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Research Article

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Enhancing dyeing of wool fibers with colorant pigment extracted from green algae

E. M. El-Khatib[1]*, N. F. Ali[2] and R. S. R. El-Mohamedy[3]

[1]Proteinic and Synthetic Fibers Department, National Research Centre, El Buhouth St., Dokki, Cairo, Egypt
[2]Dyeing and Printing Department, Textile Research Division, National Research Centre, El Buhouth St., Dokki, Cairo, Egypt
[3]Plant Pathology Department, Agriculture Research Division, National Research Centre, El Buhouth St., Dokki, Cairo, Egypt

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ABSTRACT

Natural dye obtained from green algae is used for dyeing wool fibers which are used in handloom carpets. Environmentally friendly pretreatment with chitosan and tannic acid were used for enhancing the dyeability of wool fibers. Factors affecting the dyeing properties such as dye concentration and time of dyeing with microwave were studied. Color strength was measured for dyed wool fibers.The results indicate that, wool fibers pretreated with chitosan and tannic acid leads to high color strength than the untreated fibers. The antimicrobial activity of dyed wool fibers pretreated with chitosan and tannic acid were studied. Some forms of bacterium and Fungi were tested, and therefore the results indicated that the pretreated samples exhibit higher growth reduction % than the untreated samples. Microwaves heating is eco-friendly, saving time and energy.

Keywords: Wool fibers, colorant pigment, algae, chitosan, tannic acid, dyeing, antimicrobial activity.

INTRODUCTION

Natural dyes are used since precedent days for coloring and printing fibers [1]. Natural dyes area unit environmental friendly, perishable and non-toxic. They're attracting the attention of individuals [2-4]. Many studies on the appliance of natural dyes are reported [5-7] to protect the environment and prevent pollution. Recently, the potentiality of using natural dyes in textile coloration as UV-protection and antimicrobial has been investigated [8-12].

Dyes and Colorants pigment from natural sources are environmentally friendly. Algae contain a wide range of photosynthetic pigments. Three majorclasses of photosynthetic pigments are chlorophylls, carotenoids and phycobilins. Phycocyanin and phycoerythrin belong to the major class of phycobilins, photosynthetic pigment while fucoxanthin and peridinin belong to carotenoid group of photosynthetic pigment. Chlorophyll was a mixture of two compounds, chlorophyll-a and chlorophyll-b. Chlorophyll-a (C55H72MgN4O5, mol. wt.: 893.49). The methyl group is replaced by analdehyde in chlorophyll-b (C55H70MgN4O6, mol. wt.: 906.51). [13]. Chlorophyta green algae contain chlorophyll as shown in Figurs 1-3.

The benefits of utilizing green algae as the source of dyes and food colorants matter are, in food coloring most of the pigments have high nutritional value unlike their manufactured added substances. They are eco-friendly because the process of production of natural dyes from algae does not involve the usage of harmful or polluting chemicals. The greater part of these effluents is biodegradable and can likewise be reused as fodder. Pigments derived from algae have been certified as safe for utilization as sustenance colorants due to non-toxicity and non cancer-causing nature.

These reasons have contributed to the increase in the requirement for non-toxic, eco-friendly colorants matter and dyes from Algae.

Chlorophyll as a food colorant is found to exhibit anti-mutagenic property. This is accomplished by inducing production of qarcinogen detoxifying enzymes, and thereby reducing the risk of cancer [14]. In pharmaceuticals, beta-carotene used in food coloring is a source of vitamin A. The human body converts beta-carotene to vitamin A via body tissues as opposed to the liver, hence avoiding a buildup of toxins in the liver. Beta-Carotene has antioxidant qualities [15].

Chlorophyll is photosynthetic green pigment mainly derived from Chlorella Spirogyra (sp).In the recent times; there is widening scope for industries to exploit the availability of other algal products, mainly dyes, fodder and bio-plastics. There is increased interest in bio-fuels and food supplements of algal origin. Due to the green color of chlorophyll, it has many uses as dyes and pigments. In textile Chlorophyll derivatives are used for dyeing fabrics such as wool and cotton.

Green strategy was used in this study for dyeing wool fibers which are used in handloom carpets. Colorant pigment extracted from green algae used for dyeing pretreated wool fibers by microwave heating.

