Asian Journal of Chemistry; Vol. 23, No. 2 (2011), 566-568

ASIAN JOURNAL OF CHEMISTRY

www.asianjournalofchemistry.co.in

Colour and Fastness of Fabrics Dyed with Walnut (*Juglans regia* L.) Base Natural Dyes

MUSTAFA TUTAK[1,*] and HÜSEYIN BENLI[2]

[1]Department of Textile Engineering, Erciyes University, TR-38039, Kayseri, Turkey
[2]Mustafa Çikrikçioglu Vocational School, Erciyes University, TR-38039, Kayseri, Turkey

*Corresponding author: Fax: +90 352 4375784; Tel: +90 352 4374937-32876; E-mail: mtutak@erciyes.edu.tr

(*Received*: 8 February 2010; *Accepted*: 20 September 2010) AJC-9109

Turkey has a great number of walnut trees which include nutritious components. However, only the inside part of walnut is used as a nutrient while the rest of it is waste. This study suggests that the waste parts of the walnut could be used as a natural dye for dyeing textile fibres. The dyeing properties of leaves, husk and shell of the walnut were examined on various textile fibres (wool, cotton and viscose) by using different metal salts. Mordants used in dyeing process were choosen as potassium dichoromate, copper sulphate, iron sulphate and alumunium sulphate. Colour performance and fastness properties were investigated after dyeing process. The experimental results indicate that walnut based products can be used in textile dyeing as natural dyes.

Key Words: Walnut, Natural dye, Textile, Dyeing, Fastness.

INTRODUCTION

Walnut fruit is widely produced in Turkey. It was estimated that there are 4 milion walnut trees and the annual shelled walnut production is about 170 thousand tones in Turkey while it is 1.724 thousand tonnes in the world[1-3]. The walnut is reaped usually in autumn depending on the climatic conditions. Only the inside part of walnut is used as a nutrient while the rest of it is waste. In this study, the unused parts of the walnut were intended as a dye for textile dyeing materials. Fig. 1 shows the parts of the walnut which we used.

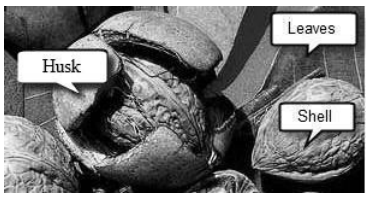

Fig. 1. Walnut parts used in textile dyeing

Natural dyes derived from vegetable and other sources are used for different purposes[4-8]. These natural dyes are ecological not only for human health, but also for environment[9-11]. In this study, some parts of walnut were choosen as plant based natural dyes and the dyeing performance of leaves, husk and shell of walnut was examined on wool, cotton and viscose fabric.

Metal salts were used to provide exhaustion and fixation for the dyeing of textile materials. Metal ions are collected on the fiber surface in an aqueus media and supported dyeing textile materials creating natural dye and metal ion. Fig. 2 shows the complex structure formed between fiber and dye.

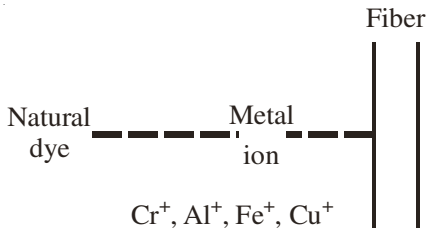

Fig. 2. Natural dye, metal ion and fiber schematically

EXPERIMENTAL

Fabric: The wool, cotton and viscose fabrics were considered as fabric types. The characteristics of the fabrics used are shown in Table-1.

TABLE-1
CHARACTERSITICS OF THE FABRICS

Fiber type	Weight (g/m^2)	Surface type	Fabric density
Wool	117	Weawed	r: 25, s: 11
Cotton	245	Weawed	we: 18, wa: 40
Viscose	137	Knitted	r: 25, s: 11

r: row, s: stick, we: weft, wa: warp.

Natural dyes and mordants: The leaves, husk and shell of walnut were first dried in outdoors. After that, they were kept in distilled water (the rate of dry natural dye source to

distilled water is 1:15) during one day for the extraction of natural dyes. The aqueus solution was boiled two times and cooled down to room temperature for increasing the yield of natural dye. The obtained coloured solutions were filtered and used in dyeing process[12,13].

