International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 2 Mar–Apr 2025, pp: 1896-1901 www.ijprajournal.com ISSN: 2456-4494

Phytochemical Analysis and Evaluation of Hylocerus undatus Fruit Peel for Nutritional Supplement

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Date of Submission: 15-04-2025 Date of Acceptance: 25-04-2025

ABSTRACT: The present study focuses on the phytochemical analysis and nutritional evaluation of Hylocereus undatus (dragon fruit) peel, an underutilized by-product of fruit consumption. Preliminary phytochemical Analysis revealed the presence of key bioactive compounds such as flavonoids, phenolics, tannins, saponins, andalkaloids. Quantitative analysis indicated significant antioxidant potential, suggesting possible health benefits. Nutritional profiling demonstrated the peel's richness in dietary fiber, essential minerals (including calcium, magnesium, and potassium), and trace amounts of proteins and lipids. The findings highlight the potential of Hylocereus undatus peel as a sustainable and valuable ingredient for nutritional supplements, promoting waste valorization and supporting functional food development.

Keywords: Hylocereus undatus peel, Dragon fruit peel, Fruit peel extract, Phytochemicals, Nutritional supplement, Antioxidant activity, Bioactive compounds

I. INTODUCTION:

In the face of increasing demand for sustainable and health-promoting food sources, there is a growing emphasis on the utilization of agricultural by-products for nutritional and therapeutic applications. One such promising but underutilized resource is the peel of Hylocereus undatus, commonly known as the white-fleshed dragon fruit. This tropical fruit, native to Central America but now widely cultivated in Asia and other warm climates, has gained popularity for its rich nutritional content, vibrant color, and unique appearance. While the fruit pulp is widely consumed and commercialized, the peel, which constitutes a significant portion of the fruit's biomass, is often discarded as waste. However, emerging research suggests that dragon fruit peel contains an array of phytochemicals and nutrients that could be repurposed into valuable dietary supplements and functional foods.

Phytochemicals are naturally occurring compounds in plants that play critical roles in defense mechanisms and contribute to the plant's color, flavor, and resistance to diseases. In human health, these compounds are known for their antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Common classes of phytochemicals include flavonoids, tannins, phenolicacids, alkaloids, saponins, and terpenoids. The growing body of evidence supporting the health benefits of phytochemicals has driven the scientific community to explore diverse plant sources, particularly those that are often over looked or wasted in the food supply chain. Fruit peels are one such source, having been found to contain higher concentrations of phytochemicals compared to the edible pulp in many species.

Hylocereus undatus peel has shown promising results in preliminary studies, revealing the presence of phenolics, flavonoids, betacyanins, and dietary fiber. These compounds are known to exhibit strong antioxidant activity, which can help mitigate oxidative stress—an under lying factorinm any chronic diseases such as cardiovascular disorders, diabetes, and cancer. Additionally, the vibrant pink to red dishcoloration of dragon fruit peel is attributed to natural pigments such as betacyanins and betalains, which have been associated with anti-inflammatory and detoxifying effects. These features make the peel a potential candidate for use in nutraceuticals, health drinks, dietary supplements, and even cosmetic formulations.

Nutritionally, the peel also contains macro- and micronutrients, including carbohydrates, proteins, and essential minerals such as calcium, magnesium, phosphorus, and potassium.

Dietary fiber, particularly in soluble fiber, is another important component of the peel. Fiber is essential for gastrointestinal health, aiding in

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digestion and promoting satiety. The presence of such nutrients enhances the nutritional value of dragon fruit peel and supports its incorporation into a balanced diet. Furthermore, the peel's low fat and calorie content make it suitable for health-conscious consumers.

The valorization of fruit peels not only contributes to the development of value-added products but also addresses major concerns related to food waste and environmental sustainability. Globally, fruit processing industries generatetons of organic waste, much of which ends up in landfills, contributing to methane emissions and resource wastage. Utilizing these by-products as sources of bioactive compounds aligns with the principles of a circular economy and sustainable agriculture. It also provides economic benefits to fruit growers and processors by opening new avenues for product diversification and revenue generation.

Despite the promising potential of Hylocereus undatus peel, its application in the health and food sectors remains limited due to a lack of comprehensive scientific evaluation. Detailed phytochemical profiling, nutritional analysis, and assessment of functional properties are necessary to establish its safety and efficacy as a nutritional supplement. In addition, understanding the extractability and stability of these compounds during processing is critical for developing formulations that retain their bioactivity during storage and consumption.

