

Influence of *Hylocereus Polyrhizus* Peel Powder on Sensory, Functional and Physico-Chemical Properties of Dried Noodles

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Abstract: The impact of *Hylocereus polyrhizus* (red dragon fruit) peel powder on the sensory, functional, physicochemical, and microbiological characteristics of dried noodles was assessed in this study. Refined wheat flour noodles were mixed with 5% (Sample A) and 10% (Sample B) of dragon fruit peel powder (DFPP), a rich source of dietary fibre, minerals, antioxidants, and natural colour. Sample B received higher colour scores because of the natural pigmentation of DFPP, while Sample A demonstrated greater overall acceptability (8.4) with better flavour, texture, and consistency, according to a sensory evaluation utilizing a 9-point hedonic scale. According to functional analysis, Sample B had a slightly larger cooking loss (2.525%) and a higher oil absorption capacity (95.00%), while Sample A had a higher water absorption capacity (93.2%) and swelling capacity (4.61%). Increased DFPP integration improved nutritional quality, according to proximate analysis, especially in ash content (1.56%), crude fibre (1.61%), and crude fat (3.40%). Both noodle samples were found to be microbiologically safe after five months of storage, according to microbiological tests. The results indicate that DFPP can be effectively used as a sustainable functional ingredient in noodles, with 5% integration offering the optimal balance between consumer appeal and nutritional benefit.

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INTRODUCTION

In many Asian nations, noodles are among the most popular staple meals due to their affordability, convenience, long shelf life, safety, and palatable flavors. Noodles have been a significant source of carbs and wheat-based nutrients in Asian diets for about 4,000 years [15]. The creation of functional wheat-based noodles enhanced with dietary fibre and bioactive substances has been aided in recent years by growing consumer awareness of good eating practices. Noodles can be a useful vehicle for adding nutrients like phenolics, anthocyanins, carotenoids, and other health-promoting substances that are normally absent from wheat flour [22].

Large amounts of byproducts are produced by the food processing industry, many of which include useful phytochemicals that could be used in functional foods [17]. Particularly fruit peels are known to be abundant in natural colours, dietary fibre, and antioxidants that can be used as functional food ingredients or additions [10]. Due to its high concentration of phenolic compounds, antioxidants, betacyanin's, and antibacterial elements, the peel from *Hylocereus polyrhizus*, which is frequently thrown away as garbage, has substantial nutritional and medicinal potential [18]. Additionally, the peel may be used as a natural colouring agent [16]. Thus, the purpose of this study was to promote sustainable use of food waste by evaluating the effects of adding red dragon fruit peel powder to noodles on their physicochemical characteristics, cooking quality, and sensory acceptability.

MATERIALS AND METHODS

➤ *Sample Collection and Preparation*

The researchers obtained the peel of red-fleshed dragon Fruit from the discarded byproducts of cordial processing. Fresh skins were washed thoroughly with tap water to eliminate dirt and dust. Withered and hard portions of the skin were trimmed.

➤ *Dragon Fruit Peel Powder Preparation*

The peels of the dragon Fruit were chopped into 1 cm² piece using a stainless-steel knife. After which, it was tray-dried by spreading thinly on a drying tray until completely dry and crispy. Then, the dry peel was ground in a multipurpose swing disintegrator for 3 minutes followed by sieving to produce a fine powder. The resulting powder was stored in the airtight dark storage to retain the colour and to prevent re-humidification of the powder. Then it was transported to the processing laboratory for noodle manufacturing. [13]

➤ *Preparation of Noodles*

A popular method to improve dietary fibre, antioxidant activity, and functional qualities is to add fruit peel powders (such pitaya or mango peel) to noodles [10]. Pitaya peel can be used as a functional ingredient in cereal-based foods since it is especially rich in pectin, phenolics, and natural colours [3]. However, optimization (5–10%) is advised since higher incorporation levels may decrease gluten structure and impact texture [6].

➤ *Formulation of Noodle Dough*

Noodles were prepared with pitaya peel powder at different levels (5% and 10%) along with refined wheat flour. The formulation was as follows in table 1. The dry ingredients (flour and PPP) were mixed thoroughly to ensure uniform distribution. Salt was dissolved in water and gradually added to the flour mixture to form a cohesive dough.

