

Investigation of the Usability of Hibiscus Plant as a Natural Dye Source

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Abstract

In this study, it was targeted to investigate the availability of hibiscus plant in the coloration of wool fabrics. For this aim the wool samples, which are ready for dyeing, were dyed directly with the dried and grinded hibiscus plant. Dyeings were carried out using different mordanting agents according to the simultaneously mordanting method. In addition, mordant-free dyeing processes were carried out too. The dyeing process was carried out at 3 different concentrations of the natural dye source. After dyeings, for the evaluation of the colored wool samples, the CIE L*a*b* color values and color efficiencies (K/S) of the dyed fabrics were examined. In addition, washing and light fastnesses were also tested in order to evaluate the usage performances. As a result, it was observed that wool fabrics could be colored in the dyeing processes with hibiscus.

Key words: Wool, hibiscus, natural dyeing, mordants

1. Introduction

Dyes are generally used in textile, paper, cosmetic, food, pharmaceutical and leather industries [1]. The use of natural colors for dyeing fabrics has been in practice for ancient times [2]. Natural dyes have many advantages, such as low toxicity and allergic reactions, in addition to biodegradability, because they are taken from animal or plant matter without chemical processing [3]. Together with the development of technology and production of synthetic dyes, natural dyes started to lose their importance gradually [4]. However application of natural dyes for textiles is increasing due to awareness of environment, ecology and pollution control [5].

Hibiscus sabdariffa L. (family Malvaceae), commonly known in English as roselle or red sorrel and in Arabic as karkadeh, is widely grown in Central and West Africa, South East Asia and away [6]. Hibiscus anthocyanins are phenolic natural pigments extracted from the dried flowers of *Hibiscus sabdariffa L.* (Malvaceae) that have been used effectively in folk medicines and recently, it has gained an important position in the local soft drink market [7]. Being high in anthocyanin, Rosella petal is both a good colorant and potentially a good source of antioxidants [8].

Hibiscus can be used as a source of dyestuffs in natural dyeing, although there are many uses in the health and beverage industry today. Therefore, it is aimed to investigate the usability of hibiscus plant in natural dyeing.

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2. Materials and Method

2.1. Materials

Wool fabrics, which were ready for coloration, were used in the study. The hibiscus was obtained from local markets in dried form and then they were grinded before using in dyeing.

2.2. Methods

In dyeing of textile materials different mordanting agents: 3% copper (II) sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), 3% tin (II) chloride ($\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$), 3% iron (II) sulphate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$), 3% potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$), or 20% alum ($\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$) were simultaneously used and not mordanted but dyed samples were tested. The hibiscus used in the dyeings was added directly to the dye bath without applying any extraction previously. The liquor ratio was adjusted to 1:50 during the dyeings and the ratio of hibiscus used in dyeing to fabric was 1:0.5, 1:1 and 1:2. The dyeing process was carried out in a laboratory-type sample dyeing machine.

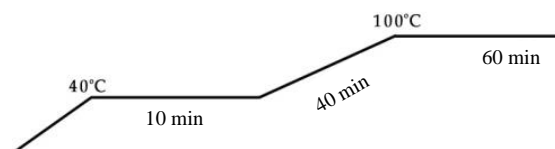


Figure 1. Dyeing diagram

The dyed fabrics were then tested in terms of color efficiencies (K/S) and color values (CIE $L^*a^*b^*$) with the help of Konica Minolta 3600d spectrophotometer. Also the washing fastness with ISO 105-C10 standard in test condition of Test A (1) [9] and light fastness with ISO 105-B02 standard [10] were evaluated too.

3. Result and Discussion

In dyeing of wool fabrics with hibiscus 5 different mordanting agents; “copper (II) sulphate, tin (II) chloride, iron (II) sulphate, potassium dichromate, alum” was used also not mordanted but dyed samples were prepared too. After dyeing process wool fabrics were washed and dried in room temperature.

After dyeing of the fabrics with hibiscus the colors and color efficiencies of the fabrics were measured and collected in Table 1. In terms of the color efficiencies generally the low concentration of dye source caused lower color efficiency. For example not mordanted-dyed samples and the samples dyed in presence of alum mordant have exhibited the lowest color efficiencies in 1:0.5 dye concentrations. In that case the color efficiencies were 3.23 and 2.23 respectively. Meanwhile the highest color efficiencies were observed from the fabrics dyed in presence of iron (II) sulphate for wool fabrics in 1:2 dye concentration. In that case the color efficiencies were 13.47.

