EXTRACTION OF ANTHOCYANIN FROM ONION PEELS: BIO-WASTEMANAGEMENT

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ABSTRACT

The increasing demand for natural dyes can be attributed to their eco-friendliness and the growing awareness among individuals about the environmental and health risks associated with the use of synthetic dyes. Environmentalists are always concerned about the uncontrolled use of synthetic dyes as they lead to toxicity and pollution. Synthetic dyes are highly carcinogenic and pose a great health risk and due to this natural colours/dyes have gained an upper edge over synthetic dyes in recent years. Onion peels, which are frequently thrown away as waste contain bioactive compounds like quercetin and anthocyanin. These compounds exhibit potential colorant properties and are explored for their viability as natural alternatives in the dye industry. This research aims to study the extraction process of natural colour compounds from onion peels and their subsequent industrial application. In this study the colour was extracted from the onion peels and in the spectrophotometric study the absorbance was found at 300 and 520nm. The extracted anthocyanin was studied for its stability at various pH. As pH is the measure factor that affect anthocyanins stability, an attempt was made to stabilize anthocyanin using organic acids (Acetic acid and Citric acid). The utilization of onion peels as source of natural colorant will not only aids to mitigate the environmental consequences linked to waste disposal but will also provide a sustainable substitute for conventional chemical-laden dyes. Such value-adding application addresses waste management and combines the economic and environmental benefits of the actual implementation of sustainability, and circular economy resulting in industrial symbiosis.

KEYWORDS

Anthocyanin, Biowaste, Natural dyes, Circular economy, Sustainability.

1.INTRODUCTION

Colorants are the most crucial factor for attracting consumers and deciding their preferences in various domains, such as the textile, food, or cosmetic industries. Indian cuisine is known for its vibrant, eye-catching colours, it is regarded as the center of food diversity, also increasing demand for packaged food has fueled the exponential rise in synthetic dyes as a food colouring. However, there is a need to address the health risks associated with these fascinating synthetic colours, primarily reported in children. Synthetic dyes are thought to be highly carcinogenic, and using them can have detrimental effects on both the environment and human health. Even the food processing and regulatory authorities are seeking to minimize the use of synthetic food dyes and colorants. Nowadays, the food industry and extensive research have shifted towards natural alternatives and their health benefits in functional foods [1,2] Environmental, health, and sustainability concerns are the main reasons for the preferencefor natural dyesover their synthetic counterparts. Natural dyes are bioresources that are renewable and sustainable, derived from plants, insects, and animals, and have minimal environmental impact. The use of natural dyes as a component of a sustainable

business model is driven by consumer values of transparency and ethical manufacturing processes. Natural colours provide consumers with a safer option because they are non-toxic and biodegradable.[3]

Globally, fruits and vegetables are consumed as raw, processed, or as an additive, accounting for approximately 50% of total food wastage, onion (Allium cepa L) has been grown as a major and popular vegetable in India around the world; India's main export good that generates foreign exchange is onion.International onion output is rising, with China and India at the top of the charts. Global onion output has increased by at least 25% over the last 20 years; with 47 million tons annually, it is now the second most significant horticultural crop. Rising onion output and demand have resulted in a rise of onion byproducts during processing namely peel and skin, among all producers, European countries alone have been reported to be able to give rise to nearly 0.6 MT of onion peel waste annually[4]contributing to 70% of the total waste. Therefore, Effective utilization of onion peel should be needed to develop value-adding products, since they are excellent sources of bioactive compounds and phytochemicals. Also, proper disposing of this produced trash not only solves issues related to waste management but also supports the circular economy concept, which encourages sustainability in a variety of industries.[5]

Onion peels, which are typically thrown away as biowaste contain the important substance Anthocyanins which is responsible for red, purple, and blue colours in fruits and vegetables andpossessanti-inflammatory and antioxidant properties[6]. While anthocyanin exists as a blue pigment in alkaline settings, it appears as a red pigment in acidic environments. The compound anthocyanin is classified as a flavonoid despite having a positive charge at the oxygen atom in the C-ring of the fundamental flavonoid structure. It is also known as the 2-phenylchromenylium flavylium ion. Anthocyanins, beyond their bioactivity, are used in foods as natural colorants, fulfilling the public demand for clean labels in food products.[7]

The purpose of this work is to shed light on the extraction of anthocyanins from onion peels using different solvents, which is a ground-breaking approach to biowaste management. The food processing sector produces a lot of onion peels as a byproduct, and disposing of them adds to environmental problems. Acknowledging this, our research aims to transform this biowaste into an important asset. By using onion peel as a source of anthocyanin, we can derive the natural pigment's therapeutic potential while simultaneously addressing the environmental issues around its disposal.