Table 1 Formulation of Noodles

INGREDIENTS	Sample A	Sample B
Refined Wheat flour	1 cup [250ml]	1 cup [250ml]
Pitaya peel powder	5 g	10 g
Salt	A pinch	A pinch
Water	As required	As required
Oil	2tsp	2tsp
Egg	1	1

➤ *Dough Kneading and Resting*

To create a smooth and elastic consistency, the dough was manually kneaded for ten to fifteen minutes. In order to promote the production of gluten, the dough was then wrapped with a moist towel and left to rest at room temperature for 20 to 30 minutes.

➤ *Extruding and Cutting*

A piston extruder was used to extrude the rested dough to a consistent thickness. A noodle cutter or knife was then used to cut the shreds into noodle strands.

➤ *Cooking Procedure*

After being softened in boiling water for two to three minutes, the extruded noodles were drained and dried on a tray.

➤ *Drying of Noodles*

The cooked noodles were dried for four to six hours at 40 to 50°C in a tray dryer until the moisture content was between ten and twelve percent. After cooling, the dried noodles were sealed in airtight containers.

➤ *Evaluation of Quality Parameters*

Sensory evaluation of samples was carried out by a consumer panel using 9-point hedonic scale developed [14] with required modification. The sample is cooked in chicken stock and served. Consumer acceptability test was conducted with a 9-point hedonic scale to evaluate attributes such as colour, flavour, appearance, texture, taste, and overall

acceptance with individual scores from 9 (like extremely) to 1 (dislike extremely).

➤ *Evaluation of Noodles Properties* Water absorption, oil absorption, cooking loss, solubility, swelling, bulk density

Water absorption capacity (WAC) of noodle samples was determined following a standard cooking and weighing method described by recent studies with slight modifications [21].

The water absorption capacity (%) was calculated using the following equation:

$$\text{Water Absorption (\%)} = \frac{W_2 - W_1}{W_1} \times 100$$

Where:

- W1 = Weight of uncooked noodles (g)
- W2 = Weight of cooked noodles (g)

Oil absorption of noodle samples was determined using a frying and gravimetric method, commonly employed in recent noodle quality studies with slight modifications [25].

The oil absorption (%) was calculated using the following equation:

$$\text{Oil Absorption (\%)} = \frac{W_2 - W_1}{W_1} \times 100$$

Where:

- W1= Weight of raw noodles (g)
- W2 = Weight of fried noodles (g)

Cooking loss of noodle samples was determined according to standard AACC Method 66-50 with slight modifications, as reported in recent studies [23].

The cooking loss (%) was calculated using the following equation:

$$\text{Cooking Loss (\%)} = \frac{W_3}{W_1} \times 100$$

Where:

- W1= Weight of raw noodles (g)
- W3= Weight of dried residue from cooking water (g)

The solubility of noodle samples was determined as Water Solubility Index (WSI) using a standard centrifugation and drying method described in recent literature with slight modifications [11].

The Water Solubility Index (%) was calculated as:

$$\text{Solubility (WSI, \%)} = \frac{W_2}{W_1} \times 100$$

Where:

- W1 = Weight of dry sample (g)
- W2 = Weight of dried solids in supernatant (g)

Bulk density of noodle samples was determined using the standard tapping method described in recent studies with slight modifications [2].

The bulk density (g/cm³ or g/mL) was calculated using the following equation:

$$\text{Bulk Density} = \frac{W_2 - W_1}{V}$$

Where:

- W1 = Weight of empty cylinder (g)
- W2 = Weight of cylinder + sample (g)
- V = Final volume of sample after tapping (mL or cm³)

➤ *Evaluation of Proximate Composition:*

Moisture content, ash content, crude fibre content, and crude fat content of the sample were measured using the [1] method.

➤ *Microbiological Analysis*

Samples were serially diluted in Rangers Solutions up to 10⁷. After that, the usual procedure advised by APHA 2001 was used to count the microorganisms [12]. HiMedia Laboratories Pvt. Ltd. advocated the standard method for preparing plate count agar media [4] and [9] presented the standard plate count method for determining the total viable count.