Potassium dichromate, copper sulphate, iron sulphate and aluminium sulphate were used as metal salts, the mordaning procedure of textile fabrics is together mordantaion (1 % owf, ower weight for fiber). In this process, metal salt was added to the dyeing bath before adding the natural dye.

Dyeing: All of the dyeing processes were carried out in a laboratory dyeing machine (Termal) at a liquor ratio of 20:1 (rate of 20 mL natural dye solution to 1 g of textile materials) according to exhaustion technique. Dyeing diagram is shown in Fig. 3.

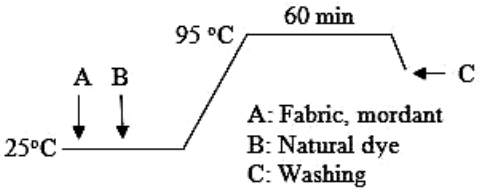

Fig. 3. Dyeing diagram of natural dyeing

Dyeing was started at 25 ºC, fabric, mordant and natural dye were added, respectively. The temperature was then raised to 95 ºC (2 ºC/min) and dyeing continued at this temperature for further 1 h. After dyeing, the washing of dyed fabrics was carried in cold and warm water[14].

Determination of colour performance: The colour performance of naturally dyed fabrics with various mordants was determined in two stages: (i) K/S colour yield and Lab colour coordinates; (ii) light, washing and rubbing fastnesses.

Colour measurement of dyed fabrics were performed on Konica minolta 3600d reflectance with D65 light source and 10º observer. Irradiation of the dyed fabrics was carried out using a Xenotest 150S+ light fastness test instrument (Atlas). Washing and rubbingfastness test were performed according to the standards[15].

RESULTS AND DISCUSSION

Colour strenght: The colour yield of dyed fabrics is experssed by K/S Kubelka-Munk equation[16]. The experimental K/S results are presented in Fig. 4.

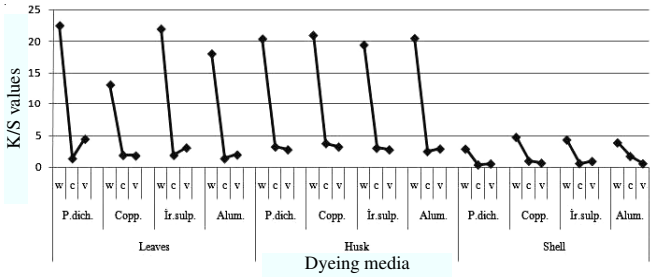

Fig. 4. K/S values of dyed fabrics

The results showed that the obtained K/S values were varied between 0.50-22.5. The colour yields of fabrics dyed by leaves and husk were higher than those of fabrics dyed by shell of walnut in general. Husk and leaves colour yields were higher on wool fabrics by using potassium dichromate mordant than the other fabric and mordant types which K/S were smaller than 5.

CIE Lab colour coordinates were determined for different walnut base natural dyes, mordants and fabric used. CIE Lab colour coordinates of the dyed fabrics are presented in Table-2.

TABLE-2
CIE LAB COLOUR COORDINATES OF DYED FABRICS

	Mordant	Fiber	L	a	b
Leaves	$K_2Cr_2O_7$	Wool	46.05	14.22	47.91
		Cotton	74.88	0.72	18.01
		Viscose	69.04	0.52	23.55
	$CuSO_4$	Wool	58.19	4.44	36.45
		Cotton	75.52	1.27	25.13
		Viscose	73.18	0.11	21.78
	$FeSO_4$	Wool	25.11	3.53	10.96
		Cotton	75.52	1.27	25.13
		Viscose	60.98	2.17	15.85
	$Al_2(SO_4)_3$	Wool	49.85	3.87	35.22
		Cotton	74.86	0.20	26.71
		Viscose	71.52	1.65	17.65
Husk	$K_2Cr_2O_7$	Wool	27.36	11.13	14.93
		Cotton	55.67	3.65	16.05
		Viscose	53.60	5.31	15.74
	$CuSO_4$	Wool	27.16	11.94	16.35
		Cotton	52.07	3.34	15.14
		Viscose	54.72	4.39	14.88
	$FeSO_4$	Wool	25.88	8.48	12.11
		Cotton	56.11	3.22	15.35
		Viscose	58.19	5.30	15.51
	$Al_2(SO_4)_3$	Wool	26.70	10.26	14.24
		Cotton	58.72	3.24	15.2
		Viscose	58.36	5.76	17.19
Shell	$K_2Cr_2O_7$	Wool	62.7	2.21	16.51
		Cotton	80.78	1.24	76.70
		Viscose	78.66	1.98	9.96
	$CuSO_4$	Wool	57.03	-0.24	19.35
		Cotton	73.80	3.05	12.96
		Viscose	75.99	2.60	10.09
	$FeSO_4$	Wool	52.89	2.54	12.96
		Cotton	79.78	2.06	11.87
		Viscose	62.28	2.89	7.84
	$Al_2(SO_4)_3$	Wool	56.10	3.17	14.09
		Cotton	62.09	2.42	9.49
		Viscose	75.53	2.27	6.62