2.Material and Methods

2.1Procurement of active: -

Onion peels were procured from Shetkari Bhandar, Khamla, Nagpur, Maharashtra.

2.2Extraction of active: -

Procured Onion peels were cleaned of impurities and dried and crushed into powder beforeanalysis.Extraction of the active was done by the process of maceration (Fig.1). For this2.5g of powder was soaked overnight in 50 ml of three different solvents (Water, Ethanol, and hydroalcoholic). These flaskswerekept undisturbed for 24 hours and then they were filtered the next day using, “Whatman” filter paper.[8]

Fig.1 Maceration of onion peels.

2.3Phytochemical screening: -

Thesamples were subjected to qualitative analysis to identify the Phytochemicals present in the sample.[9]

2.4Spectrophotometric Measurement: -

The extracts of all three solvents wereanalyzedusing aSpectrophotometer (NSP 369) to observe maximum absorbance in UV and Visible regions.[10]

2.5Reagents: -

Buffers solutions for pH 2,4,6,8 were prepared using Indian Pharmacopeia.[11]

pH 2 (Chloride buffer) - Dissolve 6.57g of potassium chloride in water add 119.0ml of 0.1 M hydrochloric acid and dilute with water at 1000ml

pH 4 (Acetate buffer) -Place 2.86 ml of glacial acetic acid add1.0 ml of a 50% w/v solution of

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sodium hydroxide in a 100 ml volumetric flask, add water to volume, and mix.
pH 6 (Citro-phosphate buffer) -mix 36.8ml of a 2.1% w/v solution of citric acid with 63.2ml of a 7.15% w/v solution of disodiumhydrogen phosphate.
pH 8 (Phosphate buffer) -Mix 50ml of 0.2M potassium dihydrogen phosphate with 46.8ml of 0.2M sodium hydroxide and add sufficient water to produce 500ml.

2.6pH Meter: -

pH meter (CL 54) wasstandardized with buffer solutions of pH 4 and7.[10]

2.7 Stability OfColour at DifferentpH:-

To check the stability of the active 2.5g of onion peel powder was dissolved in 50 ml of Water, Ethanol, and Hydroalcoholic (50:50). pH plays a significant roleinthe stability of Naturalcolours. The stability of the colour in different solvents were examined at four different pH (2,4,6,8). The test solutions of different pH were prepared by taking 1 part test solution and 4 parts buffer solutions so as not to exceed the buffer capacity of the reagent. Further dilutions were made with Dilution factor 1:20 with the buffer solutionsto get an absorbance within a linear range of the spectrophotometer.(i.e. between 0.2-2.0) [10]

2.8Discolouration Study of Anthocyanin: -

All the above-prepared flasks were incubated for 15 days at 25°C, and absorption spectroscopy evaluated the discoloration. The samples were drawn daily for observation they were centrifuged at 5000 rpm for 10 minutes and the discolouration was assessed by measuring the absorbance of the supernatant with the help of a spectrophotometer at wavelength maxima of the respective colour.[12]

2.9Discolouration Assay: -

Discolouration assay was carried out for 15 days the % of discolouration was calculated from the following equation.[12]

Formula:

% Discolouration =
Initial O.D – Final O.D x 100
Initial O.D

1. Initial O.D = Initial Optical Density
2. Final O.D = Final Optical Density

3. RESULT

The natural dye Anthocyanins was extracted from waste material (onion peel).
It is a biodegradable and renewable source of dyes.Extraction with Water gave Dark cherry red colour, Hydro-ethanol gave light maroon colour, and Ethanol gave a Raspberry red colour. The red onion peel extract was characterized in terms of phytochemical content shown in Table no 1.UV-visible spectrophotometric analysis was done for each dye extracted. Maximum absorption spectra were observed at 300 and 520nm at neutral pH for each extract.

