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Determination of Dyeing Properties in Petals of Different Safflower (*Carthamus tinctorius* L.) Varieties

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The aim of the study is to determine weld dyeing properties by using different mordants and dyeing methods. A pre-mordanting method was used in the dyeing of woolen yarn with petals of safflower varieties. In this study, Dincer, Yenice and Remzibey safflower varieties (thornless, thornless, thorny) and control, N_5, N_{10}, N_{15}, kg/da nitrogen doses were used. The experiment was carried out in randomized complete block design with 3 replications that were grown in the Department of Field Crops, Faculty of Agriculture, Ankara University. Petals of safflower that were obtained were exposed to dyeing without using mordant and by using copper sulphate, iron sulphate, potassium bichromate, sodium chloride, sodium sulphate mordants. Colours obtained as a result of the dyeing were evaluated subjectively and colourful wools were assessed in terms of light, rubbing and water drop fastness values.

Key Words: Vegetable dyeing, Safflower, Dyeing methods, Fastnesses.

INTRODUCTION

In recent years, the demand of natural products, considered to be components of safer characteristics than the synthetic ones, has contributed to the rediscovery of colours from plant sources[1]. Because of the health hazards of many synthetic dyes, the industry is looking for more ecologically friendly products. Plant dyes appear as interesting alternatives however, the dyeing process must be optimized to enhance the fastness to washing, to light and the resistance to rubbing[2].

Plants are traditionally used for dyeing of the yarn of wool carpet and rug. The plants of those dyes consist of plants that grow naturally and of culture plants. Active dyestuff parts of plants are used for dyeing. Some parts of plants like leaf (grapevine, walnut, quince, *etc.*), flower (daisy, safflower, *etc.*), sprigs (crimson tree, *etc.*), under ground soil suckers (madder, *etc.*), roots (kadin tuzlugu, licorice), peel of fruits (onion, walnut, *etc.*) and seeds as well as whole parts of some plants like mullein and peppermint are used[3].

Safflower (*Carthamus tinctorius* L.) consists of tubular florets, which are light red in colour. The florets are used for the same purposes as saffron, the dried stigma of *Crocus sativus* L. and are sometimes admixed with it or occasionally, substituted for it[4]. The red florets are used as crude drug in oriental medicine and as a natural dye, especially in silk cloth and rouge. The red pigment in the petals of safflower has been used as dye, raw material of cosmetics, a safe colouring agent and herbal medicine[5].

A water-soluble yellow dye, called safflower yellow, is also extracted from it as well as an alcohol-soluble red dye, safflower carmine or carthamin, a chalcone glycoside[6]. Carthamin has been applied as a useful dye-stuff for over 2000 years in some countries in the world, particularly in Egypt, Arabia, Iran, India, China, Korea and Japan[7].

The aim of the present study was to determine light, abrasion, wet and dry water drop fastness of various safflower varieties and different nitrogen doses by assaying several mordants.

EXPERIMENTAL

Petals of three different safflower varieties (Yenice, Dincer and Remzibey) were collected from the trials of the Department of Field Crops, Faculty of Agriculture, Ankara University and Ankara, Turkey.

The obtained petals of safflower were exposed to dye without using mordant and by using copper sulphate, iron sulphate, potassium bicromate, sodium chloride, sodium sulphate mordants as well as 2.5 Nm white (non-dyed) woolen carpet yarn. A total of 72 dyes were carried out by making use of non-mordant and the above-mentioned mordants.

The extract was prepared with the same method in the dyes with and without mordant.

Preparation of the dye extract: Dried leaves were crumbled into tiny pieces by hand in order to enable the dye content of the safflower to ooze into water. Then the plant taken by 100 % according to the weight of the wool yarn to be dyed was boiled for 1 h in the water at a rate of 1/50 according to the weight of the wool yarn that is subjected to dye. At the end of this process, the remnants of the plant were discarded and thus the extract was obtained.

Colours obtained as a result of the dyeing were evaluated subjectively and colourful wools were assessed in terms of light, rubbing and water drop fastness values.

Dyeing without mordanting: Wool yarn that had been kept wet for dampness beforehand was put into the prepared extract and was boiled for 1 h. During the boiling, some more water was added. At the end of this stage, it was left for cool and rinsed with plenty of water and finally dried.

