

Characterization and Application of Natural Dye Extracted from Rinds of Pomegranate (*Punica granatum* L)

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ABSTRACT

In this research, the rinds of pomegranate (*Punica granatum* L.) was chosen for dye extraction. The mineral contents of sample was analyzed by Energy Dispersive X-ray Fluorescence (EDXRF) spectroscopy. The dye solution of sample was extracted by using aqueous method. Physical properties (pH, specific gravity, viscosity) of natural dye were determined by using AOAC official method. Two different mordants such as common salt and ash were used in the dyeing process. After that, the extracted dye was applied in dyeing of wool yarn, cotton cloth and silk cloth. Finally, rubbing fastness and washing fastness tests were used to predict the performance of dye in wool yarn, cotton cloth and silk cloth.

Keywords : pomegranate, viscosity, wool yarn, cotton and silk cloth

1 INTRODUCTION

Natural dyes were used only for coloring of textiles from ancient times till the nineteenth century. Coloring materials obtained from natural resources of plant, animal, mineral, and microbial origins were used for coloration of various textile materials. Recent environmental awareness has again revived interest in natural dyes mainly among environmentally conscious people. Natural dyes are considered eco-friendly as these are renewable and biodegradable; are skin friendly and may also provide health benefits to the wearer. [1]

There are two types of dyes: natural dyes and synthetic dyes. Natural dyes are biodegradable, non-toxic and generally have higher compatibility with the environment when compared with their synthetic counterparts. [2] For thousands of years people all over the world followed the same basic techniques using roots, stems, barks, leaves, hard wood, berries fruits, flowers of various dye plants and tree, as well as from certain insects and shell-fishes. Some other associated advantages include excepted non-toxicity/lower toxicity and anti-allergen and some medicinal value as well as antimicrobial and UV protective character of some of the natural dyes. Finally, the process of natural dyeing becomes more expensive than synthetic dyes. [3]

Pomegranate resources have many active components which have not been fully utilized, almost all abandoned, which caused great waste of resources. Pomegranate peel contains yellow pigment, and folk has the records about using the bioled water of pomegranate dyeing the white cloth. The main components of natural pigment are pomegranate polyphenols. Pomegranate peel is a good natural vegetable dye. [4] The main coloring agent in the pomegranate peel is granatonine which is present in the alkaloid form N-methyl granatonine. [5] In this research, the rinds of pomegranate (*Punica granatum* L.) was chosen for dye extraction.

Botanical Description

Family name: Punicaceae
Scientific name: *Punica granatum* L.
Myanmar name: Tha-lae



Figure (1) The plant and fruit of *Punica granatum* L.

2 EXPERIMENTAL

2.1 Sampling

The sample of rinds of pomegranate was collected from Hopin Township, Kachin State in Myanmar. The collected sample was cleaned and removed unwanted materials. These cleaned samples were cut into small pieces and dried in good ventilation place for a week. These samples were used for dye extraction.

2.2 Determination of Elemental Compositions in the Rinds of Pomegranate

The elemental contents of the rinds of pomegranate (*Punica granatum* L) were measured by applying EDXRF (Energy Dispersive X-ray Fluorescence) Spectroscopy method.

2.3 Extraction of Natural Dye Solution from the Rinds of Pomegranate

Dye solution was extracted from the rinds of pomegranate (*Punica granatum* L.) by using aqueous method. 20 g of dry sample was boiled with 300 ml of distilled water about 1 hour. And then, the dye solution was cooled for a few minutes and filtered. Finally, the filtrate was used in the dyeing process.

2.4 Determination of Physical Properties of Dye Sample

The pH was determined by using AOAC official method. [6] 20 ml of dye sample solution was placed in a beaker. The pH of dye solution was determined by using pH meter. The specific gravity was determined by using AOAC Official method. [7] The viscosity of dye solution was determined by using Ostwald viscometer. [8]

2.4 Application of Prepared Dye Solution

2.4.1 Bleaching of Wool Yarn, Cotton Cloth and Silk Cloth

Firstly, wool yarn, cotton cloth and silk cloth were washed in tap water with two drops of detergent to remove water soluble material. It was soaked in cold water about 24 hours. It was washed with distilled water and wring out. Finally, they were used for the dyeing process.

