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Studies on Natural Dye (*Pelargonidin)* Extraction from Onion Peel and Application in Dyeing of Leather

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Abstract

In recent times, synthetic dyes are more widely used than natural dyes. However, natural dyes are eco-benign and harmless. In the growing demand for eco-friendly coloring agents in process industries such as food, textiles, leather, and others, natural dyes have high potential. The manufacture and the use of the same necessitate better raw materials and processing methods. These natural dyes could also be obtained from waste vegetable materials such as peels, shells, seeds. The sources were pomegranate peels, onion peels, leaves of eucalyptus, walnut husks, peanut shells, strawberries, indigo seeds, sunflower seeds. India is the second-largest onion producer globally, and about 2.3 to 4.5 Million Tonnes of onion peels are produced per year in India. The peels of onions provide a prosperous source of plant compounds called flavonoids, and a dye named Pelargodinin can also be obtained. The dye extraction was carried out by using acetic acid (10% solution) and compared with water-based extraction. The yield of natural dyes from onion peel has been analyzed using UV-VIS spectroscopy. Extraction using water gave a dark red dye. Acetic acid extraction yielded a dark pink dye. UV-VIS spectrometry and gravimetric analysis have been done for each dye extracted. Percentage Extract Yield of Dye is 20% and 23.3%, respectively, for the water and acetic acid-based extraction processes. A piece of leather was also dyed using Pelargonidin dye obtained from Onion peel, extracted using acetic acid, and useful. In this regard, the present paper, practical use of these Onion peels for a beneficial purpose such as Natural Dye extraction has been studied as viable Development of Eco-benign products from Agricultural waste material.

Keywords: *Leather, Natural Dyes, Pelargonidin dye, Onion Peel extract, Eco-benign, Eco-friendly, Leather Dyeing, Cleaner processing.*

I. INTRODUCTION

Dyes derived from natural sources have emerged as an essential alternative to synthetic dyes. Therefore, there is a need for developing better solid-liquid extraction techniques for leaching natural colorants from plant materials for applications in plant research, food as well as dyeing industries. Studies were already carried out using dyeing of leather using onion peel dye along with mordants [1-3]. The use of Onion peel extract natural in textile dyeing for UV protection has also been studied [4]. Adam et al. has extracted dye stuff from onion and evaluated its application in feathered leather, woolen, and cotton [15]. It is possible to extract natural dyes from by-products such as food, wood, and agricultural waste at lower costs [2]. Examples of unconventional sources of dyeing can be beetroot, beetle nut, marigold flower, mango seed, onion peel. These sources are easy to collect, and their dyeing process does not harm the environment [3]. Synthetic dyes suffer from several drawbacks and toxic [6]. The application of synthetic dyes releases a large amount of waste and unfixed color. Natural dyes are good biodegradable [7]. Due to increasing awareness among people about the harmful effects of synthetic dyes, products made from natural materials are gaining popularity [8]. The natural source used in the present study is onion peel. Onion is a beneficial and available source of natural dye [9]. Process optimization is one of the major works carried out by chemical engineers. Extraction of natural dyes from beetroot and other plant materials using ultrasound-assisted leaching of coloring matter from plant materials has been studied earlier [10,11].

A. Onion Peel Natural Dye – Pelargonidin

Onion is one of the widely used vegetables in different food dishes for consumption. India is the second-largest producer of onion in the world and accounts for about 22.43 Million Tonnes of onion per year [12]. Onion peels are essentially removed before usage, and the %yield of the usable peeled onion vary from 73.5 – 81.6 % depending on the size of the onion in the range of 2.5 inches to 4.5 inches [13]; therefore, on average, Onion peels account for about 10-25% (%*w/w* basis) based on the total weight of the onion; which produces significant quantities of the vegetable waste material. In extrapolation of the values, about 2.3 to 4.5 Million Tonnes of onion peels are produced per year in India. This would not only cause a substantial environmental problem for waste disposal but reduce the economic value of the valuable Onion material as an Agricultural product. Hence, these Agricultural product wastes provide enormous opportunities for developing countries like India for the development of some value-added and Eco-benign products, as necessary for generating both Economics as well as Employment generation on the

one hand and Development of Eco-benign products on the other. In this regard, the present paper studies, practical use of these Onion peels for a beneficial purpose such as Natural Dye extraction has been studied.

