

Tara Gum Carbamate: A New Thickening System for Cotton Printing Using Vat Dyes

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Abstract: Green technology-based textile thickeners, namely, glectomannan was isolated from tara seeds and harnessed to vat printing of cotton fabrics before and after being carbamated. Carbamation was effected through reaction with urea at 160 °C for 15 and 90 min. to produce tara carbamate derivatives having 1% N and 3.12 % N respectively. These derivatives are soluble in water at room temperature and characterized by non-Newtonian pseudoplastic behaviour. However, for a given rate of shear, tara carbamate derivative having 1% N exhibits lower apparent viscosity than the derivative with 3.12 % N. On the other hand the apparent viscosity of pastes prepared from these two derivatives increases by storing for 24 or 48 hours before commence measuring. Prints could successfully be achieved using either of the two new tara carbamate derivatives in single use or in admixture with conventional thickener viz. Lameprint A6. Colour strength (K/S) values of prints prepared using the new tara carbamate –based thickeners are higher than those obtained with the conventional thickener, meanwhile the overall fastness properties of all prints are equal, irrespective of the thickener used.

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1. Introduction:

Tara gum is obtained from the kernels (seeds) of the tara shrub *Caesalpinia*, sometimes referred to as *Caesalpinia tinctoria* (H.B.K.) or *Caesalpinia pectinata* (Cav.)⁽¹⁾. This legume is native to northern regions of Africa and South America. It is mainly distributed in the valley area in the middle of the east Andes and in the sea shore desert along the Pacific ocean⁽²⁾. Peru is the primary commercial source of tara⁽³⁾.

Vat dyes give a wide range of bright colours resistant to wet treatment and weather conditions; hence they occupy one of the prominent places among the other classes of dyes. They are used for printing cellulosic fabrics and also proteinic fabrics. At any event, however, although this group of dyes embrace a wide range of molecular structure types which are often complex yet all contain one or more carbonyl (=C=O) groups^(4,5). When they are treated with reducing agents, the carbonyl groups combine with hydrogen to form the leuco compounds, which contain secondary hydroxyl group. These compounds do not dissolve in water but form soluble sodium derivatives in the presence of alkalis. On oxidation the sodium compounds are converted to the insoluble coloured derivatives⁽⁶⁾.

Urea, on the other hand is one of the most important materials used in the field of textile finishing and printing. In the latter it acts as a solvent for dye and it promotes the dye migration from the printed film to the fibre interior. It has been reported⁽⁷⁾ that urea reacts with alcohol and polyhydric alcohols to bring about the corresponding carbamate derivatives. A temperature range from 160 – 190 °C was reported as optimal for carbamate derived from urea and alcohols. Furthermore, it was shown that under such high temperature urea decomposes with loss of ammonia to form cyanic acid. The latter reacts with the alcohol to yield carbamates.

In a very recent study we have reported on the synthesis, characterization and application of carboxymethyl tara derivatives in reactive printing of cotton fabrics. Results were so promising that they stimulate current work especially after the search revealed that no systematic study was so far carried out on carbamation of tara gum.

Obviously, then, current work is undertaken with a view to carbamate tara gum by reacting it with urea and harness the obtained derivatives in printing cotton fabrics with vat dyes. The work involves technical applications in textile chemical technology evaluation of the tara carbamate derivatives through monitoring the nitrogen content as a measure for the

extent of carbamation, the rheological properties of the derivatives –based thickeners, printability of the tara carbamate derivatives alone as well as in admixture with the universe commercial thickener (Lame Print A6) and, properties of the prints. A comparison is also made between Vat prints obtained with the new tara carbamate derivatives and prints obtained using Lame Print A6.

2. Experimental

2.1. Materials

2.1.1. Cotton fabric: Cotton fabric: Mill desized, Kier boiled and bleached poplin cotton fabric (140 g/m²) produced by Misr/helwan for Spinning and Weaving Company was used throughout the present work.