Mordanting: Mordants that were taken by 3 % according to the wool weight were dissolved in 1/50 warm water, pre-dampened woolen yarn was placed into this mordanted water and boiled for 1 h. At the end of this stage, woolen yarn was compressed and readied for dye treatment.

Mordanting dyeing: Woolen yarns that had been mordanted through the aforementioned methods were boiled in the extract for 1 h and left to cool up by itself. It was then rinsed with plenty of water to dry up in a shadowy and airy place.

Determination of the colours obtained: The naming of the colours obtained was made subjectively. They were named by the experts of Ankara University, Faculty of Agriculture, College of Home Economy, Unit of Textile and Wearing, Department of Village Hand Craft. For this purpose, dyed woolen samples were spread out on white ground where the sunlight came from the side. They were divided into groups according to colour differences and common colour names were given[8].

Light fastness determination: Light fastness determination was done according to TS 867 prepared by TSE (for dyed or pressed textiles colour fastness testing methods-colour fastness determination methods facing sunlight)[9] and DIN 5033[10].

Rubbing fastness determination: Rubbing fastness determination was done according to TS 717 prepared by TSE (for dyed or pressed textiles colour fastness testing methods-determination of colour fastness to rubbing)[11] and TS 423 (using methods of the gray scale for sum up the staining leaking of dye and discolouring chancing of colour, in the determination of colour fastness of textiles)[12].

Water drop fastness determination: Water drop fastness determination was done according to TS 399 prepared by TSE (the determination of colour fastness to water drop)[13] and TS 423 (using methods of the gray scale for sum up the staining leaking of dye and discolouring chancing of colour, in the determination of colour fastness of textiles)[12].

RESULTS AND DISCUSSION

In this experiment, the colours obtained as a result of the 72 dyeing made with the application of 5 mordants in proportion of 3 % and without mordant by using safflower petals in proportion of 100 % in compliance with the weight of wool yarn were shown in Table-1.

As seen in Table-1, light green olive oil, green olive oil, light henna green, henna green, mustard, light mustard, dark mustard, yellow, light straw yellow, dark straw yellow, dirty yellow, chicken yellow, saffron yellow, cumin, dark cumin, filtered honey and dark filtered honey were obtained as a result of the usage of mordants in proportion of 3 % from safflower petals. When the proportion of mordant was 5 %, green, dark green, dry oak leaf, light henna green, dark henna green, light green olive oil, light mustard and mustard colours were obtained.

TABLE-1
COLOURS THAT WERE OBTAINED ACCORDING TO SAFFLOWER VARIETIES AND NITROGEN DOSES IN MORDANT RATE 3 %

Safflower varieties and nitrogen doses	Mordant name	Colours	Safflower varieties and nitrogen doses	Mordant name	Colours
Dincer variety and N_0	Copper sulphate	Light henna green	Yenice variety and N_{10}	Copper sulphate	Light green olive oil
	Iron sulphate	Henna green		Iron sulphate	Green olive oil
	Potassium bichromate	Mustard		Potassium bichromate	Mustard
	Sodium chloride	Mustard		Sodium chloride	Light mustard
	Sodium sulphate	Light mustard		Sodium sulphate	Light mustard
	Without mordant	Yellow		Without mordant	Yellow
Dincer variety and N_5	Copper sulphate	Light green olive oil	Yenice variety and N_{15}	Copper sulphate	Cumin
	Iron sulphate	Henna green		Iron sulphate	Henna green
	Potassium bichromate	Mustard		Potassium bichromate	Dark straw yellow
	Sodium chloride	Dark filtered honey		Sodium chloride	Filtered honey
	Sodium sulphate	Filtered honey		Sodium sulphate	Filtered honey
	Without mordant	Yellow		Without mordant	Chicken yellow
Dincer variety and N_{10}	Copper sulphate	Henna green	Remzibey variety and N_0	Copper sulphate	Dark cumin
	Iron sulphate	Light green olive oil		Iron sulphate	Cumin
	Potassium bichromate	Mustard		Potassium bichromate	Saffron yellow
	Sodium chloride	Dark filtered honey		Sodium chloride	Saffron yellow
	Sodium sulphate	Saffron yellow		Sodium sulphate	Saffron yellow
	Without mordant	Dark straw yellow		Without mordant	Saffron yellow
Dincer variety and N_{15}	Copper sulphate	Green olive oil	Remzibey variety and N_5	Copper sulphate	Light henna green
	Iron sulphate	Henna green		Iron sulphate	Henna green
	Potassium bichromate	Light mustard,		Potassium bichromate	Dark straw yellow
	Sodium chloride	Straw yellow		Sodium chloride	Dark filtered honey
	Sodium sulphate	Dirty yellow		Sodium sulphate	Filtered honey
	Without mordant	Chicken yellow		Without mordant	Chicken yellow
Yenice variety and N_0	Copper sulphate	Light henna green	Remzibey variety and N_{10}	Copper sulphate	Light green olive oil
	Iron sulphate	Henna green		Iron sulphate	Green olive oil
	Potassium bichromate	Saffron yellow		Potassium bichromate	Dark mustard
	Sodium chloride	Light mustard		Sodium chloride	Light mustard
	Sodium sulphate	Light mustard,		Sodium sulphate	Light mustard
	Without mordant	Yellow		Without mordant	Filtered honey
Yenice variety and N_5	Copper sulphate	Light green olive oil	Remzibey variety and N_{15}	Copper sulphate	Light green olive oil
	Iron sulphate	Green olive oil		Iron sulphate	Green olive oil
	Potassium bichromate	Dark mustard		Potassium bichromate	Dark mustard
	Sodium chloride	Dark filtered honey		Sodium chloride	Light mustard
	Sodium sulphate	Dark filtered honey		Sodium sulphate	Light mustard
	Without mordant	Dirty yellow		Without mordant	Yellow