The objectives of this study are

- To extract Pelargonidin dye from onion peels acetic acid.
- To optimize the extraction process based on various temperature conditions and the number of onion peels used.
- Dyeing of leather using extracted dye solution using the acetic acid method.

B. Natural dyes

Sources of natural dyes

There are many sources of natural dyes. The majority of natural dyes are vegetable dyes from plant sources; roots, berries, bark, leaves and peels, and other biological sources such as fungi and lichens.

Properties of natural dyes

- It is cost beneficial.
- It is eco-friendly.
- It is free from carcinogens, unlike synthetic dyes.

Advantages of natural dyes

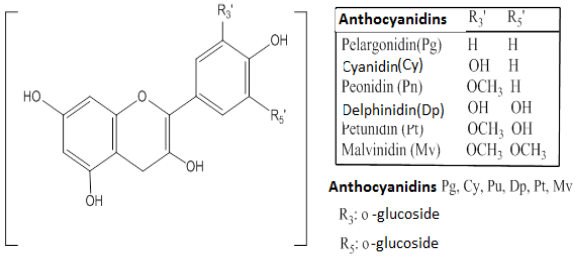
- Natural dyes are more eco-friendly than synthetic dyes.
- Most of the natural dyes are antioxidants.
- Natural dyes are obtained from renewable sources that can be harnessed without imposing harm to the environment.
- No disposal problem.
- Natural dyes are non-hazardous to human health.
- The sources of natural dyes are readily available.
- Natural dyes are biodegradable.
- Natural dyes are skin-friendly.
- It is possible to obtain a full range of colors using various mordants.

C. Onion peel

Components and structure of onion peel

- Onion peel (Fig. 1) possesses a high content of carbohydrates (88.56%) and deficient protein (0.88%), ash (0.39%) and crude fiber (0.15%).
- Analyses of mechanical properties show that the mechanical strength of papery scales was higher than the fleshy scales of onion.
- Papery scales of onion contain quercetin, an anti-inflammatory compound. It is composed of three layers, namely, epidermis, parenchyma tissue, and lower epidermis.
- The lower epidermis contains galactose and calcium cross-linking pectic polysaccharides.
- Calcium cross-linking pectic polysaccharides plays an important role in cell-cell adhesion.
- Onion peel contains a dyestuff called Pelargonidin (3, 5, 7, 4 tetrahydroxy antocyanidol), as shown in Fig. 2.
- Pelargonidin is linked with glucosides namely quercen-49- glucoside and quercen-3, 49-diglucoside.

Fig.1. Papery scales of onion



Anthocyanidins	R_3'	R_5'
Pelargonidin(Pg)	H	H
Cyanidin(Cy)	OH	H
Peonidin (Pn)	OCH_3	H
Delphinidin(Dp)	OH	OH
Petunidin (Pt)	OCH_3	OH
Malvinidin (Mv)	OCH_3	OCH_3

Anthocyanidins Pg, Cy, Pu, Dp, Pt, Mv

R_3: o-glucoside

R_5: o-glucoside

Fig.2. Structure of Pelargonidin

D. Applications of Pelargonidin dye

The applications of Pelargonidin dye are

- Dyeing of leather
- Dyeing of textiles
- Dyeing of paper
- Food coloration
- Natural coloring agent

II. MATERIALS AND METHODS

A. Materials used

Onion peels were collected from a local vegetable market waste (Fig. 3) and some residential areas located in Chennai. These onion peels were cut into small pieces for effective extraction.

