dye, the mordant and the fiber substance of the fabric are responsible for the enhancement in color strength by the mordant.

Table 5 reveals that the overall fastness properties are either improved by the mordant or remained unaltered. This may be due to the presence of tannic acid in the self printing paste isolated from Tara seeds.

Incorporation of mordant in the printing paste

The aforementioned mordants were independently incorporated in the printing paste at a concentration of either 10 g or 20 g per 1Kg of the paste. Samples of cotton, silk or wool fabric were printed using the self printing paste containing the mordant as detailed in the experimental section and the prints were monitored for K/S and overall fastness properties. The results obtained are given in Tables 5 and 6.

TABLE 5. Fastness properties of cotton, wool, and silk fabrics printed using the self–printing paste in the presence of mordant when the latter was applied before affecting the prints.

Mordants used at [1%]	Cotton			Wool			Silk		
	WF	RF	PF	WF	RF	PF	WF	RF	PF
None	4-5	4-5	4	4-5	4	4-5	4-5	4	4-5
Copper Sulfate	4-5	3-4	4-5	4-5	4	4-5	4-5	4	4
Potassium dichromate	4-5	4	4-5	4	3-4	4	4-5	4	4-5
Alum.	4-5	4-5	4	4-5	4-5	4	4-5	4-5	4-5
Tannic Acid	4	4	4-5	4-5	4	4-5	4-5	3	3-4
Ferrous Sulfate	4-5		4-5	4-5	4	4-5	4-5	3	4-5

WF= Washing fastness ; RF= Rubbing fastness ; PF= Perspiration fastness. When expressed as alteration or staining, the results were identical and the values given in the table are typical of these results. Dry and wet rubbing fastness properties obtained using 1% and 2% concentration of any of the mordants used were almost equal. The same holds true for alkaline and acidic perspiration fastness. Fastness properties for the cotton, wool, and silk fabrics printed with the self printing paste containing the mordant or when the latter was applied after the prints were effected exhibit values which are almost equal to those given in the table.

TABLE 6. Effect of addition of different mordants on the color of fabrics printed using Tara galactomannan self printing paste.

Mordant used	Colour obtained on		
	Cotton	Silk	Wool
Without mordant	Gray	Dark gray	Dark gray
Tannic acid	Light brown	Olive	Brown
Allum	Gray	Dark gray	Dark gray
Ferrous sulphate	Brown	Olive brown	Olive brown
Cupper sulphate	Ochre	Brown	Brown
Potassium dichromate	Yellowish brown	Dark yellowish brown	Dark yellowish brown

It is clear (Table 4) that the K/S values for silk and wool fabrics are higher than those of cotton fabric. This is rather in conformation with the results obtained when the mordant was applied to the fabrics before printing as discussed above and hence could be explained on similar lines. It should be pointed out, however, that by and large the K/S values obtained with current

method where the mordant incorporated in the self printing paste are lower than their corresponding K/S values obtained with the padding method where the mordant is applied as pretreatment. It is further observed that current method involving simultaneous application of the mordant along with the self printing paste is accompanied to some extent by gelling and coagulation. The latter two combined phenomena occur immediately upon using copper sulphate and after different times with other mordant salts, depending on the nature of the mordant.
The above observation concerning gelling and coagulation are in full conformation with previous studies which disclosed that galactomannan gum of guar bean gum form complexes with cis-hydroxyl groups of two mannose chains to form cross links in presence of borate ions[20] and transition metal ions[18] as clear from Fig. 3.

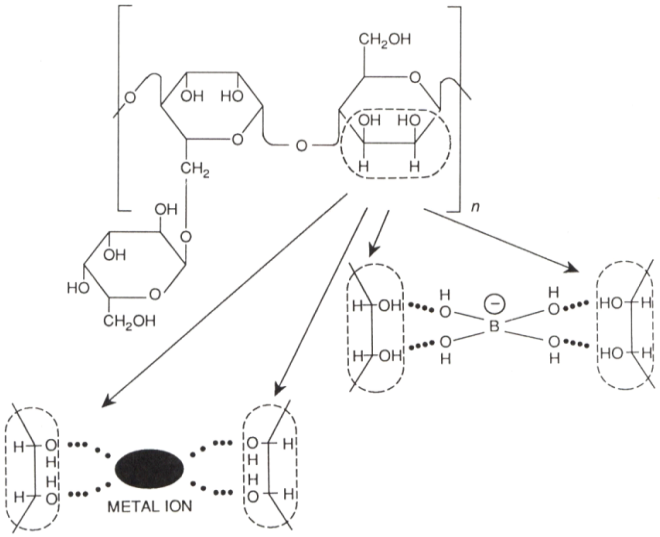

Fig. 3. Proposed mechanism for the cross linking of galactomannan with borate and metal ions[12].

Results of application of the mordant after printing (Table 4) agree generally with results of the other two methods where the mordants were applied before and during printing but with the following arguments.

1. The K/S values are relatively higher than corresponding values obtained with the other two methods regardless of nature of fabrics and mordants. Differences in amounts of mordant functioning in favor of color, printing and fixation among the three methods may account for this.
2. The K/S values produce the following order when tannic acid was used as a mordant: silk > wool > cotton. With ferrous sulphate mordant, on the other hand, the K/S values follows the order: cotton > silk > wool.

3. With cupper sulphate and potassium dichromate the K/S values of silk and wool are practically equal meanwhile they are higher than that for cotton.

Table 5 reveals that colour fastness to rubbing, to washing and to perspiration ranges from very good to excellent as they exhibit values either 4 or 4-5.