RESULTS AND DISCUSSION

The functional, proximate, microbiological, and sensory characteristics of noodles containing dragon fruit peel powder (DFPP) were assessed. DFPP was added to two formulations at 5% (Sample A) and 10% (Sample B). The findings showed that adding DFPP enhanced the noodles functional and nutritional qualities despite affecting their sensory attributes.

With a crude fibre content of 21.34%, ash content of 16.74%, moisture content of 5.6%, and fat content of 1.28%, the dragon fruit peel powder [fig no.2-a] employed in the study demonstrated a noteworthy nutritional composition. Additionally, the powder demonstrated good solubility (76.14%), swelling index (18.31), oil absorption capacity (1.89 g/g), and water absorption capacity (14.9%). These features show that DFPP's high fibre and hydration qualities make it a useful functional element in noodle compositions. [5]

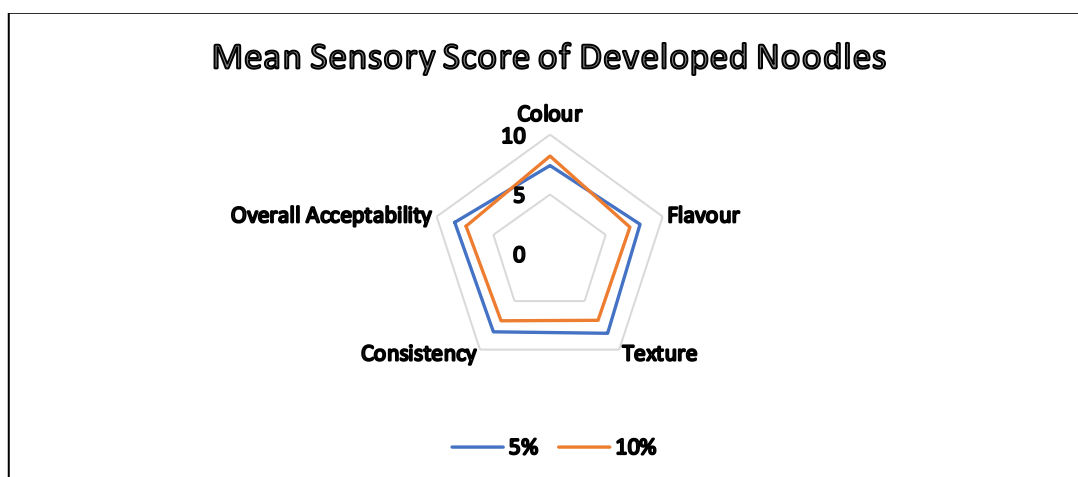


Fig 1 Sensory Score of Developed Noodles

Using a 9-point hedonic scale, 10 customers assessed two sets of samples during the first week of preparation. The results are plotted in a radar map, which is shown in fig. no 1. Sample B (10% DFPP) had a better colour score (8.2) because of the appealing natural hue found in dragon fruit peel, whereas Sample A (5% DFPP) had higher marks for flavour (8.0), texture (8.3), consistency (8.1), and overall acceptability (8.4). However, due to the greater peel flavour and disruption of gluten structure, higher inclusion levels somewhat decreased the acceptability of flavour and texture. The sensory panel often favoured noodles with 5% DFPP.

As shown in table no 2, there were notable differences in the functional characteristics of noodles between the sample A and B. Sample A has a greater water absorption capacity (WAC) (93.2%) than Sample B (74.5%). The disruption of the starch-protein network in the noodle matrix and dilution of gluten proteins may be the cause of the decrease in WAC with increased DFPP incorporation. Dragon fruit peel powder's dietary fibre may hinder the formation of gluten, making it harder for noodles to hold onto water while hydrated. Similar results were reported by Sudha et al., who found that the weakening of the gluten structure in fibre-enriched noodles resulted in decreased water absorption.