2.1.2. 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 are composed of three components namely hull, endosperm, and germ obtained from ripe pods. 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^(8,9).

2.1.3. Thickening agent: Lameprint A6, commercial plant seed gum ether, manufactured by Grunau, Germany, was kindly supplied by Misr/El-Mahala for spinning and weaving. It is resistant to metal salts, non-ionic, no residues. It is recommended for printing with Vat dyes and Rapidogen and Neutrogen dyes, fast colour salts and aniline salt.

2.1.4. Vat dyes: Two different Novatic microperle Vat dyes manufactured by Atul LTD, Gujarat, India were employed. These dyes were Novatic Orange 3G Microperle (C.I. Vat Orange 15) and Novatic Blue RS Microperle (C.I. Vat Blue 4).

2.1.5. Other chemicals: Urea and Sodium carbonate were of laboratory grade chemicals whereas ethyl alcohol was of technical grade. Sodium sulphoxalate formaldehyde (Rongalite C) as a reducing agent. Hostopal CV-ET (non -ionic detergent).

2.2. Methods:

2.2.1. Preparation of carbamate derivatives: After being isolated from the tara seeds, galactomannan gum was allowed to react with urea using the solid state technique as follows:

The gum and urea (1:1) were mixed well in the solid state using a laboratory mixer. The mixture was transferred to a porcelain crucible then subjected to high temperature (160 °C) for different periods of time (15, 30, 45, 60, and 90 min). At this end the

thermally treated mixture was dissolved in distilled water at room temperature, precipitated with commercial ethyl alcohol, filtered on a sintered glass funnel and washed several times with 75% ethyl alcohol then purified.

2.2.2. Purification: The prepared carbamate derivatives prepared as described above were purified by extraction in soxhlet using 75% ethyl alcohol, and the purified derivatives were dried in a desiccator containing calcium chloride.

2.2.3. Preparation of the printing paste: This is done according to the popular potash / Rongalite process. The following is the recipe which has been employed:

Preparation of the thickening agent:

Thickening Agent*-----	X	g
Water -----	1000 - X	g
Total -----	1000	g

*The thickening agent used were Tara carbamate derivative, 2.5 g, or commercial thickening agent namely Lameprint A6 6g.

Preparation of stock thickener:

Thickening agent -----	600	g
Glycerine -----	80	g
Potassium carbonate -----	150	g
Rongalite C -----	150	g
Water -----	20	g
Total -----	1000	g

Preparation of the printing paste:

Novatic microperle dye-----	20	g
Water -----	180	g
Stock thickener -----	800	g
Total -----	1000	g

The required amount of dyestuff was pasted with warm water and stirred well to make homogenous suspension paste. The previously prepared stock thickening was added into the paste and mixed thoroughly.

2.2.4. Printing technique: All the printing pastes were applied to cotton fabric as per flat screen printing.

2.2.5. Steaming: After printing and drying, the printed goods were subjected to steaming at 100-102 °C for 10 minutes.

2.2.6. Washing: After steaming the printed goods were washed with cold water to remove the thickening agent and alkali and the vat dye was oxidized with dilute sodium perborate 5 g/l followed by washing thoroughly, soaping at the boil in a solution containing 2 g/l non-ionic detergent namely Hostopal CV, and cold water, air dried and assessed for K/S and overall fastness properties.

2.3. Analysis and Measurements:

2.3.1. Determination of nitrogen content:

The nitrogen content of the purified tara gum carbamate derivatives was determined at Micro Analytical Laboratory, NRC, Egypt.