2.4.2 Pre-mordanting of Wool Yarn, Cotton Cloth and Silk Cloth

Only pre-mordanting technique was used. These samples were soaked in 300 ml of common salt solution and 300 ml of ash solution and each for 30 minutes. It was used for dyeing process. After applying mordant, the sample was squeezed and subjected for dyeing.

2.4.3 Dyeing of Wool Yarn, Cotton Cloth and Silk Cloth with Prepared Dye Solution

The sample after applying mordant was placed in the beaker. 300 ml of dye solution was added in this beaker and stirred with glass rod to uniform the color on the sample and boiled about 1 hour. After that, the dyeing sample was left out from dye solution and dried in shade and good ventilation place. The dried dyeing sample was obtained.

2.5 Determination of Rubbing Fastness and Washing Fastness

The dried dyeing sample was sent to Development Center for Textile Technology, Ministry of Industry, Yangon, Myanmar to measure the color fastness to rubbing test and color fastness to washing test.

3 RESULTS AND DISCUSSION

3.1 Determination of Mineral Compositions in Rinds of Pomegranate

The results of mineral contents of rinds of pomegranate using EDXRF spectral data are described in Table (1).

Table (1) Mineral Contents of Rinds of Pomegranate

No.	Element	Symbol	Relative Abundance (%)
1.	Potassium	K	0.677
2.	Silicon	Si	0.141
3.	Calcium	Ca	0.130
4.	Sulphur	S	0.067
5.	Phosphorus	P	0.048
6.	Iron	Fe	0.005
7.	Copper	Cu	0.001
8.	Titanium	Ti	0.001
9.	Manganese	Mn	0.001

According to the EDXRF spectral data, there are nine mineral elements are present in the sample. Among them, potassium was found to be highest amount (0.677 %) in the rinds of pomegranate. In addition, there is no toxic heavy metal in the sample. Thus, natural dye extracted from the rinds of pomegranate can be considered as eco- friendly and safe to the wearer.

3.2 Determination of Physical Properties of Dye Solution

3.2.1 The pH of Dye Solution and Mordant Solution

The pH of the dye and mordant solutions were determined by using pH meter and the recorded data are described in the tables (2) and (3).

Table (2) pH of Dye Solution

Solvent system	Sample	pH	
Distilled Water	Rinds of pomegranate	4.9	5 ± 0.12
		4.9	
		5.1	

Table (3) pH of Mordant Solution

No.	Mordant solution	pH	
1.	Common salt	6.5	6.5 ± 0.10
		6.6	
		6.4	
2.	Ash	12.6	12.5 ± 0.12
		12.6	
		12.4	
		12.4	

3.2.2 Specific Gravity of Dye Solution

The specific gravity of dye solution was determined by using specific gravity bottle and the recorded data are described in Table (4).

Table (4) Specific Gravity of Dye Solution

Solvent system	Sample	Specific gravity	
Distilled water only	Rinds of pomegranate	1.148	1.148 ± 0.002
		1.150	
		1.146	

3.2.3 Viscosity of Dye Solution

The viscosity of dye solution was determined by using viscometer and the recorded data are described in Table (5).







Table (5) Viscosity of Dye Solution

Solvent system	Sample	Viscosity	
D/W only	Rinds of pomegranate	2.06	2.07 ± 0.031
		2.08	
		2.07	

3.3 Dyeing Process of Wool Yarn, Cotton Cloth and Silk Cloth

In the dyeing process, two types of mordant solutions were used. The different colors of Wool Yarn with two different mordants are tabulated in the table (6).

Table (6) Color of Dyeing Wool Yarn with Two Mordants

Dye Solution	Mordant (Common Salt)	Mordant (Ash)
Rinds of pomegranate (wool yarn)		
Rinds of pomegranate (Cotton cloth)		
Rinds of pomegranate (Silk cloth)		

3.4 Washing Fastness Properties of Dyeing Products

This test determines the loss & change of color in the washing process by a consumer and the possible staining of other garments or lighter portion that may be washed with it.

