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Nutritional and Organoleptic Evaluation of Fiber-Rich Biscuit Fortified with Dragon Fruit peel

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Authors' contributions

This work was carried out in collaboration among all authors. Author PD wrote the paper and revised the article. Author SB checked the article, suggested the changes, and submitted the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Dragon fruit peel is a by-product of dragon fruit processing industry. The powder was prepared from fruit peel and utilized to make healthy and nutritious fiber rich biscuits. The biscuits were prepared by incorporating the 30, 40 and 50% level of dragon fruit peel. The baking and sensory properties of prepared biscuits were studied. Replacement of wheat flour upto 50% of dragon fruit peel powder is organoleptically accepted as well as fiber content was found maximum in dragon fruit peel powder biscuits ($DFPB_{50}$). The overall acceptability of $DFPB_{50}$ was 7.75 as compared to

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control ($DFPB_0$). The fiber content of biscuits made with 50% incorporation of dragon fruit peel powder was 7.60 % as compared to control biscuits (1.10 %). Biscuits made up with half of wheat flour and half of dragon fruit peel powder was nutritionally rich as well as organoleptically acceptable.

Keywords: Biscuits; dragon fruit; fiber; peel powder.

1. INTRODUCTION

Among all the tropical fruits, *Cactaceae* family fruits are gaining more attention due to its health benefits, and nutritional value (Hossain *et al.,* 2021; Patwary *et al.,* 2013). *Hylocereus polyrhizus* is one of that Cactaceae family fruit. Vietnam, China, and Indonesia are the countries which produce large amount of dragon fruit; whereas, a total of 12113.4 tons of dragon fruit were cultivated in India (Wakchaure *et al.,* 2021). A fruit that may be eaten, dragon fruit has water-soluble fiber, a lot of vitamin C, and antioxidants such flavonoids, hydroxycinnamates, and betalains (Moshfeghi *et al.,* 2013; Hossain *et al.,* 2021). It can help with weight loss, enhance digestion, lower blood LDL cholesterol, and strengthen the immune system, among other health advantages. By acting on blood arteries and brain cells, flavonoids lower the risk of heart disease and hydroxycinnamates aid in the prevention of cancer (Hossain *et al.,* 2021). Betacyanin and phenolic substances with significant antioxidant activity are also present in the pitaya fruit peel (Nurliyana *et al.,* 2010). In relation to diseases like diabetes, obesity, hyperlipidemia, and cancer, extracts from the stems, peels, and pulp of dragon fruit possess a variety of advantageous biological actions (Luu *et al.,* 2021).

After conducting enough research on the dragon fruit, researchers began to create products from it to extend their shelf life, and provide consumers with nutritious foods at reasonable prices. Many researchers, scientists, and entrepreneurs utilized dragon fruit pulp for making bakery products, jam, jelly, and beverage. However, later studies on dragon fruit peel and seeds suggested that by-products from all dragon fruit industries also have very good nutritional value. These by-products are primarily used for animal feed or fertilizers rather than being very beneficial for human diets, and they have a very good nutritional value. Many phytochemicals present in flesh of fruit as well as peel, and seed of dragon fruit makes utilization of dragon fruit in food products more interesting. Many of bioactive compounds such as Betalains, flavonoids, polyphenols, terpenoids, steroids, saponins, alkaloids, tannins, and carotenoids are present in dragon fruit (Luu *et al.,* 2021). Studies of Zain *et al.* (2019) (Zain *et al.,* 2019), and Wybraniec *et al.* (2007) found 13 phenolic compounds, and 10 betacyanins in peel, respectively.

Dragon fruit peel contributes around 46 to 50% of the fruit. Peel, and seeds of dragon fruit is very rich in fiber, phenols, and betacyanin. So, by-product of juice industry such as peel, and seeds are very nutritious, and must be utilized in food products. Bakery industry has wide scope of utilizing food by-products of other industries, and make new products which are healthy than existing products. Betacyanin present in peel of red fleshed dragon fruit able to impart red or pink color to products, which will be helpful to attract consumer. Therefore, this study was planned to develop a bakery product from dragon fruit peel powder as by-product of dragon fruit processing industry.

2. MATERIALS AND METHODS

2.1 Materials

Dragon fruits were procured from farmer of Kachchh district of Gujarat. Other raw materials for preparation of biscuits were purchased from local market of Anand district. Food-grade (LR grade) chemicals were used for laboratory analysis of ingredients and biscuits.

2.2 Methods

Methods for moisture, protein, fat, ash, crude fiber, and carbohydrates were adopted from AOAC (1984).