2.3.2. Determination of the rheological properties⁽¹⁰⁾:

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

$$\eta = \frac{\tau}{D}$$

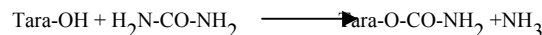
2.3.3. COLOUR MEASUREMENTS^(11, 12):

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

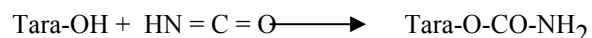
3. Results and Discussion:

3.1. Tentative Reaction Mechanism of Carbamation of Tara Gum:

To start with, tara galactomannan gum was isolated from tara seeds according to the procedure described elsewhere⁽¹³⁾. The obtained dry gum was allowed to react with urea using the solid state technique⁽¹⁴⁾. The reaction was conducted as detailed in the experimental section, at 160 °C for different intervals of time (15 to 90 minutes). The reaction may be drawn as follows:



Previous reports⁽⁷⁾ have also disclosed that urea decomposes at high temperature and loses ammonia to form cyanic acid ($\text{HN}=\text{C}=\text{O}$) which react with the hydroxyl groups of the carbohydrate to give the carbamate derivative. Thus:



After the necessary purification, obtained tara gum carbamate derivatives were analyzed for nitrogen which is an indication of the degree of carbamate substitution in the molecule. The results obtained are given in Table I.

Table I: Effect of time of carbamation of tara gum on the nitrogen, carbon, and hydrogen contents of the obtained products*.

Time of reaction in minutes	%N	%C	%H	Solubility in	
				Water	Ethyl alcohol
0	0	38.67	6.55	Swelled only	Insoluble
15	1	38.69	4.81	Soluble	Insoluble
30	1.63	37.46	4.86	Soluble	Insoluble
45	2.08	37.25	5.4	Soluble	Insoluble
60	2.28	37.85	5	Soluble	Insoluble
90	3.12	36.67	6.22	Soluble	Insoluble

* The reaction was carried out at 160 °C; the ratio of urea: gum is 1:1

3.2. Dependence of Carbamation on Reaction Time:

It is seen (Table I) that, the percent nitrogen increases significantly by prolonging the duration of carbamation from 15 to 90 minutes. A nitrogen content of 1 % could be achieved with the derivative when urea was allowed to react with the tara gum for 15 minutes. This is against a nitrogen content of 3.12 % for a reaction time of 90 minutes. Trials have been made to increase the duration of carbamation more than 90 minutes. Allowing the carbamation reaction to proceed for 120, 150 or 180 minutes brings about tara gum derivatives which are insoluble in water. Longer durations cause charring of the reaction mixture.

Table I shows the element analysis, namely carbon and hydrogen of the derivatives under

investigation. It also shows the solubility of these derivatives. While the results of carbon and hydrogen are self explanatory, the derivatives are soluble in water but are insoluble in ethyl alcohol. Insolubility in water is encountered when these derivatives were prepared under the influence of reaction time longer than 90 minutes as indicated above.

3.3. Rheology:

The scientific study of the mechanical properties such as flow, ductility and plasticity of concentrated colloidal system has been termed rheology⁽¹⁵⁾. Textile printers have long been aware of the empirical relationship between the characteristic flow properties of the various thickening agents, their

use, and their suitability for printing various types of design^(15,16)

It is, therefore, of interest to investigate the rheological characteristic of pastes of the prepared carbamate tara gum derivatives. Hence aqueous pastes at a concentration of 2 % were prepared and their rheological properties were measured using Rheomat-15 immediately after preparation and also after storing of their pastes for 24 and 48 hours.

The investigation performed permits to obtain experimental rheograms (up and down flow curves), in which the ordinate represents the values of X proportional to the shearing stress (τ), and the abscissa represents the values of Y proportional to the rate of shear (D) as shown from figures 1,2 and 3 for the freshly prepared pastes and after storing of their pastes for 24 and 48 hours respectively.

It is obvious (figure 1) that all the examined samples, of % N equal to 1.63, 2.08, 2.28 and 3.12 are characterized by a non-Newtonian pseudoplastic behaviour, since the up and down flow curves are coincident. This means that, if the viscosity (resistance to flow) of these pastes is measured using a large applied force (shearing stress) which causes a high velocity of flow (shear rate), the apparent viscosity is less than that of the same paste determined with smaller force and at lower rate of flow⁽¹⁶⁾. In this system, i.e. pseudoplastic, no time dependent effects are observed, i.e. as soon as the applied force is removed, the paste rebuilds itself and retains its original viscosity immediately.