On the other hand, Sample B's oil absorption capacity (OAC) rose from 83.91% in Sample A to 95.00%. The fibrous and porous structure of DFPP, which offers a greater surface area for oil binding, may be linked to the higher OAC. A higher fibre content can trap oil in the food matrix and improve hydrophobic interactions. Choo and Azizah observed similar findings, noting that adding fruit peel powders greatly enhanced the oil retention qualities of baked goods and noodles.

These results suggest that the addition of DFPP modifies the hydration and lipid-binding properties of noodles, which may have an impact on the texture, sensory qualities, and cooking quality. Therefore, while preserving acceptable product attributes, moderate integration levels may enhance functional quality.

The addition of dragon fruit peel powder (DFPP) had an impact on the noodles cooking and physical characteristics. From 2.005% in Sample A to 2.525% in Sample B, cooking loss increased marginally. This increase could be the result of the partial substitution of DFPP for wheat flour, which weakens the gluten network and increases the leaching of soluble solids during cooking. But for high-quality noodles, the cooking loss values stayed within reasonable bounds. [18] reported similar results.

Sample A's swelling capacity (4.61%) was marginally greater than Sample B's (3.81%). Dietary fibre may compete with starch for water absorption, decreasing starch gelatinization, which could explain the reduced swelling capability of DFPP noodles. [24] reported similar findings. Due to the light and porous character of DFPP, which resulted in a less compact noodle structure, bulk density dropped from 0.76g/mL in Sample A to 0.71 g/mL in Sample B. Overall,

the structural characteristics and cooking of noodles were somewhat affected by the addition of DFPP.

After adding dragon fruit peel powder (DFPP), the nutritional content of the noodles changed noticeably, according to proximate composition analysis shown in fig no 3 and 4. Sample B's moisture content rose somewhat from Sample A's 9.3% to 9.5%. This increase could be explained by the dietary fibre in DFPP's capacity to hold onto water, allowing the noodle matrix to retain more moisture. Because plant fibres are hydrophilic, similar increases in moisture content have been observed in fibre-enriched noodle products.

Ash concentration rose from 1.38% to 1.56%, suggesting that adding more peel powder improved the mineral content. The higher ash levels seen in the fortified sample can be attributed to the necessary minerals and bioactive substances found in dragon fruit peel. The efficiency of DFPP as a dietary fibre source was confirmed by the significant increase in crude fibre content from 0.77% in Sample A to 1.61% in Sample B. Noodles' nutritional and functional value may be enhanced by higher fibre content.

The natural lipid components in dragon fruit peel powder may have contributed to the small rise in crude fat content from 3.16% to 3.40%. Overall, by increasing the fibre and mineral levels, DFPP inclusion improved the nutritional make-up of noodles.

Microbiological analysis indicated satisfactory microbial quality during the storage period of 5 months. Total plate count values remained within safe and acceptable limits throughout storage, indicating that the developed noodles possessed good microbial stability when properly dried and packaged.

The study demonstrated that dragon fruit peel powder can be successfully utilized as a functional ingredient in noodles to improve fibre and mineral content while maintaining acceptable cooking and sensory quality. Incorporation at 5% level was found to be the most suitable formulation, providing a balance between nutritional enhancement and consumer acceptability.



Fig 2 [a] Dragon Fruit Peel Powder



Fig 2 [b] Boiled Noodles Incorporated with DFPP.



Fig 2 [c] Dried Noodles Sample [5% DFPP].



Fig 2 [d] Dried Noodles Sample [10% DFPP].

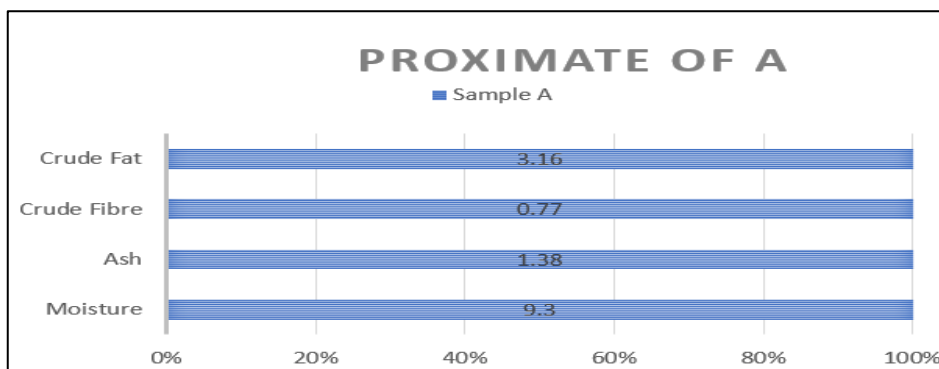


Fig 3 Proximate Composition of Sample.