2.2.1 Moisture content

According to Ranganna (1997), the moisture content of pulp was assessed using a hot air oven, and the gravimetric method (NOVA Instruments Pvt. Ltd., Ahmedabad). A sample of 5 g of dragon fruit pulp was measured for moisture content before being transferred to a hot air oven, and heated at 105°C until the product's final weight remained consistent. A similar procedure was used to dry a 10 ml sample of RTS in a hot air oven at 105°C until the product's final weight remained consistent (Okokon & Okokon, 2019). Then samples were cooled in desiccator, final weight of dried pulp, and RTS was noted. The following formula was used to compute the percentage of moisture content.

$$\text{Moisture content (\%)} = \frac{(W_1\text{-}W_2)}{W} \times 100$$

W = sample weight (g)
W_1 = dish, and sample weight before drying (g)
W_2 = dish, and sample weight after drying (g)

2.2.2 Fat content

A semi-automatic type Soxhlet apparatus (Pelican Equipment's, Chennai) was used to assess the fat content of the samples according to the standard method (Ranganna, 1997). The following formula was used to determine the sample's fat content.

$$\text{Fat (\%)} = \frac{(W_1\text{-}W_2)}{W} \times 100$$

W = sample weight (g)
W_1 = weight of empty flask (g)
W_2 = weight of flask, and fat (g)

2.2.3 Crude fiber content

By using Fibra plus (Make: Pelican Equipments, Chennai), the standard method (Ranganna, 1997) was used to determine the crude fibre content of the samples. One gramme of material was weighed in a silica crucible before being treated with 150 ml of 1.25% sulfuric acid, and 150 ml of 1.25% sodium hydroxide at 450°C. The residue that was left after the acid and alkali treatments contained fibre and ash. The residue was then sent to a muffle furnace, where it was ashed for 3 h at 450°C. Only the inorganic materials were left in the crucible as ash after the biological matter was burned. The weight difference between the residue before and after ashing was used to calculate the weight of crude fibre. The samples' fibre content according to the formula below.

$$\text{Crude fiber (\%)} = \frac{(W_1\text{-}W_2)}{W} \times 100$$

W = sample weight (g)
W_1 = weight of crucible before ashing (g)
W_2= weight of crucible after ashing (g)

2.2.4 Protein content

To determine the protein content of samples, the Kel-plus automatic Kjeldahl set up (Make: Pelican Equipment's, Chennai, Plate 1) was used (Ranganna, 1997). Inside the digestion tube, a 1g sample was digested with 2 g of a catalyst mixture (5:1 of K_2SO4:$CuSO_4$), and 10 ml of concentrated H_2SO_4. Digestion resulted in the production of a clear liquid. With distilled water, the volume of the digested material was increased to 10 ml. With saturated NaOH solution, the digested sample was distillated, and the liberated ammonia was captured in 20 ml of 4% boric acid solution. 0.1 N hydrochloric acid was used to titrate the trapped ammonia, and 2-3 drops of a mixed indicator (methyl red: bromocresol green; 1:5) were added. The titration's end point had a very light pink color. The same procedures were used to digest, distil, and titrate blank samples. The following formula was used to determine the sample's nitrogen content, and factor (6.25) was used to convert nitrogen to protein.

$$\text{Protein Content (\%)} = \text{\% Nitrogen} \times \text{factor}$$

$$\text{Nitrogen (\%)} = \frac{14 \times (T\text{-}N) \times \text{Normality of HCL} \times 100}{W \times 1000}$$

T = Titre value burette reading
N = Blank burette reading
W = Weight of the sample(g)

2.2.5 Ash content

By employing a muffle furnace, and the standard method (Ranganna, 1997), the total ash content of the samples was calculated (Plate 2). Five grams of the material were weighed, and placed in a dried silica crucible before being burned on a gentle flame from a burner. Ashing of burned sample was done for 4-5 h at 525°C in a muffle furnace. The % ash was calculated using following formula.

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

2.2.6 Carbohydrate content

According to ICMR and NIN (2020), the percentage of carbohydrates was determined using the subtraction method as follows: Carbohydrate (%) = 100 - [% Moisture + % Protein + % Fat + % Ash]

Preparation of dragon fruit peel powder (DFPP): Dragon fruits were washed, peeled, and then peel was slices in thin strips for blanching. Slices were arranged on net of stainless-steel tray of tray dryer. Slices were dried at 60ºC for 48 hours, and packed in plastic zip bags. Dried slices were crushed in a mixer (Inalsa Food Processor with Mixer Grinder Juicer 1200 Watt) until particle size was reached to 300 mm. Powder was then sieved, and packed in airtight bag then stored at 10ºC (Pawde *et al.,* 2020).