It is also clear from (figure 1) that, in spite of the fact that all the pastes are characterized by pseudoplasticity, yet the degree of carbamation, (i.e. % N) plays a dominant role on the viscometric properties of these pastes. As the degree of

carbamation increases, the rheogram is shifted regularly near the rate of shear axis which indicates a decrease in the apparent viscosity at a constant rate of shear. This will be discussed later.

Figures 2 and 3 depict the effect of storing of carbamated tara gum pastes on their rheological properties. On comparing figures 2 and 3 with figures 1, one would realize that storing of these pastes has no effect on the rheological properties of these pastes, since they are still characterized by non-Newtonian pseudoplastic properties after storing. However, a close examination of these rheograms would reveal that, the location of the rheogram with respect to the rate of shear depends on the time of storing. As the latter increases the location of the rheogram is shifted far from the rate of shear axis indicating an increase in apparent viscosity by storing at a constant rate of shear. This state of affairs is more clarified in Tables II, III and IV.

Table II shows that as the degree of carbamation (expressed as % N) of tara gum increases, the apparent viscosity at a given rate of shear decreases. For example at a rate of shear 5.139 sec^{-1} , the apparent viscosity decreases from 128.9 to 13.32 poise by increasing the nitrogen content from 1 % to 2.28 %. This indicates that higher extents of carbamation of tara gum are accompanied by higher thermal molecular degradation of the gum. It is understandable that carbamate derivatives with higher nitrogen content could be achieved at relatively longer reaction duration at a temperature as high as 160°C . Under such conditions thermal hydrolytic decomposition of the derivative inevitably occurs. Once this is the case, the molecular weight and therefore, apparent viscosity decreases.

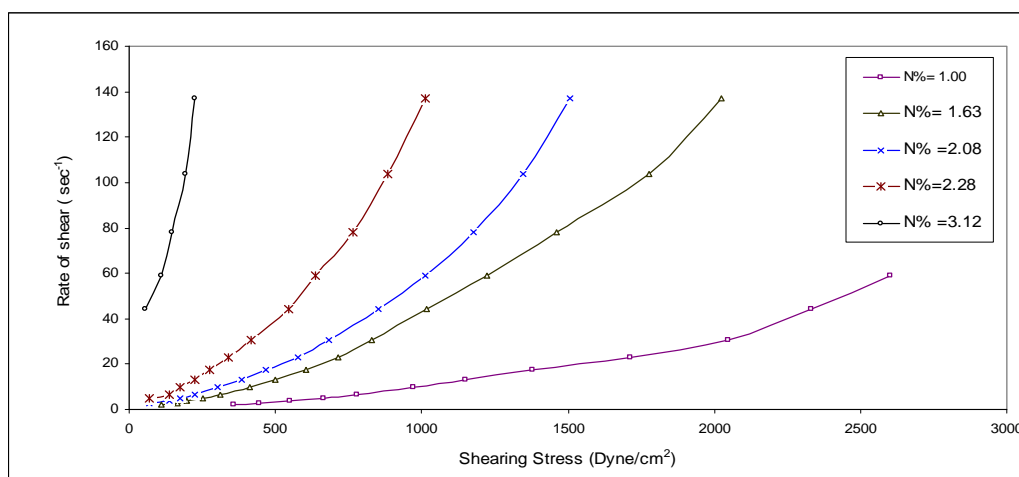


Figure 1: Effect of degree of carbamation of tara gum expressed as %N on the rheological properties of pastes freshly prepared thereof.