Fig.3. Photograph of Onion peel waste

B. Chemicals used

Acetic acid (glacial) used for dye extraction was purchased from Merck company. The collected Pelargonidin dye was dried in a hot air oven at 40^0C for 4-5 hours. The hot air oven is bought from SEMCO Company. The maximum temperature at which the hot air oven can be set is 250^0C, and the rating 1.8KW.

C. Equipment's used

The equipment used in the manufacture of Pelargonidin dye is:

- Magnetic stirrer (IKA C-MAG HS 10 digital company)
- Hot air oven (SEMCO company)
- UV-Vis spectrophotometer (SHIMADZU UV-2700)

Pelargonidin dye was extracted by a magnetic stirrer. The collected Pelargonidin dye was dried in a hot air oven at 40ºC for 4-5 hours. All the samples were analyzed using a UV-Vis Spectrophotometer. The absorbance of the samples was recorded for the wavelength range of 200 – 400 nm using the spectrum method.

D. Methods

a) Standard graph

- 0.3 gm of the powdered Pelargonidin dye (water extracted) was taken in a volumetric flask and made up to 100 ml using distilled water.
- From this stock solution, known volumes (0.1,0.2,0.3,0.4,0.5,0.6,0.7) of the dye samples were again taken in a volumetric flask and made up to 10 ml using distilled water.
- A plot of Concentration (mg/ml) Vs. Absorbance at λmax. = 292 nm was made, and this was taken as the standard plot.
- The slope of this graph was found and which was used to calculate the concentration of the dyes obtained by various methods.

b) Extraction using acetic acid

The dye is extracted using solvents like acetic acid and water. For extraction, 0.5 g of onion peels were taken, and 5 ml of the concentrated acetic acid was dissolved in 45 ml of distilled water and was used for extraction purposes. Therefore acetic acid and water were taken in the ratio of 1:9.

The mixture is continuously stirred using a magnetic stirrer. The process was continuously monitored for the entire experimental period. Samples of 5 ml were collected from the mixture at regular intervals. 4 ml of the sample was taken for gravimetric analysis. 1 ml of the sample was taken for UV analysis. All the experiments were performed as batch processes (Fig. 4).

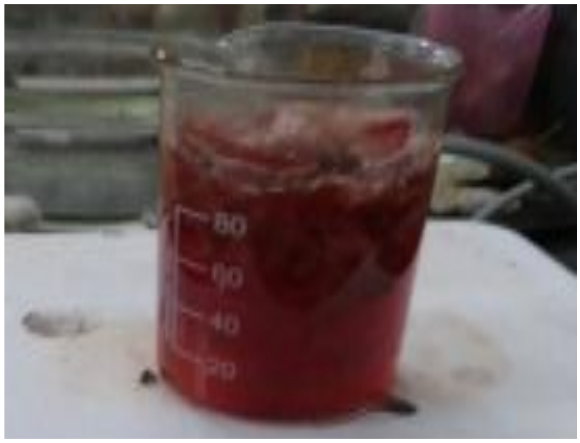


Fig.4. Extraction of dye using a magnetic stirring method

a) Analysis of Natural Dye

1) UV-Vis spectrophotometer

All the samples were analyzed using a UV-Vis Spectrophotometer, SHIMADZU UV-2700. The absorbance of the samples was recorded for the wavelength range of 200 – 400 nm using the spectrum method.

2) Gravimetric Analysis

For Gravimetric analysis, 4 ml of the Pelargonidin dye was collected and allowed to dry in a hot air oven for 5-6 hours. The weight of the dye obtained was determined.

The percentage yield was calculated using the following formula:

%Yield of Natural Dye = (Weight of dried sample) × (Volume of the sample left in the beaker) / (Volume of the sample taken for gravimetric analysis) × (Weight of onion peel used)

III. RESULTS AND DISCUSSIONS

A. Standard graph

A standard graph (Fig. 5) was drawn for different dye extract concentrations from the Absorption value at 292 nm taken as λmax. The slope of the standard graph was 0.7411. The concentration of various Pelargonidin dye samples was calculated, incorporating a suitable dilution factor. The various Absorption values and Concentrations of the dye samples in stock solution are shown in Table. 1.