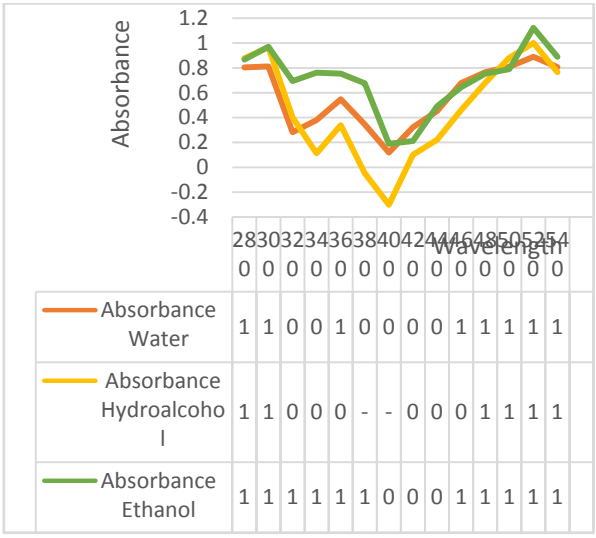
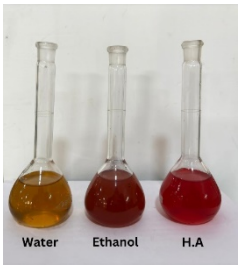


Fig 2. Spectral characteristics of Anthocyanins in different solvents

Research has classified Anthocyanins based on UV-visible spectral data and the colour of the characterized molecular was reported by Pheling in 1939.[13]



The typical UV-visible spectrum of Anthocyanins shows 2 basic clusters of absorbance one at 300nm (UV- region) and the other at 520nm (Visible region). This was like the UV-visible spectral analysis of Anthocyaninanalysed by Shaha and Singh et al [13]. They saw the peak at 260-280nm (UV-region) and 490-550nm (Visible region).

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Yield for each solvent was20mg/L, 23mg/L, and 25mg/forwater, Hydro-ethanolic, and ethanolicextract respectively.

The red onion peel extract was characterized in terms of phytochemical content shown in Table no 1.

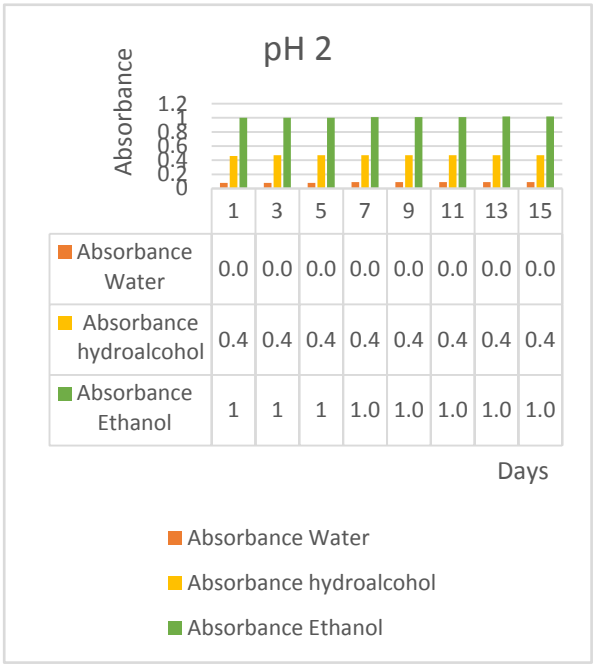
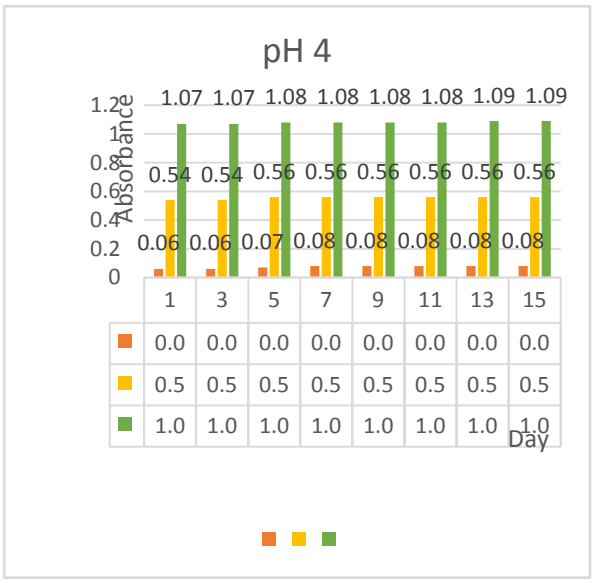