Several methods are used for the phytochemical analysis of plant materials, including qualitative tests for detecting the presence of secondary metabolites and quantitative assays for determining concentrations of specific compounds. Spectrophotometric techniques such as the Folin-Ciocalteu method for total phenolics and aluminum chloride colorimetric method for flavonoids are widely used due to their reliability and sensitivity. Antioxidant capacity is commonly assessed using assays like DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2′-azino-bis-3-ethylbenzothiazoline-6-sulfonic acid), and FRAP (Ferric Reducing Antioxidant Power). Nutritional analysis typically includes proximate composition—moisture, ash, crude fiber, fat, protein, and carbohydrate content—as well as mineral profiling through techniques such as atomic absorption spectroscopy.

This study aims to conduct a thorough phytochemical and nutritional evaluation of Hylocereus undatus fruit peel, with the objective of determining its potential as a functional ingredient in nutritional supplements. The research will involve both qualitative and quantitative phytochemical Analysis, assessment of antioxidant activity, and a detailed nutritional profile including macronutrient and micronutrient content. The findings are expected to provide valuable insights into the functional properties of dragon fruit peel and promote its utilization in various health-oriented products.

In addition to scientific implications, this study also addresses broader societal concerns such as waste management, food security, and sustainable development. By identifying new uses for agricultural by-products, it supports initiatives to reduce post-harvest losses and optimize resource use in food systems. Moreover, developing affordable and natural supplements from locally available materials can improve access to essential nutrients, particularly in low-income populations where malnutrition remains a concern.

In conclusion, the peel of Hylocereus undatus represents a promising but underexploited source of phytochemicals and nutrients. Through scientific validation, this by-product can be transformed from waste into a valuable component of health-promoting dietary supplements. The present study seeks to bridge the knowledge gap by providing a comprehensive analysis of dragon fruit peel, contributing to the growing field of plant- based nutraceuticals and sustainable nutrition.

II. PLANT PROFILE

Dragon Fruit

Scientific Name–Hylocereus Undatus

Synonyms–Selenicereus Undatus

Biological source-Hylocereus undatus, commonly known as dragon fruit

Family-Cactaceae

Chemical Constituent –

- Alkaloids
- Tannins
- Saponins
- Flavonoids
- Terpenoids

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Dragon Fruit

III. MATERIAL AND METHOD

Collection and Preparation of Plant Material

Fresh fruit peels of Hylocereus undatus (dragon fruit) were collected from local markets or directly from farms. The peels were washed thoroughly under running water to remove any dirt and contaminants, then air-dried under shade for 5–7 days. The dried samples were then powdered using a mechanical grinder and stored in airtight containers for further analysis.

Extraction Procedure

The powdered peel material (100 g) was subjected to solvent extraction using ethanol, methanol, and distilled water. The extraction was carried out using a Soxhlet apparatus for 6–8 hours. The extracts were filtered using Whatman No. 1 filter paper and concentrated under reduced pressure using arotary evaporator. The crude extracts were stored at 4°C until further analysis.

Phytochemical Analysis

Qualitative phytochemical Analysis of the extracts was performed to detect the presence of major bioactive compounds such as:
Alkaloids (Mayer's and Wagner's test) Flavonoids (Lead acetate test)
Tannins (Ferricchloride test) Saponins (Frothing test) Phenols (Ferric chloride test)
Terpenoids and Steroids (Salkow ski test)

Requirement

1. Test tubes
2. Beakers
3. Flasks (e.g., Erlenmeyer, round-bottom)
4. Pipettes(e.g., micropipettes, volume tricpipettes)
5. Burette
6. Separating funnels
7. Chromatography chambers(e.g., TLC, HPLC)
8. Spectrophotometers (e.g., UV-Vis, IR)
9. pHmeter
10. Hotplate or water bath
11. Mortar and pestle
12. Filter paper and filter funnel
13. Centrifuge
14. Vortex mixer
15. Autoclave (for sterilization)

Steps Involved in Decoction:-

1. **Drawing off:**

Aportion of the mash (often around a third) is drawn off from the mashtun and into a separate kettle or vessel.

2. **Boiling:**

The decoction is then brought to a boil, which helps breakdown cell walls and extract more starches from the grains.

3. **Returning to Mash:**

After boiling for asetperiod (typically20-30minutes), the decocted portion is returned to the main mash, raising its temperature.