Frequency distribution of the colours obtained is indicated in Table-2. It is seen that light mustard was obtained with 13.89 % as the highest, followed by henna green (9.72 %), light green olive oil and saffron yellow (8.33 %) and mustard, yellow, dark filtered honey, filtered honey, green olive oil (6.94 %), light henna green, dark straw yellow, chicken yellow, dark mustard (4.17 %), dirty yellow and cumin (2.78 %), straw yellow and dark cumin colours were obtained as the lowest (1.39 %) (Table-2).

TABLE-2
FREQUENCY DISTRIBUTION OF THE COLOURS OBTAINED

Obtained colours	Number	%
Light mustard	10	13.89
Henna green	7	9.72
Light green olive oil	6	8.33
Saffron yellow	6	8.33
Mustard	5	6.94
Yellow	5	6.94
Dark filtered honey	5	6.94
Filtered honey	5	6.94
Green olive oil	5	6.94
Light henna green	3	4.17
Dark straw yellow	3	4.17
Chicken yellow	3	4.17
Dark mustard	3	4.17
Dirty yellow	2	2.78
Cumin	2	2.78
Straw yellow	1	1.39
Dark cumin	1	1.39

It was found that colours obtained when dyeing with and without mordant by means of petals of safflower varieties which are Dincer, Yenice and Remzibey and nitrogen doses (N_0, N_5, N_{10} and N_{15}) obtained from 12 plots with different treatments were used the most in weaving carpets and rugs.

Determination of the light, rubbing and water drop fastnesses of the colours obtained is significant for the usage of colourful yarns for longer periods in weaving carpets and rugs. For this reason, in this study, light, rubbing and water drop fastnesses were carried out according to the standards[9-12]. According to the standards, light fastness values are considered between 1 and 8 and the other fastnesses between 1 and 5. Values obtained as a result of the fastness analyses were determined and are given in Table-3.

As can be observed from Table-3, light fastness values are found to have ranged between 2 and 7. The highest value of 7 was obtained from the dyeing by means of the use of copper sulphate mordant in the Dincer variety petals and with no nitrogen. The lowest value of 2 was obtained from the

TABLE-3
LIGHT, ABRASION, DRY AND WET WATER DROP FASTNESS THAT WERE OBTAINED ACCORDING TO SAFFLOWER VARIETIES AND NITROGEN DOSES IN DIFFERENT MORDANTS (MORDANT RATE 3 %)