Table1Results of Phytochemical Screening

Phytochemical Analysis	Aqueous	Hydro-alcoholic	Alcoholic
Phenol	+	+	+
Carbohydrates	-	-	-
Alkaloids	-	-	-
Terpenoids	+	+	+
Glycosides	-	+	+
Starch	-	-	-
Flavonoids	+	+	+



The presence of bio-actives such as Phenol, Terpenoids, and Flavonoids can be seen in all three solvents whereas the presence of Glycosides can only be seen in Hydro-alcoholic and Alcoholic solvents.

pH differential method was used to see the variation of Anthocyanin colour with pH.The results demonstrated that anthocyanins in red onion extract were more stable at low pH values (pH2,4) and highly unstable at high pH values (pH6,8) as shown in Fig 3,4,5,6. As previously reported, under strong acidic conditions, anthocyanins exist as flavylium cations which showed lower degradation.

Fig.3 Extract at pH 2Fig.4 Extract at pH4

Fig.5 Extract at pH 6Fig.6 Extract at pH 8

The Anthocyanins degradation parameter in terms of days absorbing at 520nm was studied over 15 days and absorbance was quantified using a UV spectrophotometer every alternate day.

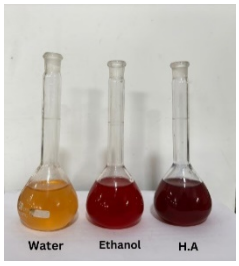
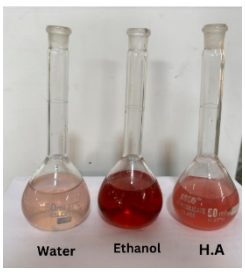
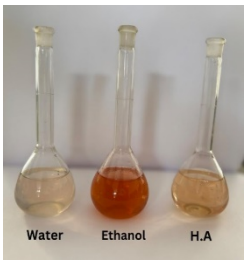


Fig.7 Degradation studies of Anthocyanin at **pH 2** with Time

Fig.8 Degradation study of Anthocyanin at **pH 4** with time





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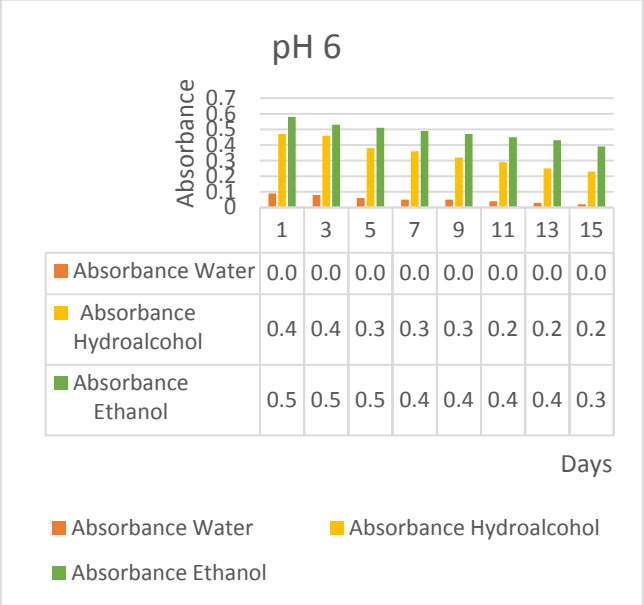
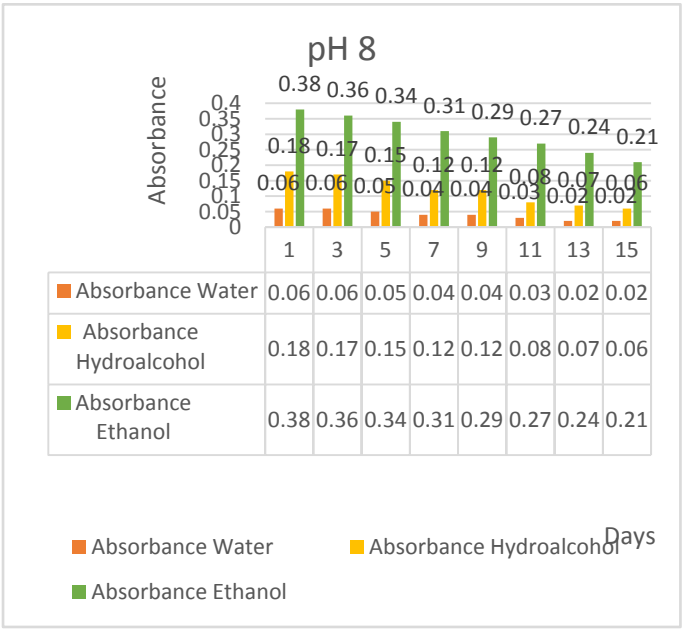


