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Valorization of Radish Pomace and Dragon Fruit Peel for Development of Antioxidant Dietary Fiber Enriched Cookies

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Abstract: ***The cookies were high in antioxidant and dietary fiber prepared by replacing refined wheat flour with radish pomace powder (RPP) and dragon fruit peel powder (DFPP) at 0, 5, 10, 15, 20 % levels and sugars at 50 %. The cookies were evaluated for physico-chemical and sensory quality parameters. The addition of RPP and DFPP increases weight, diameter, spread ratio, spread factor, dietary fiber, ash content, fat content, antioxidant activity and decreases protein and carbohydrate contents. The cookies with 15 % substitution each of RPP and DFPP scored maximum for all the sensory quality attributes.***

Keywords: Cookies, Radish pomace powder, dragon fruit peel powder, dietary fiber, antioxidant activity

1. Introduction

In current years, new trends in the food market are in continuous movement as consumers change their demands during acquire healthier food. The innovation of functional foods has a singular potential to enhance food quality as well as consumer health and wellbeing (Daziki *et al*. 2014). The various kinds of plant by-products have been used to create certain useful baked items. Because they include such high levels of dietary fiber, antioxidants, and carotenoids, these by-product enhanced foods (bread, biscuits, and cookies) are beneficial. The essential amino acids, fiber, and antioxidants are all lacking in traditional cookies made with refined wheat flour. The main aim of refined wheat flour-based cookies is attempted to be improved nutritional quality by including a variety of low-cost functional ingredients. These newly designed functional cookies could be a fantastic meal alternative for working women and children, as well as anyone suffering from obesity, diabetes, and cardiovascular diseases. (Goswami *et al*. 2020).

The abundance of radish in the area, the some researchers decided to focus their research on this plant to maximize its nutritional value. In phylogenetic analyses of the *Brassicaceae* family, radish (*Raphanus sativus L*.) is classified as *Rapa / Oleacera*. Radishes come in a variety of colors, ranging from white in Asia and red in Europe, as well as purple-green, and black are available. In addition, the flesh of most European and Asian crops is white. Because of its phytochemical concentration, radish has several favorable characteristics. Anthocyanin pigments give the root a red color, and isothiocyanates' high strength adds to the bitter taste (Gamba *et al*. 2021).

The red pitaya, popularly known as the dragon fruit (*Hylocereus polyrhizus*), is a tropical fruit that belongs to the *Cactaceae* family of *cacti*. It is endemic to tropical America and can adapt to a wide range of climatic conditions in its natural environment, which includes arid Pacific Coast coastal plains and also found in Malaysia, Thailand, Vietnam, and another places of the world (Raveh *et al*. 1999). The purple dragon fruit (*Hylocereus polyrhizus*) and the white dragon fruit (*Hylocereus polyrhizus*) are the two types of dragon fruit commonly found in Malaysian markets (*Hylocereus undatus*). Their distinctions are in the fruit in size and shape and the color of their seeds, which are either red (*H. polyrhizus*) or white (*H. polyrhizus*) (*H. undatus*). A dragon fruit weighs about 350 gm on average (Lim *et al*. 2006).

2. Materials and Methods

The raw materials like refined wheat flour, white radish, and red dragon fruit were procured from the local market of Loni-Kalbhor, Pune. Radish, dragon fruit were carefully cleaned, free from blemishes.

Preparation of radish pomace powder: The radish was clean by thoroughly washing to remove any adhered impurities. The radish was then, peeled it and cut it into small pieces with help of knife. The cut pieces were blanch for 2 min using boiling water. The blanched pieces were grinded in mixer grinder Further, the radish pomace was obtain by separation of the juice using muslin cloth. The pomace was then spread in thin layer and subjected to dehydration using cabinet dryer. The drying was carried out at 60 to 70˚C till the final moisture content reached to 5 to 7 %. The dehydrated radish pomace was again grinded and passed through sieve of 60 mesh size to obtain radish pomace powder of uniform particle size. The dragon fruit peel powder was packed in LDPE pouches and storage at cool and dry place till its further use. (Gupta *et al*. 2012)

Preparation of dragon fruit peel powder: The dragon fruits were peeled manually and the peel was cut into small pieces of 2 mm thickness using knifes. For preventing browning, the peel pieces were treated by soaking in sodium metabisulphite solution (0.2 %) for 15 min. The pieces were washed and spread in a thin layer on trays. The trays were placed in cabinet dryer and peel pieces were subjected to drying at 50 to 60˚C till the moisture reached to 15%. The dried pieces were grinded using mixer grinder and the powder was passed through sieves (60 mesh). The dragon fruit peel powder was packed in LDPE pouches and storage at cool and dry place till

its further use. Lee Ho *et al*. (2016).