Dependence of colour on nature of both mordant and fabric

The above results conclude that the mordant enhances colour strength, expressed as K/S values, irrespective of the method used for application of the mordant and/or the nature of fabric used for printing. They also reveal that addition of different mordants creates different colours as shown in Table 6.

Resistance of the prints to alkali treatment

This research brings into focus that to isolate self colored printing paste from Tara seeds, it is a must to treat the crushed seeds with 1% sodium hydroxide. This means that the latter aqueous solution dissolves the colored matter in the seeds and brings it along with the viscous solution of the gum. To check the susceptibility of the colour to the same concentration of alkali used in its dissolution from the seeds, samples of cotton, silk, or wool fabric printed in absence and presence of each of the said mordants were subjected to alkali treatment using 1% sodium hydroxide for 30 min at ambient temperature. It was observed that there is no colour change in the printed samples as far as the colour strength is (K/S) the same in different colours obtained with different mordants. Only in case of copper sulphate mordant, the background of printed wool and silk samples has changed. Furthermore , the printed samples have undergone no observed change in overall fastness properties.

Conclusions

Tara seeds were first crushed and sieved then soaked in water followed by filtration to isolate the galactomannan gum. Rheological properties of this gum were studied before and after the gum was treated with different concentrations of sodium hydroxide ranging from 0.5 to 10 % .

Experience gained from this study was used to isolate both eco – friendly galactomannan gum and safe natural dye from Tara seeds simultaneously in one step process.

Evaluation was made of the obtained self printing paste for printing cotton, wool, and silk fabrics in presence and absence of different mordants. Conclusions from these studies may be presented as follows:

1. Pastes of tara gum treated with sodium hydroxide at a range of 0.5 to 2 % exhibit non-Newtonian pseudoplastic behavior; similar to pastes prepared from the untreated gum.

2. The colored printing paste, which was isolated from Tara seeds, could successfully be used in printing of silk, wool and cotton fabrics without any additives, but the shade is only confined to one colour.

3. The K/S values of silk and wool are practically equal meanwhile they are higher than that of cotton.

4. Mordants enhance printing and create different colors, depending upon their nature; in case of cotton fabric for example the K/S of printed samples displays the highest value with tannic acid and the lowest with alum and follows the order tannic acid > copper sulphate > ferrous sulphate > potassium dichromate > alum; an order which is also valid for wool and silk fabrics.

5. The fabrics printed by the self printing paste acquire colour fastness to rubbing, to washing, and to perspiration ranging from very good to excellent; besides, resistance of the prints to alkali treatment.

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تكنولوجيا صديقة للبيئة لطباعة المنسوجات بأستخدام عجينة طباعة ذاتية مبتكرة

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فى هذا العمل تم التوصل إلى استخلاص صمغ الجلاكتومنان وذلك عن طريق الدَش والنقع فى الماء ثم العصر للحصول على الصمغ فى صورة عجينة لزجة ذات لون شفاف تم معالجتها بتركيزات مختلفة من هيدوكسيد الصوديوم من (0.5 : 10 جرام ٪) وتم دراسة الخواص الريولوجية لعجائن الصمغ قبل وبعد معالجته بالقلوى وتم الإستفادة من نتائج تلك الدراسة فى التوصل إلى طريقة اقتصادية لإستخلاص عجينة الطباعة المحتوية على المتخن واللون فى مرحلة واحدة عن طريق المعالجة بمحلول مخفف من الصودا الكاوية والعصر وتم استخدام تلك العجينة بدون إضافة أى مواد أخرى فى طباعة عينات من قماش القطن والصوف والحرير. كما تم قياس شدة اللون ودرجات ثباته المختلفة وفيما يلى أهم النتائج التى تم التوصل إليها فى هذا الفصل :

1- عجائن صمغ التارا المعالج بهيدوكسيد الصوديوم بتركيزات من 0.5: 2 ٪ تتميز بخواص ريولوجية غير نيوتونية من نوع البسيدوبلاستيك أما العينات التى تم معالجتها بتركيزات أعلى من 2٪ تميزت بخواص ريولوجية غير نيوتونية من نوع السكسوتروبك كما هو الحال فى الصمغ الغير معالج.
2- عجينة الطباعة المحتوية على الصبغة الطبيعية أمكن استخدامها بنجاح بدون أى إضافات فى طباعة أقمشة الصوف والحرير والقطن.
3- شدة اللون التى تم التوصل إليها على عينات الصوف والحرير كانت تقريباً متساوية وفى جميع الحالات أعلى من عينات قماش القطن.
4- عند إضافة الموردنت إلى عجينة الطباعة التى تم استخلاصها من بذور التارا تم الحصول على ألوان مختلفة تعتمد على كلٍ من الخامة المطبوعة ونوع الموردنت وبصفة عامة فإن إضافة الموردنت يعمل على زيادة شدة اللون على سطح الخامة المطبوعة بغض النظر عن نوع الخامة. ففى حالة قماش القطن فإن أعلى شدة لون تم الحصول عليها عند استخدام حمض التانيك كموردنت وأقل شدة لون تم الحصول عليها عند استخدام الشب وذلك وفق التتابع التالى: حمض التانيك > كبريتات النحاس > كبريتات الحديدوز > ثنائى كرومات البوتاسيوم > الشب.
5- الأقمشة المطبوعة بالعجينة التى تم استخلاصها من بذور نبات التارا تتميز بدرجات ثبات للاحتكاك والغسيل والعرق تتراوح بين جيد جداً إلى ممتاز بالاضافة إلى مقاومتها للمعالجة بمحلول هيدوكسيد الصوديوم.