EXPERIMENTAL SECTION

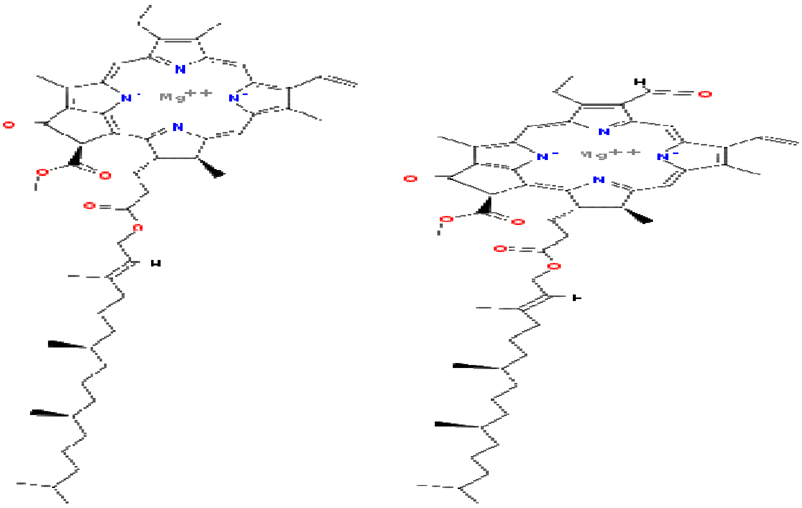
2.1. Materials:
2.1.1. Wool fibers**:** Wool fibers10/2, supplied by El Mahalla company-Egypt.

2.1. 2. Chemicals:
Chitosan high molecular weight (210,000), Poly (D-glucose amine).Tannic acid are laboratory grade chemical, non ionic detergent (hostapal CV. ET, Hochest)

2.1. 3. Dyestuff: Algal Pigments
Scientific classification:

Kingdom	: Protesta
Division	: Chlorophyta
Phylum	: Charophyta
Class	: Zygnematophyceae
Family	: Zygnemataceae
Order	: Zygnematales
Genus	: Spirogyra

Figure 1, Green algae



(a) **(b)**

Figure 2, Chemical Structure of Chlorophyll (a) and Chlorophyll (b)