CIE Lab colour presented in Table-2 were analyzed, it was understood that the leaves, husk and shell of walnut give different colours on fabrics. In particular, different colours were obtained depending on the mordant types used in dyeing process. Such as, dyeing wool fabric with leaves of walnut dark red colour was obtained by using iron sulphate mordant, while brown colour was obtained by using copper mordant. In this regard, obtaining different colours of the same fabric by using different mordants can be accepted as an advantage.

Fastness properties: The colour fastness to light, rubbing and washing of dyed fabrics was determined. Light fastness results are shown in Fig. 5. Rubbing and washing fastnesses are shown in Table-3.

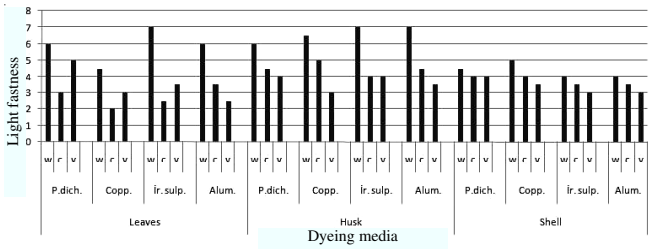

Fig. 5. Light fastness of dyed fabrics (w: wool, c: cotton, v: viscose)

TABLE-3
RUBBING AND WASHING FASTENESS OF DYED FABRICS

	Mordant	Fiber	Rubbing fastness		Washing fastness	
			Dry	Wet	Chan.	Stain.
Leaves	$K_2Cr_2O_7$	Wool	5	5	5	4/5
		Cotton	5	4	5	4/5
		Viscose	5	3/4	4	4/5
	$CuSO_4$	Wool	4/5	4/5	5	4/5
		Cotton	5	4/5	2	4/5
		Viscose	5	5	4	4/5
	$FeSO_4$	Wool	4	2/3	4	4/5
		Cotton	5	3/4	4	4/5
		Viscose	4/5	4	3	4/5
	$Al_2(SO_4)_3$	Wool	5	4/5	4	4/5
		Cotton	5	5	4	4/5
		Viscose	5	5	4	4/5
Husk	$K_2Cr_2O_7$	Wool	5	5	5	4/5
		Cotton	5	3/4	2	3
		Viscose	4/5	3/4	3	3/4
	$CuSO_4$	Wool	5	4/5	5	4/5
		Cotton	5	3	2	3
		Viscose	5	3/4	4	3
	$FeSO_4$	Wool	5	4/5	5	4/5
		Cotton	5	3/4	2	3
		Viscose	4/5	4	3	3/4
	$Al_2(SO_4)_3$	Wool	5	4	5	4/5
		Cotton	5	5	2	3
		Viscose	5	3/4	3	3
Shell	$K_2Cr_2O_7$	Wool	5	5	5	4/5
		Cotton	5	5	4	4/5
		Viscose	5	5	3	4/5
	$CuSO_4$	Wool	5	5	4	4/5
		Cotton	5	5	4	4/5
		Viscose	5	5	5	4/5
	$FeSO_4$	Wool	4/5	4/5	4	4/5
		Cotton	5	5	4	5
		Viscose	5	5	4	4/5
	$Al_2(SO_4)_3$	Wool	5	5	4	4/5
		Cotton	5	3/4	4	4/5
		Viscose	5	5	4	4/5

The highest light fastness were achieved on fabrics dyed with the husk madder used. In fabrics dyed by husk, the light fastness of wool fabric was better than cotton and viscose fabrics. The light fastness levels of fabrics dyed by leaves and shell of walnut were between medium and low. Similar with fabrics dyed by using husk, the light fastness of wool fabric dyed by leaves and shell was better than cotton and viscose fabrics depending on the types of mordant.