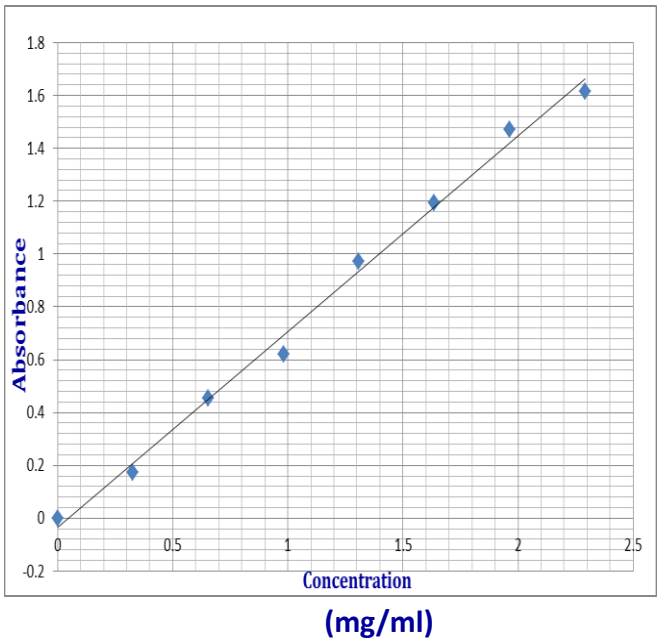


Fig.5. Standard graph of Pelargonidin dye

Table 1 UV analysis for dye samples extracted using Acetic acid

Time (H)	Control		Experiment	
	Absorbance	Concentration (mg/ml)	Absorbance	Concentration (mg/ml)
0	0.205	0.3733	0.075	0.1012
1	0.297	0.5408	0.356	0.4804
2	0.334	0.6081	0.372	0.502
3	0.340	0.6191	0.400	0.5397
4	0.390	0.7101	0.442	0.5964
5	0.414	0.7538	0.563	0.7597

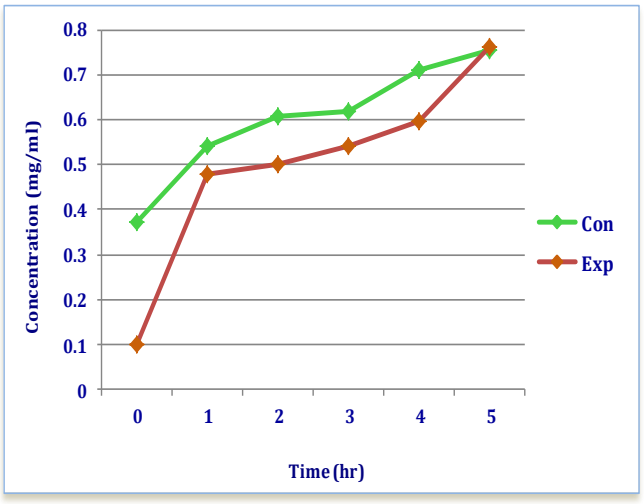


Fig.6. Graphical representation of the concentration of dye extracted using Acetic acid 10% Soln. (Exp) and Water (Con) at different time intervals

Table 2. Gravimetric analysis for dye samples extracted using acetic acid

Time (H)	Control		Experiment	
	Weight (mg)	Percentage yield	Weight (mg)	Percentage yield
0	4.5	10.1	5.2	11.7
1	10	20	10.1	20.2
2	10.5	18.37	15.2	26.6
3	12.36	18.54	15.5	23.25
4	17.89	22.36	17.98	22.47
5	20	20	23.3	23.3

Fig.7. Graphical representation percentage of yield of dye extracted using acetic acid 10% Soln. (Exp) and Water (Con) at different time intervals.