Table 1. Color efficiencies and color values of dyed samples

Dye Concentration	Type of Mordant	K/S	CIE L*a*b* (D65)				
			L*	a*	b*	C*	h°
1:0.5	No mordant	3.23	55.45	7.41	11.45	13.64	57.16
1:1	No mordant	5.34	48.72	10.30	13.50	16.98	52.64
1:2	No mordant	9.42	41.51	11.00	14.64	18.31	53.16
1:0.5	CuSO ₄ .5H ₂ O	5.61	52.61	7.67	20.98	22.34	69.91
	SnCl ₂ .2H ₂ O	6.34	38.64	-1.36	-9.56	9.65	261.89
	FeSO ₄ .7H ₂ O	7.75	47.23	4.30	15.56	16.14	74.52
	K ₂ Cr ₂ O ₇	4.06	55.44	2.24	16.92	17.07	82.48
	KAl(SO ₄) ₂ .12H ₂ O	2.23	61.79	3.24	10.94	11.42	73.68
1:1	CuSO ₄ .5H ₂ O	8.19	46.82	9.44	20.86	22.90	65.64
	SnCl ₂ .2H ₂ O	9.02	32.39	1.21	-9.29	9.37	277.41
	FeSO ₄ .7H ₂ O	10.17	41.06	5.15	13.59	14.53	69.23
	K ₂ Cr ₂ O ₇	5.82	49.79	4.16	17.47	17.96	76.62
	KAl(SO ₄) ₂ .12H ₂ O	3.74	53.99	6.15	11.57	13.10	61.98
1:2	CuSO ₄ .5H ₂ O	13.07	39.31	10.42	19.21	21.86	61.53
	SnCl ₂ .2H ₂ O	13.01	29.44	2.47	-2.65	3.64	313.59
	FeSO ₄ .7H ₂ O	13.47	35.18	6.34	12.33	13.86	62.81
	K ₂ Cr ₂ O ₇	10.11	41.66	6.46	17.26	18.43	69.49
	KAl(SO ₄) ₂ .12H ₂ O	7.41	45.37	8.70	14.09	16.56	58.23

Wool fabrics were dyed with hibiscus and different colors were obtained such as blue, brown, khaki. Besides, depending on the mordanting agent type different color shades were obtained too. For example, it was observed that light brown color can be obtained with hibiscus in 1:1 dye concentration mordant-free dyeing and the color obtained after the dyeings with hibiscus in presence of mordant-free has L*=48.72; a*=10.30; b*=13.50 and h°= 52.64 in 1:1 dye concentration. Interestingly blue color has been obtained with hibiscus in 1:1 dye concentration via SnCl₂.2H₂O and the color obtained after the dyeings in presence of SnCl₂.2H₂O has L*=32.39; a*=1.21; b*=-9.29 and h°= 277.41.

➤ Color Fastnesses of dyed samples

To analyze the usability of the hibiscus as a natural dye source washing and light fastnesses were also examined.

Table 2. Light fastness of samples

Type of Mordant	Dye Concentration		
	1:0.5	1:1	1:2
No mordant	2	2	2-3
CuSO ₄ .5H ₂ O	4-5	3	3-4
SnCl ₂ .2H ₂ O	2	2	2-3
FeSO ₄ .7H ₂ O	2	2-3	2-3
K ₂ Cr ₂ O ₇	3-4	3-4	4
KAl(SO ₄) ₂ .12H ₂ O	2	2	2

The light fastnesses of samples were varied depending on the mordanting agent type and concentration. The highest light fastness was obtained in sample dyed with CuSO₄.5H₂O at natural dye concentration of 1:0.5.

Table 3. Washing fastness of samples

Type of Mordant	Dye Concentration					
	1:0,5		1:1		1:2	
No mordant	C.C.	1/2	C.C.	2/3	C.C.	2/3
	Sta.	5	Sta.	4/5	Sta.	5
CuSO ₄ .5H ₂ O	C.C.	4/5	C.C.	4/5	C.C.	4
	Sta.	5	Sta.	5	Sta.	5
SnCl ₂ .2H ₂ O	C.C.	2/3	C.C.	2	C.C.	1/2
	Sta.	4/5	Sta.	5	Sta.	4/5
FeSO ₄ .7H ₂ O	C.C.	4	C.C.	4	C.C.	3
	Sta.	5	Sta.	5	Sta.	4/5
K ₂ Cr ₂ O ₇	C.C.	5	C.C.	5	C.C.	5
	Sta.	5	Sta.	5	Sta.	5
KAlSO ₄ .10H ₂ O	C.C.	1	C.C.	1	C.C.	1
	Sta.	5	Sta.	5	Sta.	4/5

(Sta.: Staining on wool; C.C.:Color Change)

According to the fastness results in Table 3, it was observed that sufficient/good washing fastnesses can be obtained depending on the selected mordanting agent. But the dyed wool fabrics have exhibited better staining on wool samples when compared with the color change degree.

4. Conclusion

Today, studies are being carried out on the use of many plant sources in idle condition as a source of natural dyes. In this respect it is easy to face with different scientific studies however there are limited studies on the use of hibiscus as a natural dye source. For this reason hibiscus obtained from local markets were evaluated for the coloration of wool fabrics and finally it was found that hibiscus plant can be used in the coloring of woolen fabrics.

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