Preparation of biscuits: Dragon fruit peel powder biscuits were prepared by using traditional creaming method. The formulation used in the preparation is shown in Table 1 and process for preparation of biscuits using wheat flour was taken from Pawde *et al.* (2020).

Determination of tapped density: The tapped density of flour and DFPP was determined according to the method described by Tamanna *et al.* (2018). The powder (25 g) was put into a 100 ml graduated cylinder and tapped 15-20 times. The tapped density was calculated as weight per unit volume of sample.

Tapped density (g/ml) = weight of the sample / volume of the sample after tapping.

Biscuit making: The measure all the all ingredients on 100 g flour basis for biscuits making. Creaming of fat and sugar carried out with uniform mixing. Mix all the ingredients for 5 min. Add the required quantity of water in dough. Prepare dough of required consistency by kneading all the ingredients in bowl. Prepare the sheeting by rolling balls of dough on platform of uniform thickness. Cut the sheet using biscuit cutter and transfer the moulded biscuit in greased trays. Transfer the tray to baking oven for baking at 20 min at 160ºC. Remove the baking trays from oven after baking and allow to cool for 10 min at room temperature. Pack the biscuits in HDPE bag and stored in dry conditions.

Sensory analysis: The nine-point hedonic scale was used for the sensory evaluation of biscuits by using 10 semi-trained judges i.e. faculty members and post graduate and Ph.D. students of the College of Food Processing Technology & Bio-energy, AAU, Anand. Sensory attributes were color, appearance, texture, flavor, mouthfeel, and overall acceptability.

2.3 Statistical Analysis

Completely randomized design (CRD) was used for statistical analysis of experimental data. For all parameters, four replications for each treatment (B_0, $DFPB_{30}$, $DFPB_{40}$, and $DFPB_{50}$) was taken for statistical analysis.

Table 1. Formulation of control and dragon fruit peel powder incorporated biscuits

Particulars	B_0	$DFPB_{30}$	$DFPB_{40}$	$DFPB_{50}$
Refined wheat flour	50	35	30	25
Dragon fruit powder	0	15	20	25
Fat (vanaspati)	15.42	15.42	15.42	15.42
Butter	3.82	3.82	3.82	3.82
Condensed milk	4.05	4.05	4.05	4.05
Invert syrup	1.14	1.14	1.14	1.14
Lecithin	0.17	0.17	0.17	0.17
Liquid glucose	1.14	1.14	1.14	1.14
Flavor (ml)	0.04	0.04	0.04	0.04
Ammonium bicarbonate	0.47	0.47	0.47	0.47
Sodium bicarbonate	0.13	0.13	0.13	0.13
Water (ml)	4.29	4.29	4.29	4.29
Sodium metabisulphite	0.027	0.027	0.027	0.027
Dicalcium phosphate	0.08	0.08	0.08	0.08
Tertiary butyl hydroquinone	0.003	0.003	0.003	0.003
Adopted from Pawde *et al*. (2020)				

The prepared biscuits samples were coded as:
B_0 = 100 % Refined wheat flour.
$DFPB_{30}$ = 30:70 (% w/w) Dragon fruit peel powder: Refined wheat flour
$DFPB_{40}$ = 40:60(% w/w) Dragon fruit peel powder: Refined wheat flour
$DFPB_{50}$ = 50:50 (% w/w) Dragon fruit peel powder: Refined wheat flour

3. RESULTS AND DISCUSSION

The results of composition, and tapped density of refined wheat flour, and dragon fruit peel powder, chemical profile of dragon fruit peel powder incorporated biscuits, and sensory parameters of product were discussed below.

3.1 Proximate Composition of Refined Wheat Flour and Dragon Fruit Peel Powder

Results of chemical composition suggest that dragon fruit peel powder had more fiber content (24.37 %) than refined wheat flour (1.25 %), which makes developed biscuits rich in fiber. Protein content of dragon fruit peel powder is lower, which could impact on biscuit's textural properties. Dragon fruit peel powder has also higher fat, and ash content than wheat flour. As peels were dried in tray dryer, moisture content of powder is 7.25 %. Carbohydrate content was also found maximum in wheat flour than peel powder. Tapped density of wheat flour, and peel powder are 0.65, and 0.57, respectively.