Table (7) Results of Washing Fastness of Dye Wool Yarn, Cotton and Silk Cloth

Type of Sample	Type of mordant	Washing Fastness ISO. Test 3 60°C; 30mins		
		Change in Shade		
		Wool yarn	Cotton cloth	Silk cloth
Rinds of pomegranate	Common salt	1	1	1
	Ash	2	2	1

The result of washing fastness dyeing wool yarn and cotton cloth are the change in shade 1 and 2, but silk cloth observed the change in shade 1. It means that the overall results of washing fastness are not reach the best rating level but they reach fairly good rating level.

3.5 Rubbing Fastness Properties of Dyeing Products

The sample has to be tested in the delivered condition; don't wash and/or tumble it before testing the fabric/sample has to be air conditioned at least 8 hours by standard climate (20°C/ 65 % relative humidity).

Table (8) Results of Rubbing Fastness of Dyed Wool Yarn, Cotton and Silk Cloth



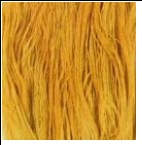



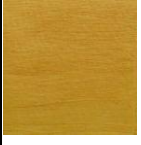
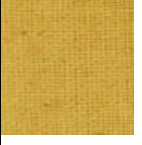
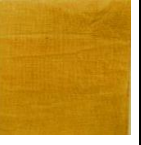


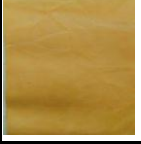
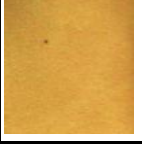


Type of sample	Type of mordant	Rubbing Fastness 500 s; 100 Times					
		Wool yarn		Cotton Cloth		Silk Cloth	
		Dry Mark	Wet Mark	Dry Mark	Wet Mark	Dry Mark	Wet Mark
Rinds of pomegranate	Common salt	3	2-3	4	3	3	2-3
	Ash	4	3	4	3	3-4	3

The standard rating and its results are:

- rating 1 - very poor
- rating 2 - poor
- rating 3 - fair
- rating 4 - good
- rating 5 - excellent

The change in color of the sample was compared with standard scale. For both wool yarn and cotton cloth are acceptable and good condition for dry test and fair condition for wet test. For silk cloth is fair condition for both dry and wet test.

Table (9) Results of Before and After Rubbing Fastness Test

Natural Dye Solution	Yarn/ Cloth	Without mordant	Mordant Common Salt		Mordant Ash	
			Before Rubbing fastness	After Rubbing fastness	Before Rubbing fastness	After Rubbing fastness
Rinds of pomegranate	Wool yarn					
	Cotton cloth					
	Silk cloth					

When rinds of pomegranate was used as dye solution for dyeing on wool yarn, cotton cloth and silk cloth with two mordants such as common salt and ash, before rubbing fastness dyed wool yarn and cotton cloth give deep yellow colors (common salt and ash) and silk cloth gives yellow color (common salt and ash). After rubbing fastness, dyed wool yarn, cotton cloth and silk cloth become fade than the original colors.

4 CONCLUSION

In this research, the natural dyes were extracted from rinds of pomegranate. Elemental analysis by using EDXRF revealed that rinds of pomegranate has little amount of mineral. This means that they have rich organic compound. In addition, the dye solutions were extracted by using distilled water only. The physical parameters of extracted dye solution were determined. The pH of dye solution is acidic. The pH of dye solution is 5. The pH of mordant solutions are pH = 6.5 (common salt) and pH = 12.5 (ash). The specific gravity of dye solution was 1.148. The viscosity of dye solutions was 2.07 cP.

The results of washing fastness dyeing wool yarn and cotton cloth are the change in shade of 1 and 2, but silk cloth observed the change in shade 1. It means that the overall results of washing fastness are not reached the best rating level but they reach fairly good rating level. Wet and dry of rubbing fastness were determined. It was found that dyeing processes was reached in good materials (rating 4) in dry mark condition. The staining ratings of dry rubbing fastness were ranged within 3-4 to 4, but wet fastness was ranged within 2-3 to 3. So, it was noticed that dry rubbing fastness was found slightly better than wet rubbing fastness.

The overall results can be concluded that very aesthetically pleasing colorants can be extracted and applied from rinds of pomegranate for the coloring textiles or any other dyeing purpose. Finally, it can be concluded that the use of natural dyes worldwide should be increased to prevent synthetic dyes, pollution, and other harmful effects.

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