4. **Repeating:**

This process can be repeated multiple times (single, double, or triple decoctions) to achieve specific temperature rests and flavor profiles.

Decoction

- **ALKALOIDS IN PEEL OF HYLOCEREUS UNDATUS**

Tests:

1. **Mayer's Test:**

A few drops of Mayer's reagent (potassium mercuric iodide) are added to the Peel extract. Formation of a white or yellow precipitate indicates the presence of alkaloids.

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2. **Dragendorff's Test:**

A few drops of Dragendorff's reagent (potassiumbismuthiodide) are added to the Peel extract. Formation of an orange or red precipitate indicates the presence of alkaloids.

3. **Wagner's Test:**

A few drops of Wagner's reagent(iodine-potassiumiodide) are added to the Peel extract. Formation of a brown or black precipitate indicates the presence of alkaloids.

4. **Hager's Test:**

A few drops of Hager's reagent(picric acid) added to the Peel extract. Formation of a yellow or orange precipitate indicates the presence of alkaloids.

Alkaloids Test

- **Tanninsin Peel of Hylocereus Undatus:**
- **Chemical Tests:**

1. **Gelatin Test:** Mix the Peel Hylocereus Undatus extract with gelatin solution. If tannins are present, a precipitate will form.
2. **Ferric Chloride Test:** Add1-2 drops offerricchloride solution to the leaf extract. If tannins are present, a blue or green color will form.

Figno 5.Tannins Test

- **Terpenoidsin Peel Hylocereus Undatus:**
- **Chemical Tests:**

1. **Libermann-Burchard Test:** Add 1-2 drops of Libermann-Burchard reagent (acetic an hydride and sulfuricacid) to the leaf extract. Formation of a blue orgreen color indicates the presence of terpenoids.
2. **Salkowski Test:** Add1-2 drops of Salkowskire agent (chloroform and sulfuric acid) to the leaf extract. Formation of a red or pink color indicates the presence of terpenoids.

Terpenoids Test

- **Saponinsin Peel Hylocereus Undatus:**
- **Chemical Tests:**

1. **Foam Test:** Shake the leaf extract with water and observe for persistent foam formation, indicating the presence of saponins.

Saponins Test

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❖ **Observation**

Table:-

Sr.No.	TEST	OBSERVATION	RESULT
1.	Alkaloids:- a. Mayers Test b. Dragendorff's test c. Wagner's test d. Hager's test	Whiteor Yellow Colour Orange or Red Colour Brown or Black Colour Yellow or Orange Colour	Present
2.	Tannis test:- a. gelatin test b. Ferricchloride test	Blueor Green Colour Blue or Green Colour	Present
3.	Terpenoidstest a. Libermann- burchard test b. Salkowski's test	Blueor Green Colour Pink or Red Colour	Present
4.	Saponins test:- a. Foam test	Foam	Present

❖ **Phytochemicals Present/ Absentin Hylocereusundatus fruit peel:-**

Hylocereus Undatus Fruit Peel	Alkaloids	Tannins	Terpenoids	Saponins	Phenolics	Flavonoids
Present(+) Absent(-)	+ (Present)	+ (Present)	+ (Present)	+ (Present)	- (Absent)	+ (Present)

IV. CONCLUSION-:

1. Local dragon fruit plants from Tanah Laut Regency contain secondary metabolic compounds (Flavonoids, Alkaloids, Saponins, and Terpenoids) and the highest levels of phytochemicals in dragon fruit stems.
2. Itis advisable to do an effective and efficient formulation of dragon fruit extract preparations on experimental animals. From the overall assessments of the present study concerning with the evaluation of some phytochemicals, mineral content, nutrient composition and pharmacological activities from fruit pulp of Hylocereus undatus (dragon fruit), the following inferences can be deduced.
3. In the preliminary phytochemical tests, the fruit maybe used for medicinal purposes due to the presence of bioactive constituents. As the reasonable concentration of potassium by elemental analysis, the fruit may be employed to reduce high blood pressure.
4. The highest amount of moisture by evaluation of nutritional composition makes the fruit with freshness and it is suitable for consumption. In the Analysis of antimicrobial activity by using agar well diffusion method, both ethanol and water extracts showed activities against all selected microorganisms.
5. The sample may be used for the formulation of antimicrobial drugs. The antioxidant activity of ethanol and water extracts was determined by DPPH method and both extracts exhibited the antioxidant activity.

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