The rubbing fastness of all fabric types dyed by using different natural dye and mordants was higher in dry form than that of the wet form of fabrics. However in wet form, rubbing fastness of wool fabric was higher compare to cotton and viscose fabrics. When the wet rubbing fastnesses of cotton fabrics and viscose fabrics were compared with each other, cotton fabrics showed better colour fastness to rubbing.

The assessing washing fastness results was performed considering the staining and changes in colour. Fabrics dyed by using leaves and potassium dichromate mordant showed the highest washing fastness in colour changing. The lowest washing fastness in colour changing was observed on fabrics dyed by using shell with each mordant. The highest washing fastness in colour changing was obtained on wool fabric. Generally, washing fastnesses in staining of fabrics were high except for the fabrics dyed by using shell.

Conclusion

The interest of using natural dyes on textile materials is recently increased. In this study, the unused parts of walnut in nutrition were used as natural dyes. For this purpose, three different parts (leaves, husk and shell) of walnut were used for dyeing wool, cotton and viscose fabrics.

The dyeing performances of these fabrics were determined considering K/S and colour fastness properties. The results of the experimental study are listed below: (i) Fabrics could be dyed by using the waste parts of walnut leaves, husks and shell with a suitable mordant. (ii) The obtained colour was changing depending on dye parts of walnut and types of mordant used in dyeing process. This situation is advantegeous in terms of the same natural dye sources obtainable different colour. (iii) Wool fabric dyed by using husk and leaves of walnut and potassium dichromate mordant gave the highest colour strength value. (iv) Rubbing fastness of fabrics was in a high level in dry form while the level of wet rubbing fastness was between medium and low. The highest dry rubbing fastness was obtained on wool fabrics. (v) Washing fastness in colour changing was in level of medium/low while it was in high level for staining.

ACKNOWLEDGEMENTS

This work was supported by Research Fund of the Erciyes University (Project Number: FBA-07-40).

REFERENCES

1. Y. Akca and S. Ozongun, *New Zealand J. Crop Horticul. Sci.*, **32**, 337 (2004).
2. E. Barut, Third International Walnut Congress, p. 442, 435 (1997).
3. www.fao.org/faostat
4. L.J. Wang, J. Li and H. Feng, *Pigm. Resin Tech.*, **38**, 347 (2009).
5. R.M. Shistawy, G.M. Shokry, N.S.E. Ahmed and M.M. Kamel, *Fibres Polym.*, **10**, 617 (2009).
6. L.H. Lv, J. Wu and F. Ye, Proceedings of the Fiber Society Conference 2009, (1-2), 1399 (2009).
7. P. Mazeyar, *Res. J. Chem. Environ.*, **13**, 49 (2009).
8. R. Sivakumar, R. Javaprakasam, V. Renuga and C. Sasikumar, *Asian J. Chem.*, **21**, 5960 (2009).
9. T. Oktem, A. Gurel and H. Akdemir, *AATCC Rev.*, **3**, 24 (2003).
10. V.R.G. Dev, J. Venigopal and S. Sudha, *Carbohyd. Polym.*, **75**, 646 (2009).
11. M. Rekaby, A.A. Salem and S.H. Nassar, *J. Textile Inst.*, **100**, 486 (2009).
12. A. Onal and B. Demir, *Asian J. Chem.*, **21**, 1149 (2009).
13. H. Merdan, F. Eray and A. Onal, *Asian J. Chem.*, **20**, 608 (2008).
14. P.S. Vankar, R. Shanker and S. Wijapala, *Pigm. Resin Tech.*, **38**, 242 (2009).
15. TSE Standard, TSE ISO 105 B02, TSE ISO 105 C06, TSE 717 EN ISO 105-X12, Ankara, Turkey (2001).
16. R. McDonald, Colour Physics for Industy, SDC Publication, West Yorkshire, pp. 57-80 (2001).