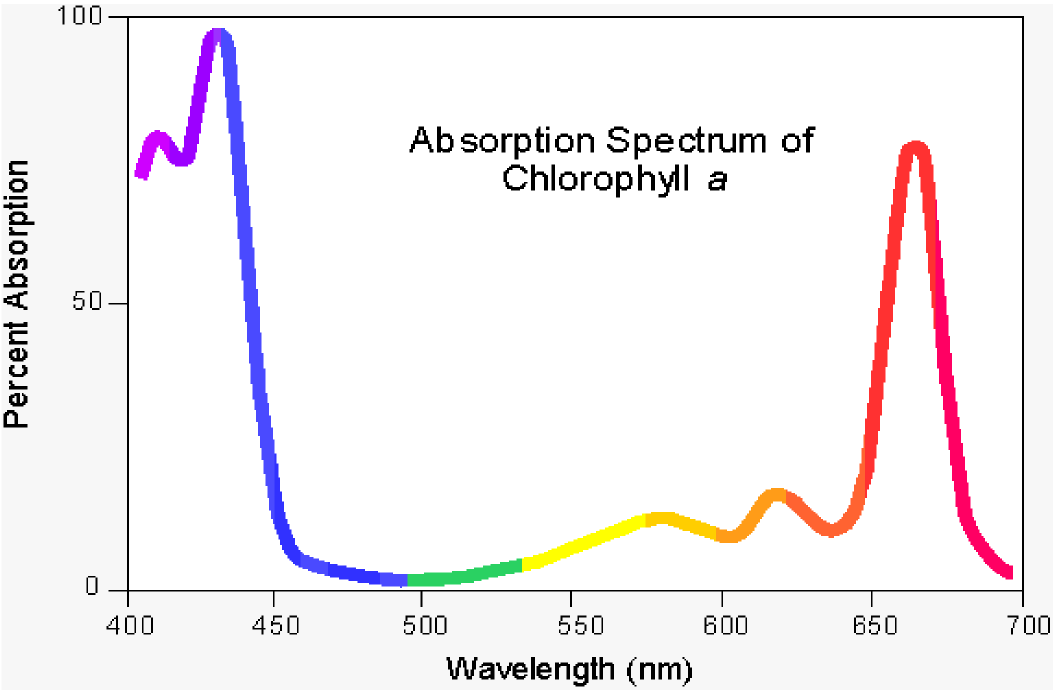


Figure 3, The uv/visible adsorption spectrum for chlorophyll

RESULTS AND DISCUSSION

3.1. Effect of The pretreatment on dyeing by microwave:

The pretreatment with chitosan and tannic acid leads to binding to the fiber. It may make chemical links either to the terminal -NH2 or -COOH groups of the polypeptide chain or to the functional groups present in the side chains of the component amino acids. Figure 4 showed that the treated samples exhibit higher values of K/S than the untreated samples .Figure 4, also, illustrate that the pretreatment with tannic acid is higher than the pretreatment with chitosan and untreated dyed wool fibers [16, 17] . Natural dyes binding by chemical bonds within the fibers without further chemical treatment . Natural dyes are adjective dyes and need the use of mordents to help their absorption on fibers. Tannic acid is a mordant make chemical bonds between the dye molecules and the functional groups of the fibers, and generally change the color produced by the dye[18].

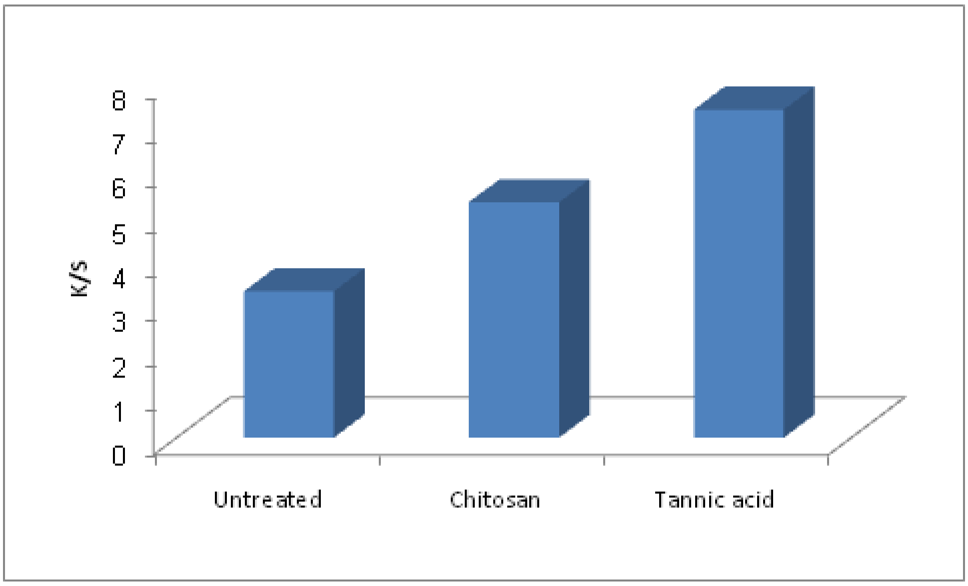


Figure 4, Effect of The pretreatment on dyeing by microwave

3.2. Effect of conc. of dye on dyeing by microwave:
Figure 5, shows that the K/S of untreated and pretreated wool fibers dyed colorant pigment extracted from green algae by microwave heating at different concentrations (1 – 5 g/L). The figure also shows that the K/S increase by increasing the concentration of chitosan and tannic acid till 5g/L [7].

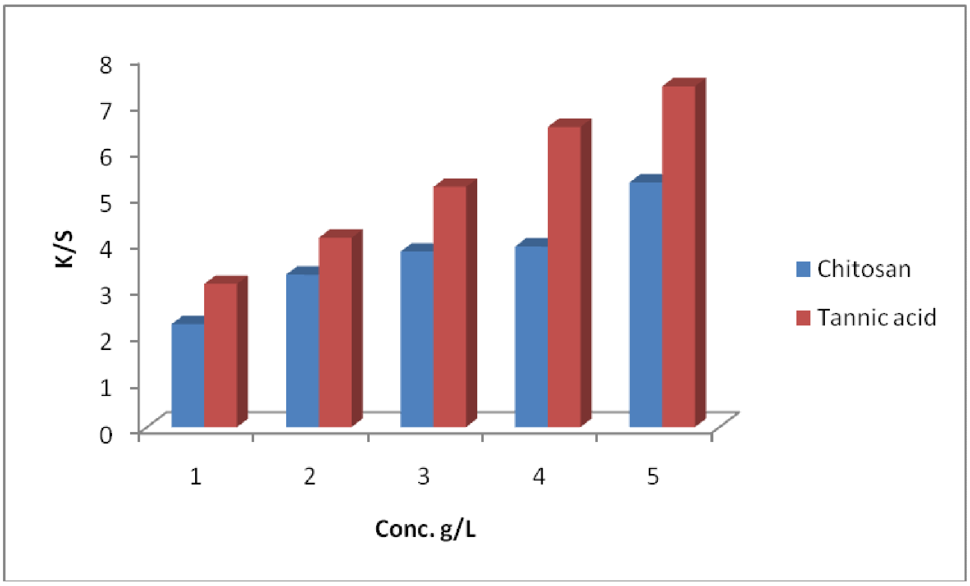


Figure 5, Effect of conc. of dye on dyeing by microwave

3.3. Effect of Time on dyeing by microwave:
The effects of time of dyeing on the K/S untreated wool fibers dyed with colorant pigment extracted from green algae at different time (1-6 minutes) were evaluated. Figure 6 shows that, the K/S increases with an increase in time till 4 minutes.