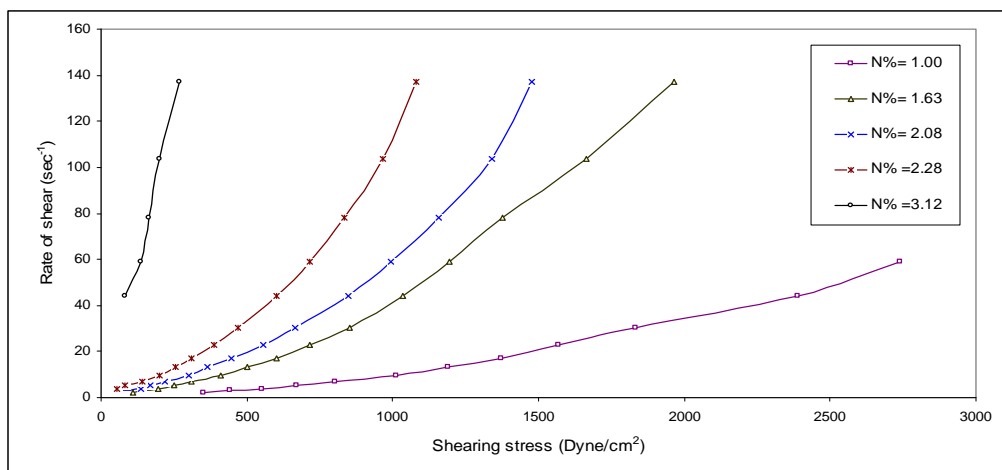


Figure 2: Effect of degree of carbamation of tara gum expressed as %N on the rheological properties of pastes prepared thereof then stored for 24 hours before commencing the rheological measurements.

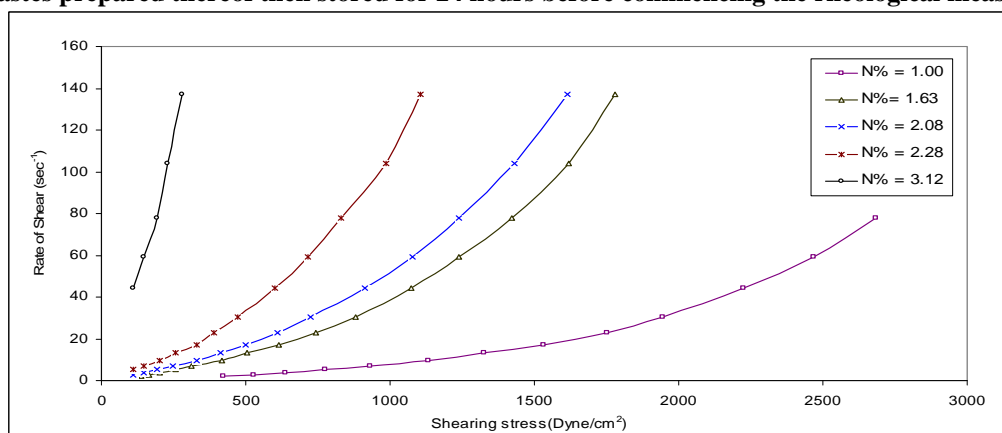


Figure 3: Effect of degree of carbamation of tara gum expressed as %N on the rheological properties of pastes prepared thereof then stored for 48 hours before commencing the rheological measurements.

Table II: Effect of nitrogen content of tara gum carbamate derivatives on the apparent viscosity of their freshly prepared pastes.

Rate of Shear (Sec ⁻¹)	Apparent viscosity in poise for carbamated tara gum acquire:				
	%N = 1	%N = 1.63	%N = 2.08	%N = 2.28	%N = 3.12
2.180	164.531	50.239	-	-	-
2.927	151.540	56.126	23.386	-	-
3.851	142.197	51.191	35.549	-	-
5.139	128.935	49.017	33.566	13.320	-
6.779	114.706	45.640	33.119	20.195	-
9.771	99.197	42.313	31.104	17.934	-
13.120	87.650	38.190	29.216	17.113	-
17.260	74.716	35.058	27.126	16.022	-
23.030	65.508	31.030	24.967	14.742	-
30.380	70.478	27.218	22.531	13.699	-
44.100	52.898	23.097	19.309	12.355	1.242
59.220	43.923	19.974	17.107	10.773	1.849
77.920	-	17.289	14.828	9.804	1.862
103.900	-	17.682	12.965	8.512	1.845
137.100	-	14.778	10.984	7.389	1.638

* The concentration of the pastes was 2%.