	1	3	5	7	9	11	13	15
Absorbance Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Absorbance Hydroalcohol	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2
Absorbance Ethanol	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3

Fig.9 Degradation study of Anthocyanin at **pH 6** withtime

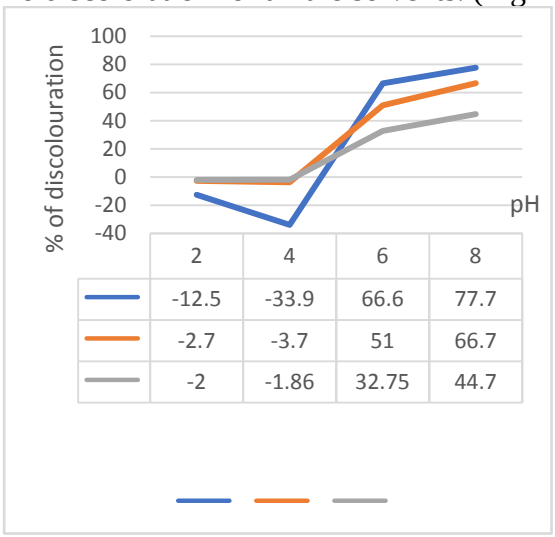


	1	3	5	7	9	11	13	15
Absorbance Water	0.06	0.06	0.05	0.04	0.04	0.03	0.02	0.02
Absorbance Hydroalcohol	0.18	0.17	0.15	0.12	0.12	0.08	0.07	0.06
Absorbance Ethanol	0.38	0.36	0.34	0.31	0.29	0.27	0.24	0.21

Fig.10 Degradation study of Anthocyanin at **pH 8** with time

The pH stability study was performed during 15-day storage of anthocyanin extracts at four different pH. For Ethanolic, hydro-ethanolic, and water extract.The highest stabilityand retention of anthocyanins (extracts) were at 2.0 pH, As the time increased, the deterioration of anthocyanins increased. From Fig 7,8,9,10, we can observe that the absorbance at pH 2 and 4 remained stable over 15 days showing the stability of Anthocyanin at this pH while absorbance at pH 6 and 8 kept decreasingshowing their degradation over the same duration of time.

Percent discolouration was found to be maximum in water extract (77.7%) at pH 6 and 8 followed by hydro-alcoholic (66.6%) and Ethanol (44.7%). Extracts at pH2 and 4 showed no discoloration for all the solvents. (Fig11)



	2	4	6	8
	-12.5	-33.9	66.6	77.7
	-2.7	-3.7	51	66.7
	-2	-1.86	32.75	44.7

Fig 11. Discoloration assay of various solvents.

4.Conclusion

The dry skin of red onions is non-edible but accumulates high levels of anthocyanins, showing great potential for developing cheap natural bioactive ingredients with functional properties. Natural Anthocyanin colour playsa very important role in determining the acceptability of food for consumers. Anthocyanins were given the highest score of colour and overall acceptability similar to synthetic colour. In general, consumer preparation has been that natural food colorant ingredients would be safe healthful, and considered as potential food colorants.

The extraction of anthocyanins from onion peels is a promising area of research that has gained significant attention in recent years. It provides a sustainable solution for waste management while offering potential health benefits and applications in various industries. With continued efforts, the utilization of anthocyanins from onion peels can contribute to a more sustainable and healthier future for both humans and the environment.

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