3.4. Fastness Properties:
The fastness properties of the untreated and pretreated wool fibers dyed with colorant pigment extracted from green algae are given in Table,1. The results revealed that the pretreated wool fibers exhibit higher values of fastness properties than the untreated wool fibers. This is due to their increased substantively to the fiber. The high ratings of fastness properties could be referred to the covalent binding linkages between the dye and pretreated wool fibers.

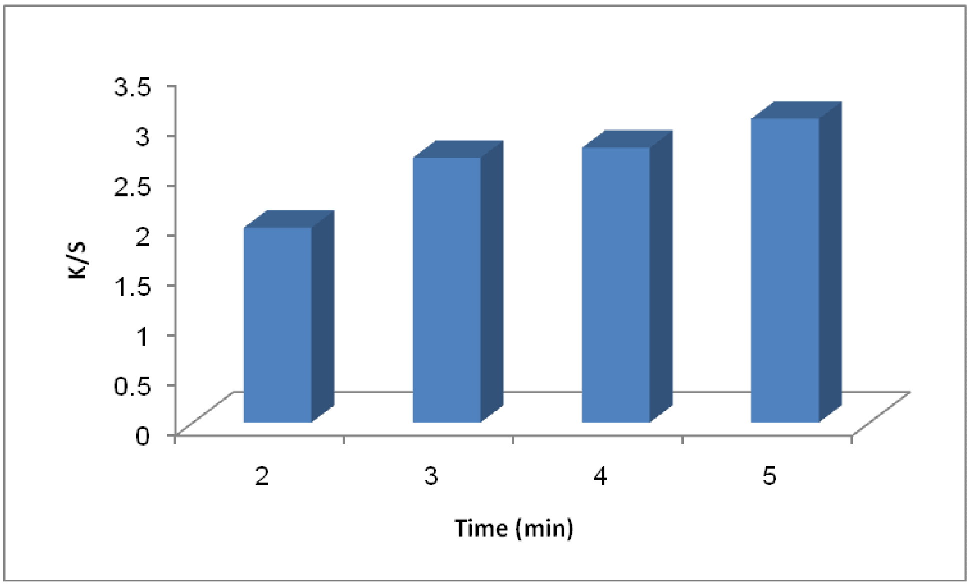


Figure 6, Effect of Time on dyeing by microwave

Table 1, The fastness properties of untreated and pretreated wool fibers with chitosan and tannic acid

Conc.	Dyed samples	Fastness to rubbing		Wash fastness		Light fastness
		Wet	Dry	Alt.	Sc.	
0	Untreated	4	4-5	4	4	5
5g/L	Chitosan	4-5	4-5	5	5	7
5g/L	Tannic acid	4	4	4	4	6

Wet = wet rubbing, Dry = dry rubbing, Alt. = change in color, Sc. = staining on cotton

3.5. Antimicrobial activity:

Antimicrobial activity of wool fibers pretreated with chitosan and tannic acid and dyed with colorant pigment extracted from green algae was evaluated and the results in Table 1. Results show that pretreatment with chitosan enhances the antimicrobial properties of wool fibers against all tested microbes. Antimicrobial activity of wool fibers tested in accordance to diffusion agented against tested microbes for example, *Pseudomans aeruginosa, Staphylococcus aureus, Asprigillus nigar, and , Asprigillus flavor.* The results indicate that, the samples pretreated with chitosan exhibit higher growth reduction percent than the untreated samples. Table 1, shows that, the antimicrobial properties against *Staphylococcus aureus,* (G +) was found to be greater than that of *Pseudomans aeruginosa* (G -), which can be attributed to the differences in the structure between the two types of bacteria. The antimicrobial properties of the pretreated samples can be attributed to the treatment by chitosan. The ability of chitosan to form true covalent bonds with wool fibers leads to improvements of the antimicrobial properties. Antimicrobial activity, expressed as growth reduction of the microorganisms, could be explained as follows, the amino groups in chitosan inhibit the microbe's metabolism by attacking the cell surface and binding with DNA. Pretreatment with chitosan shows more tendencies to attack on the surface of the fibers causing amino groups more easily inhibit microorganisms [5]. Wool fibers pretreated with chitosan and dyed with green algae as natural dye display high growth reduction of microbes [19- 21].