Table III: Effect of nitrogen content of tara gum carbamate derivatives on the apparent viscosity of their pastes after storing for 24 hours*.

Rate of Shear (Sec ⁻¹)	Apparent viscosity in poise for carbamated tara gum acquire:				
	%N=1	%N=1.63	%N=2.08	%N=2.28	%N=3.12
2.180	162.020	50.239	-	-	-
2.927	151.540	50.513	18.709	-	-
3.851	142.908	51.191	35.549	14.220	-
5.139	130.000	49.017	33.033	15.984	-
6.779	118.341	45.640	32.312	21.003	-
9.771	103.680	42.033	30.824	20.456	-
13.120	90.571	38.190	27.756	19.408	-
17.260	79.475	34.899	26.016	18.084	-
23.030	68.123	31.149	24.134	16.882	-
30.380	58.581	28.029	21.900	15.502	-
44.100	55.878	24.338	19.247	13.659	1.863
59.220	46.234	20.436	16.783	12.067	2.312
77.920	-	17.675	14.864	10.682	2.108
103.900	-	15.100	12.913	9.302	1.924
137.100	-	15.378	10.784	7.869	2.796

* The concentration of the pastes was 2%.

Table IV: Effect of nitrogen content of tara gum carbamate derivatives on the apparent viscosity of their pastes after storing for 48 hours*.

Rate of Shear (Sec ⁻¹)	Apparent viscosity in poise for carbamated tara gum acquire:				
	%N=1	%N=1.63	%N=2.08	%N=2.28	%N=3.12
2.180	193.419	62.798	-	-	-
2.927	179.602	56.126	37.417	-	-
3.851	165.659	51.902	37.682	-	-
5.139	150.779	49.549	37.828	21.312	-
6.779	137.324	46.044	36.350	21.810	-
9.771	116.010	42.593	33.906	20.456	-
13.120	101.006	38.399	31.303	19.617	-
17.260	88.834	35.534	28.871	19.036	-
23.030	76.089	32.219	26.393	17.001	-
30.380	63.989	28.930	23.793	15.502	-
44.100	50.476	24.338	20.675	13.659	2.483
59.220	41.657	20.944	18.170	12.113	2.450
77.920	34.436	18.272	15.883	10.682	2.460
103.900	-	15.601	13.756	9.487	2.187
137.100	-	12.981	11.244	8.048	2.057

* The concentration of the pastes was 2%.

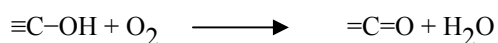
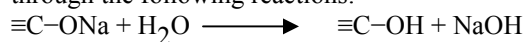
For the sake of verifying the effect of storing of the pastes under investigation on their apparent viscosity at specific rate of shear, comparison is made among Tables II, III and IV. For instance, at a rate of shear of 9.771 sec⁻¹, freshly prepared paste exhibits apparent viscosity value of 99.197 poise. This value increases to 103.68 poise and 116 poise after storing the paste for 24 hours and 48 hours respectively. This is, indeed, the case regardless of the extent of carbamation.

The increase in viscosity of carbamated tara gum by storing calls for formation of crosslinks between adjacent galactomannan tara gum chains. It is also likely that, besides exerting cross linking, storing acts in favour of inducing higher swellability of the derivative leading ultimately to increased viscosity.