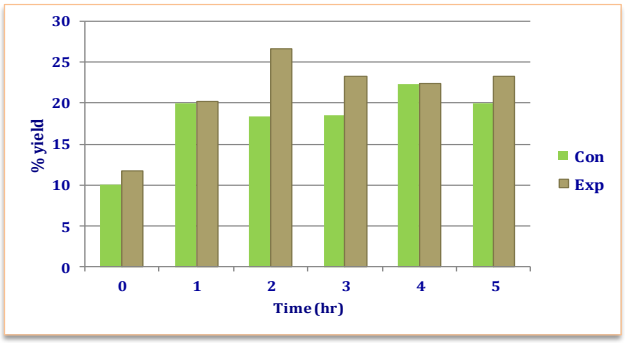


Table. 2 shows the Gravimetric analysis, and Fig 6 shows the graphical representation of dye samples extracted using acetic acid. Fig.7 shows the percentage of yield of dye extracted using acetic acid 10% Soln. (Exp) and Water (Con) at different time intervals.

B. Onion Peel Natural Dye

The dye extracted using acetic acid yields a dark pink dye, water yields a dark red color dye (Fig. 8a). Onion peel Dye solution extracted using solvents a) with water b) acetic acid is shown in Fig.8. Natural dye as dried Pelargonidin dye powder is shown in Fig. 9.

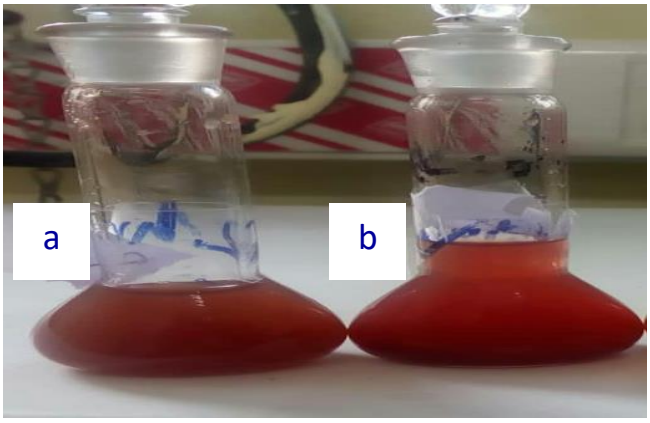


Fig.8 a) Dye solution extracted using solvents
a) With water b) Acetic acid (10% soln.)

Fig.9. Pelargonidin dye powder

C. Dyeing of leather

A Crust leather sample of approximate wt. 0.8 g (4.5 cm Dia.) was taken and soaked in 0.1% ammonia solution overnight and then placed in a magnetic stirrer for 2 hours to restore its moisture content and wet back. Then it was dyed with a Pelargonidin dye extract sample. Leather dyed using Pelargonidin dye was obtained using 0.5 gm of onion peel and 50 ml acetic acid and found to be useful (Fig. 10).

Fig.10. Leather dyed using Pelargonidin dye a) Control (water extraction) b) Dyed using acetic acid extracted dye

IV. CONCLUSION

There are various advantages for the dye extracted from onion peels. The main advantage is that dye is extracted from waste material. Hence it uses waste material to create a sufficient dye. It is a biodegradable and renewable source of dye. The cost involved in obtaining raw materials is significantly less.

Moreover, onion peels have various other properties, such as antioxidant and anti-inflammatory properties. Extraction using water gave a dark red dye. Furthermore, using acetic acid yielded a dark pink dye. UV and gravimetric analyses were done for each dye extracted. % Extract Yield has been found to be 20% and 23.3% respectively for the water and acetic acid (10% solution) based extraction processes. A piece of leather was also dyed using Pelargonidin dye obtained using acetic acid and found to be useful. Since the dye is extracted from onion peels, it is incredibly cost-efficient and also does not cause any harm to the environment. This paper provides a viable solution not only to vegetable waste management but also provides economic value, employment opportunity, and eco-benign products such as Natural Dyes from Agriculture based waste materials. This approach would also provide alternate coloring agents in the form of Natural dyes for application in Food, Textiles, and Leather Industries.

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