Table 2, Antimicrobial activity of untreated and pretreated dyed wool fibers with chitosan and tannic acid:

Microbes	% Growth reduction of the tested microbes		
	Untreated	Chitosan	Tannic acid
Staphylococcus aureus (G+)	39	90	70
Pseudomans aeruginosa (G -)	30	80	65
Asprigillus nigar	25	70	60
Asprigillus flavor	30	60	55

CONCLUSION

Wool fibers which are used in handloom carpets, pretreated with chitosan and tannic acid was dyed with colorant pigment extracted from green algae. The results obtained indicated that the dye concentration and time of dyeing affect on the color strength. The results also showed that, wool fibers pretreated with tannic acid and chitosan leads to high color strength than the untreated fibers. The antimicrobial activity of dyed wool fibers pretreated with chitosan is higher than wool fibers pretreated with tannic acid against the tested bacteria and fungi than the untreated samples. Microwaves heating is eco-friendly, saving time and energy.

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REFERENCES

[1] Fan Qinguo; Xue Hongxia; K. Kim Yong, *Research Journal of Textile and Apparel*., **2008**, 12,1-8.
[2] T. Bechtold; A. ,Mahmud- Ali; R., Mussak, *Dyes and Pigment*, **2006**. 70,1-7.
[3] T., Bechtold; A., Turcanu; E., Ganglberger; S., Gessler, *J.Clean. Prod.* **2003**.11,499–509.
[4] M.D.,Teli; R.Paul; P.D., Pardesi, *J. Colourage* . **2000**, 60, 43-48.
[5] A.A., Hebeish; N.F. Ali;. J.I., Abd El-Thalouth, *Research Journal of Textile and Apparel.* **2012**, 16 ,77-81.
[6] E. M., El-khatib; S. H., Abdel-fattah, *EL-Azahar Bulletin of Science*, **2004**, 15, 49- 58 .
[7] E. M., El-Khatib; N.F., Ali; M.A., Ramadan; *International Journal of current microbiology and applied science.* **2014,** 3, 757-764.
[8] N.F.,Ali; R.S.R., ELMohamedy; E.M., El-Khatib, *Research Journal of Textile and Appeal*, **2011**, 15, 1-10.
[9] N.F., Ali; E.M., El-Khatib; R.S.R.,El-Mohamedy; M.A.,Ramadan, *International Journal of Current Microbiology and Applied Sciences* ,**2014**, 3, 140-146.
[10] N.F.,Ali; E.M., El-Khatib; R.S.R., El-Mohamedy, *International Journal of Current Microbiology and Applied Sciences*, **2015,** 4, 1166-1173.
[11] E.M., El-khatib; N.F., Ali, *Research Journal of Textile and Appeal*, **2011,** 15, 62-69.
[12] M.M., El-Mollaa; E.M., El-Khatib; M.S., El-Gammal; S.H., Abdel-fattah; *Indian Journal of Fibre and Textile Research*, **2011**, 36, 266-271.
[13] G.M., Shokry; E. M. El-Khatib; N. F. Ali, *Al-Azhar Bull Sci*., **2010**, 21 ,21-34.
[14] M. G. Ferruzzi; J. Blakeslee, *Nutrition Research*, **2007**, 27,1–12.
[15] M. Humphrey; *Journal of Food Science*, **2004**, 69, 422–425.
[16] M.R, Avadi; A.M.M., Sadeghi; A.Tahzibi; K., Bayati; M., Pouladzadeh; M.J., Zohuriaan-Mehr, **2004**. *Eur. Polym*. 40, 1355-1361.
[17] E., Pascual; M. R., Julia, *Journal of Biotechnology*, **2001**, 89: 289-296.
[18] Y., Gao; R., Cranston; *Text. Res. J.* **2008**. 78, 60-72.
[19] J .M., Cardamone; *AATCC Rev*, **2002**, May, 30-5.
[20] M. C., Thiry, *AATCC Rev*., **2009**, Nov, 11-7.
[21] S., Rajni; J., Astha; P., Shikha; G., Deepti, *Dyes and pigment*, **2005**, 66: 99-102.