3.4. Printing:

Vat dyes are found amongst the oldest natural colouring materials used for textiles⁽⁵⁾. They

include a wide range of structural types and often the molecules are complex, but they all contain one or more carbonyl groups ($=C=O$), which, when treated with reducing agents combine with hydrogen to form leuco compounds containing ($\equiv C-OH$) groups. These secondary alcohols do not dissolve in water but form soluble sodium derivatives ($\equiv C-ONa$) in the presence of alkalis. On exposure to air, or oxidation with a suitable oxidizing agent, the sodium compound is converted to the insoluble coloured derivatives through the following reactions:



Hence printing with these dyes need a thickening agent which is not affected by the necessary auxiliaries added to the vat dye printing paste, i.e. reducing agent and alkali.

This work's objective is to introduce tara gum carbamate derivative as a new thickener for printing cotton fabrics with vat dyes.

Hence, different printing pastes thickened by tara gum carbamate derivative and containing Novatic Orange 3G (C.I. Vat orange 15) were prepared. Tara gum carbamate derivatives having

different nitrogen contents viz. 1, 1.63, 2.08, 2.28 and 3.12 % N were used.

Another two printing pastes containing the same Vat dye and thickened by a conventional commercial thickening agent namely Lameprint A6 were also prepared. This conventional thickener is recommended, in practice, for vat printing. Furthermore, a series of printing pastes thickened by a mixture of tara carbamate derivatives and the commercial Lameprint A6 thickener at a ratio of 1:1 (wt/wt) was prepared.

The so prepared pastes were employed for screen printing of cotton fabrics. This was done immediately after the preparation of the printing paste or after storing of the pastes for 24 or 48 hours before commence printing. After printing and drying the printed goods were subjected to steaming at 100-102 °C for 10 minutes followed by washing with cold water, oxidation with 5 g/l sodium perborate solution followed by a thorough wash, soaping at the boil, washing thoroughly and finally drying at room temperature. After being conditioned, the printed goods were assessed for measuring K/S and overall fastness properties. The results obtained with Novatic Orange 3G are set out in table V. Printing was performed using the freshly prepared pastes and after the latter were stored for 24 or 48 hours before commence printing.

Table V: Colour strength, expressed as K/S of cotton fabric samples printed using pastes thickened by tara gum carbamate derivative, Lame Print A6 or mixture of both when printing was performed using freshly prepared pastes, 24 hours and 48 hours stored pastes containing Vat dye namely Novatic Orange 3G. Fastness properties are also shown when only freshly prepared thickeners were used as example.

Thickening agent	K/S			Washing fastness		Rubbing fastness		Perspiration fastness			
	a	b	c	Alt.	St.	Dry	Wet	Acidic		Alkaline	
								Alt.	St.	Alt.	St.
Lameprint A6	1.48	1.35	0.77	4-5	4-5	3-4	3-4	4-5	4-5	4-5	4-5
Carbamate gum (%N = 1)	2.06	1.37	0.78	4	4	4	4	4-5	4-5	4-5	4-5
Carbamate gum (%N = 1.63)	1.94	1.35	0.75	4-5	4-5	4	4	4-5	4-5	4-5	4-5
Carbamate gum (%N = 2.08)	1.96	1.27	0.72	4-5	4-5	4	4	4-5	4-5	4-5	4-5
Carbamate gum (%N = 2.28)	1.87	1.58	0.95	4-5	4-5	4	3-4	4	4	4-5	4-5
Carbamate gum (%N = 3.12)	1.58	1.16	0.99	4-5	4-5	3-4	3-4	4-5	4-5	4	4
Lameprint / Carbamate (% N = 1) mixture	1.52	1.24	1.05	4-5	4-5	4	4	4-5	4-5	4-5	4-5
Lameprint / Carbamate (% N = 1.63) mixture	1.39	0.97	0.83	4-5	4-5	4	3-4	4-5	4-5	4-5	4-5
Lameprint / Carbamate (% N = 2.08) mixture	1.16	0.96	0.83	4-5	4-5	4	4	4	4	4-5	4-5
Lameprint / Carbamate (% N = 2.28) mixture	1.08	0.86	0.74	4-5	4-5	4	3-4	4-5	4-5	4-5	4-5
Lameprint / Carbamate (% N = 3.12) mixture	1.11	1.09	1.09	4	4	3-4	3-4	4-5	4-5	4	4

(a) Freshly prepared pastes (b) 24 hours pastes (c) 48 hours stored pastes. St: Staining; Alt: Alteration

3.4.1. Colour strength (K/S):

Results of table V disclose that the K/S value of the printed goods depends on: (1) % N of the tara gum carbamate thickener which, in turn, speaks of its nature and (2) the time elapsed before commence printing. In combination with this is the nature of the dye. When we have used different vat dyes under identical conditions, different K/S values were obtained.