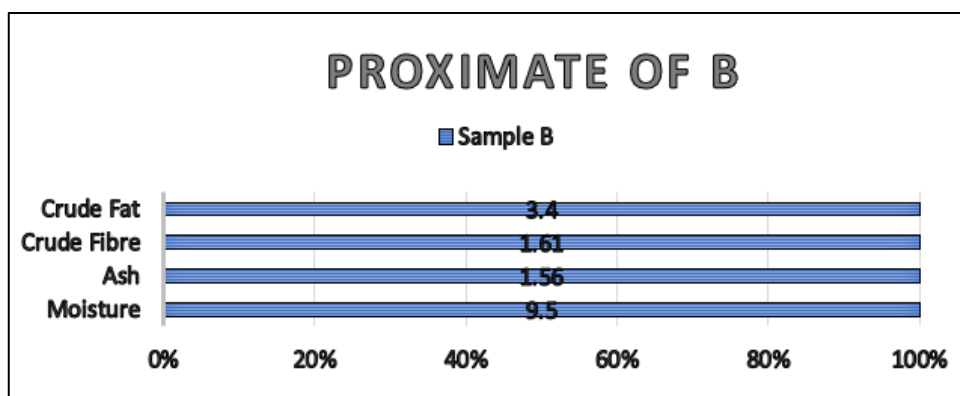


Fig 4 Proximate Composition of Sample.

Table 2 Parameter Values of Developed Noodles

PARAMETERS	A	B
Water Absorption Capacity	93.2%	74.5%
Oil Absorption Capacity	83.91%	95.00%
Cooking Loss	2.005%	2.525%
Solubility	7.14%	7.16%
Swelling Capacity	4.61%	3.81%
Bulk density	0.76g/ml	0.71g/ml
Moisture	9.3%	9.5%
Ash	1.38%	1.56%
Crude fibre	0.77%	1.61%
Crude fat	3.16%	3.40%

Table 3 TPC values of Developed Noodles

MONTH	A CFU/g	B CFU/g
1	<0	<0
2	<0	<0
3	10 ³	10 ² - 10 ³
4	10 ³ - 10 ⁴	10 ³ - 10 ⁴
5	10 ⁴ - 10 ⁵	10 ⁴ - 10 ⁵

CONCLUSION

The current study demonstrated that dragon fruit peel powder (DFPP) can be effectively incorporated into dried noodles as an active component to enhance their sensory, functional, and nutritional qualities. Two formulations were developed, Sample A containing 5% DFPP and Sample B containing 10% DFPP, and were evaluated for sensory, nutritional, functional, and microbiological characteristics.

Sample A showed better overall acceptability (8.4) with superior flavour (8.0), texture (8.3), and consistency (8.1), while Sample B achieved a higher colour score (8.2) due to the natural pigment present in dragon fruit peel. Functional and nutritional analysis revealed that Sample A had higher water absorption capacity (93.2%) and swelling capacity (4.61%) compared to Sample B, which recorded 74.5% and 3.81%, respectively. However, Sample B exhibited higher oil absorption capacity (95.00%), ash content (1.56%), crude fibre

(1.61%), and crude fat content (3.40%) than Sample A, which showed values of 83.91%, 1.38%, 0.77%, and 3.16%, respectively. Cooking loss elevated slightly from 2.005% in Sample A to 2.525% in Sample B, suggesting that the gluten network was moderately weakened at higher DFPP inclusion. Microbiological analysis confirmed that both samples remained microbiologically safe during five months of storage. Overall, Sample A was found to be the most suitable formulation, providing an optimal balance between enhanced nutritional quality and consumer acceptability while promoting the sustainable utilization of dragon fruit processing waste.

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