3.2 Effect of Incorporation Different Level of Dragon Fruit Peel Powder on Chemical Composition of Biscuits

Table 3 shows the effect of incorporation of dragon fruit peel powder on chemical profile of biscuits. Fiber content of biscuits is significantly increasing with increase in incorporation of dragon fruit peel powder (Table 3). Moisture content of biscuits was significantly increased after incorporation of peel powder. Significant decrease was found in protein content of biscuits as increase the incorporation of peel powder in biscuits. Significantly increase was found in ash content after replacing 30, 40, and 50 % wheat flour with peel powder. Ash content of $DFPB_{30}$, and $DFPB_{50}$ were quite similar (no significant difference). The fat and fiber content of biscuits, increasing pattern was found like moisture content, and ash content. Whereas carbohydrates have similar decreasing pattern like protein content of biscuits.

Table 2. Proximate composition of refined wheat flour and dragon fruit peel powder

Parameter (%)	Refined wheat flour (g %)	Dragon fruit peel powder (g %)
Moisture	11.97 ± 0.02	7.25 ± 0.09
Protein	11.76 ± 0.2	5.96 ± 3.02
Ash	0.65 ± 0.0.1	3.57 ± 0.19
Fat	1.24 ± 0.01	6.69 ± 1.07
Crude fiber	1.25 ± 0.01	24.37 ± 2.01
Carbohydrate	73.39 ± 0.26	49.78 ± 4.13
Bulk density (g/ml)	0.65 ± 0.01	0.57 ± 0.01

Table 3. Effect of incorporation different level of dragon fruit peel powder on chemical composition of biscuits

Parameter (%)	B_0	$DFPB_{30}$	$DFPB_{40}$	$DFPB_{50}$
Moisture	1.99 ± 0.03^d	2.45 ± 0.05^c	2.78 ± 0.06^b	3.09 ± 0.18^a
Protein	10.29 ± 0.08^a	8.27 ± 0.07^b	8.10 ± 0.04^c	7.87 ± 0.06^d
Ash	15.80 ± 0.08^c	16.59 ± 0.12^a	16.33 ± 0.08^b	16.65 ± 0.05^a
Fat	0.52 ± 0.04^d	0.57 ± 0.02^c	0.65 ± 0.02^b	1.01 ± 0.02^a
Crude fiber	1.10 ± 0.08^d	5.29 ± 0.13^c	6.79 ± 0.10^b	7.60 ± 0.06^a
Carbohydrate	70.3 ± 0.17^a	66.84 ± 0.11^b	65.38 ± 0.23^c	63.75 ± 0.26^d

Table 4. Effect of incorporation different level of dragon fruit peel powder sensory score of biscuits

Attributes	Color & Appearance	Texture	Flavor	Mouthfeel	Overall acceptability
B_0	7.8 ± 0.14^a	7.6 ± 0.31^a	7.13 ± 0.25^c	6.93 ± 0.12^d	7.41 ± 0.12^{bc}
$DFPB_{30}$	7.38 ± 0.14^c	7.5 ± 0.20^{ab}	7.25 ± 0.2^{bc}	7.28 ± 0.21^c	7.06 ± 0.13^d
$DFPB_{40}$	7.53 ± 0.05^{bc}	7.2 ± 0.28^{bc}	7.5 ± 0.2^b	7.60 ± 0.12^b	7.5 ± 0.2^{ab}
$DFPB_{50}$	7.74 ± 0.21^{ab}	6.9 ± 0.11^c	7.83 ± 0.12^a	7.99 ± 0.02^a	7.75 ± 0.29^a

3.3 Effect of Incorporation Different Level of Dragon Fruit Peel Powder on Sensory Score of Biscuits

Sensory analysis of biscuits revealed that overall acceptability was found maximum for $DFPB_{50}$ (Table 4). With increased level of incorporation of peel powder in biscuits, dark brown color with slightly red spots were reported on biscuit. Color of control (B_0), and $DFPB_{50}$ was acceptable for panelists. Texture of B_0, and $DFPB_{30}$ were found quite similar. Texture of $DFPB_{50}$ was liked less by panelists. Reason for low textural properties of peel powder incorporated biscuits might be less gluten formation in it. Texture is one of the more important sensory attributes which we could be improved by some changes in raw material for making biscuits. Flavor of $DFPB_{50}$ was ranked more by panelists. Mouthfeel received maximum score for $DFPB_{50}$. Overall acceptability of DFPB40 was quite lesser than $DFPB_{50}$.

4. CONCLUSIONS

The utilization of dragon fruit peel powder to develop fiber rich biscuits were studied. The biscuits were prepared by incorporating the 30, 40 and 50% level of dragon fruit peel. The baking and sensory properties of prepared biscuits were studied. Replacement of wheat flour upto 50 % of dragon fruit peel powder is organoleptically accepted as well as fiber content was found maximum in $DFPB_{50}$. So, the biscuits with 50% incorporation of dragon fruit peel powder are acceptable in sensory test, and rich in fiber which making biscuits nutritious, and healthy.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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