Table V reveals that the K/S values of Novative Orange 3G on cotton fabric samples printed using tara gum carbamate are generally higher than their corresponding samples printed using the commercial thickener (Lameprint A6). The highest K/S value (2.06) is obtained upon using the carbamate thickener with 1% N, while the lowest K/S value (1.58) is obtained when a carbamate thickener having 3.12 % N was used. This is against K/S value of 1.48 obtained on using the commercial thickening agent. Similar trend was observed when other Vat dyes were used.

The superiority of tara gum carbamate with the lowest nitrogen content (1 %) within the range studied suggests that subjecting tara gum to carbamation for only 15 minutes at 160 °C is sufficient to convert the gum into a stable thickener with high ability to transfer the dye from the printing paste to the fabric. That is, this particular tara gum carbamate is capable of swelling, dispersing and jumping in an aqueous medium without complete elimination of intermolecular forces between themselves and water. Similar observation was reported⁽¹⁷⁾ for cyanoethyl starch derivative having 1.75 % N.

Tables V shows the colour strength (K/S) of fabric samples printed using the pastes after being stored for 24 and 48 hours before commence printing respectively. As is evident storing decreases the K/S values and, the longer the storing the higher is the decrease in K/S. This suggests that the reducing agent undergoes partial decomposition under the influence of alkali and long storing at temperature of ca 30 °C as storing was carried out at ambient conditions. Storing of the pastes, before commence printing was performed during summer time in Cairo when a temperature as high as 40 °C could be encountered.

3.4.2. Fastness properties:

Table V shows the overall fastness properties including colour fastness to rubbing, to washing and to perspiration of the cotton fabric samples printed using tara gum carbamate derivatives. It is clear that these properties are almost identical to their corresponding samples printed using the commercial thickening agent (Lameprint A6). In

all cases rubbing fastness is ranging from 3-4 to 4 whereas, the washing and perspiration fastness properties range from 4 to 4-5.

3.4.3. Thickener Mixture:

Printing pastes containing the said vat dye and thickened by a mixture (1:1) of tara gum carbamate thickener and Lameprint A6 conventional thickener were prepared and used for printing cotton fabrics. The printed goods were monitored for colour strength (K/S) and overall colour fastness properties. Results obtained are set out in Tables V.

It is clear (Table V) that the highest K/S is obtained when the paste is thickened by a mixture containing the carbamate derivative having the lowest nitrogen content (1 % N). Increasing the degree of carbamation is accompanied by a decrease in K/S. This holds good for all derivatives with one exception; carbamate derivative having 3.12 % in the mixture brings about prints with marginally higher K/S than carbamate derivative having 2.28 % N in the mixture.

The effect of storing before commence printing of pastes thickened by tara gum carbamate / Lameprint A6 mixture may be realized from Table V. As is evident storing is accompanied by a decrease in K/S values. This is rather in accordance with the above results obtained upon using pastes thickened by only tara gum carbamate derivative and, therefore, could be interpreted on similar lines.

4. Conclusion

Tara gum carbamate derivatives can be used successfully in printing cotton fabrics with vat dyes. In most cases the lower the nitrogen content, the higher the K/S. Samples printed using carbamated tara gum, in most cases, acquire higher K/S values than those obtained using Lameprint A6 commercial thickening agent. The overall fastness properties of the prints are nearly, identical, and in all cases ranging between good to very good for rubbing and very good to excellent for washing and perspiration.

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