Mordant name	S. var and N. doses	1*	2	3	4	S. var and N. doses	1*	2	3	4
Copper sulphate	Dincer variety and N_0	7	2-3	4-5	5	Yenice variety and N_{10}	4	3-4	5	5
Iron sulphate		5	2-3	4	5		3	1-2	4	5
Potassium bichromate		4	3-4	3-4	4-5		4	4	5	5
Sodium chloride		4	3	3-4	4		2	4	5	5
Sodium sulphate		4	4	3	4-5		3	4	3	5
Without mordant		3	3-4	4	5		2	3-4	4-5	5
Copper sulphate	Dincer variety and N_5	4	3-4	4	5	Yenice variety and N_{15}	5	3	4-5	5
Iron sulphate		5	1-2	4-5	4-5		5	3	4-5	5
Potassium bichromate		4	2-3	5	5		4	3	2-3	5
Sodium chloride		2	3-4	3-4	4		3	3-4	5	5
Sodium sulphate		2	3-4	4-5	5		3	4	2	4
Without mordant		2	3	3	5		3	3-4	3	5
Copper sulphate	Dincer variety and N_{10}	4	2-3	2-3	5	Remzibey variety and N_0	2	3-4	3-4	4
Iron sulphate		5	3	4-5	5		2	4	4	4-5
Potassium bichromate		4	3-4	3-4	4-5		3	2	3-4	4-5
Sodium chloride		3	4	4-5	5		2	3-4	4-5	5
Sodium sulphate		2	4	4	4-5		2	4	5	5
Without mordant		2	4	3-4	5		2	3-4	3-4	5
Copper sulphate	Dincer variety and N_{15}	5	3	5	5	Remzibey variety and N_5	5	3	5	5
Iron sulphate		5	1-2	3-4	5		4	3-4	3-4	4-5
Potassium bichromate		4	3	4	5		4	4	3-4	4-5
Sodium chloride		2	4	5	5		3	3	4	5
Sodium sulphate		2	4	5	5		5	3	4-5	5
Without mordant		2	4	4-5	5		5	3	4-5	5
Copper sulphate	Yenice variety and N_0	5	3	4	5	Remzibey variety and N_{10}	3	5	2-3	4
Iron sulphate		5	2-3	4	5		3	4	2-3	2
Potassium bichromate		4	3	3	4		3	4	3	5
Sodium chloride		2	3-4	3-4	5		3	2	3-4	4-5
Sodium sulphate		2	4-5	3-4	5		3	2	3-4	3-4
Without mordant		2	3-4	3-4	5		3	3	3	4-5
Copper sulphate	Yenice variety and N_5	4	2-3	3	5	Remzibey variety and N_{15}	3	4	4	4
Iron sulphate		4	2-3	4-5	5		3	3	3	4
Potassium bichromate		3	3	3-4	4-5		3	4	3	3
Sodium chloride		4	3-4	3-4	5		3	5	3-4	4-5
Sodium sulphate		2	3-4	4-5	5		3	3	3-4	4
Without mordant		2	4	5	5		3	2	3	4

*1 = Light fastness; 2 = Abrasion fastness; 3 = Wet water spotting fastness; 4 = Dry water spotting fastness

dyeing by means of sodium cloud and sodium sulphate mordants in all the treatments except the petals from the plots of Dincer variety and with no nitrogen, Remzibey and N_{10} and Remzibey and N_5. When all the treatments are examined in general in respect of light fastness, they were found to be at medium and good levels except those that result in values of 2.

When it is reviewed in terms of rubbing fastness, the values range from 1 to 4-5. The value of 4-5, the highest of all, was derived from the dyeing conducted with the sodium sulphate mordant in Yenice safflower

petal and N_5 whereas the value of 1, the least of all, was derived from the dyeing conducted with the iron sulphate mordant of the same safflower petal and N_{15}. While dyeing that was done through iron sulphate mordant resulted in low values, the other sorts of dyeing had fairly good rubbing fastness values in general.

As to water drop fastness, wet water drops are seen to have changed between 2 and 5 and dry water drops to be between 4-5 and 5. Wet water drop fastness values were at medium and good levels whereas dry water drop fastness values indicated good values. When dry water drop fastness value is 5, no trace is left on the dyed woolen yarn after it has dried up even after water drops (Table-3).

Differentiation seen in the colours was more affected by the mordants than by the cultivars. Even though the light fastness values determined in present study as medium to good level, it can be seen as a disadvantage, tourists' choices towards the faded dyed carpets and kilims rule out this disadvantage. Generally, the fact that the colours obtained are commonly used in the hand-woven carpets and results indicates that safflower petals could be easily used as vegetal dyes.

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