***Preparation of cookies*:** The cookies were prepared using various composite flour blends (table 3.6) by following traditional creamery method as given in fig. (Kulthe *et al*. 2017). Firstly, fat and sugar were mixed together to obtain light and fluffy cream. Composite flour blends were added with milk powder and baking powder and sieved 3 to 4 times to obtain uniform mixture. The mixture was transferred to the cream bowl and dough was formed by adding sufficient amount of water with gentle kneading. The dough was sheeted using sheeting machine to obtain uniform thickness (around 0.5 to 0.6 mm) with help of cookie cutter the sheet was cut into round pieces. The sheeting and cutting process was repeated till all the dough was converted into round pieces. The pieces were rounded, flattened and placed in the baking tray smeared with fat and baked at 150-180˚C for 15 min. The cookies were allowed to cool, packed in LDPE packages and stored at ambient temperature.

***Sensory evaluation*:** The cookies were evaluated for sensory attributes by a panel of 10 semi trained judges, using a 9 point Hedonic scale system.

***Flow properties*:** The flow properties of maida, radish pomace powder, dragon fruit peel powder calculated by Beristain *et al*. (2001), (Drusch, 2007) method.

***Functional properties*:** The functional properties of maida, radish pomace powder, dragon fruit peel powder calculated by Sathe *et al*. (1982), Belewu *et al*. (2008), Ukpabi *et al*. (1990) and AOAC, (2006) method.

***Physical parameters*:** weight, diameter, thickness, spread ratio, spread factor of cookies was determined as per AACC (1976) methods.

***Chemical parameters*:** The proximate composition of maida, radish pomace powder, dragon fruit peel powder and cookies were determined as per AOAC (2005) procedures. The antioxidant activity calculated by DPPH method Mahloko *et al.* (2019).

***Texture profile analysis*:** The texture profile analysis of prepared cookies samples was performed by using Texture Pro CT V1.7 Build 28 texture Analyzer. The samples were placed on the samples holding table and cylindrical probe was used on the middle section of the cookies. A double cycle was programmed with the test speed set at 1 mm/sec. Based on the deformation curve, different parameters like hardness, cohesiveness, chewiness, gumminess and crispiness were calculated by the in- built software.

***Statistical analysis*:** All processing tools and sample analysis were done in triplicate for statistical analysis. The analysis of variance was computed using the standard ANOVA method. The entire randomised design was used to record and statistically analyse the data gathered for various treatments (CRD) approach established by Panse and Sukhatme (1967). to determine the degree of significance.

3. Results and Discussion

The proximate composition (%) maida, radish pomace powder, dragon fruit peel powder used to prepare cookies was moisture: 12.43, 11.24 and 9.78 protein: 11.40, 6.24 and 5.38 fat: 0.45, 2.03 and 4.75 ash: 0.58, crude fiber: 0.82, 14.25, 21.56 carbohydrates: 74.32, 68.52, 50.75 total phenol content: 50.34, 62.78 mg GAE/100gm and antioxidant activity: 68.54, 79.25 % inhibition respectively.

Flow properties: The flow properties of flours (maida, radish pomace powder, dragon fruit peel powder) are presented in table 1. The bulk density of flour from 0.48 to 0.42 g/ml. The Tapped density showed cohesiveness of flour. Refined wheat flour (maida) showed highest tapped density 0.53 g/ml and lowest in dragon fruit peel powder 0.46 g/ml. The Carr's index showed compressibility of flours. Refined wheat flour showed highest compressibility index 9.68 % and lowest 8.45 %. The hausner's ratio related to flowability of a powder (Hausner 1995). Refined wheat flour showed highest H. ratio (1.109) and lowest in 1.093 for dragon fruit peel powder.

Functional properties: The functional properties of flours presented in Table 2. It showed behaviour of ingredients during processing. They also determined nutrients presented in raw materials. The water absorption and oil absorption capacity depends on fiber content of raw material. The high fiber content of dragon fruit peel flour might be the responsible for high OAC index component, as protein when associated with carbohydrates form a dense matrix resulting in better oil entrapment. Gupta *et al*. (2012), Chong *et al*. (2015). In foaming capacity protein plays important role. Proteins tend to decrease surface tension air- water interface by entrapping air bubbles inside its cohesive film thus, enhancing the stability of foam. Awuchi *et al* (2019). The swelling index depends on the quantity of protein and fat in flour can prevent starch granules from expanding. According to Wang *et al.* (1996), the quantity of protein and fat in flour can prevent starch granules from expanding.

***Physical parameters*:** The physical parameters of cookies prepared by replaced maida with 0 - 20 % RPP and DFPP are presented in table 3. the weight of cookies from 15.60 g to 16.10 g from S_0 to S_4. The rise in the weight of cookies may be attributed to increasing levels of radish pomace powder and dragon fruit peel powder. The increasing diameter (50.24 to 68.19 cm) from S_0 to S_4 was observed with increasing replacement of refined wheat flour with radish pomace powder and dragon fruit peel powder. Water content enhancement in dough formulation with increasing radish pomace powder and dragon fruit peel powder level resulted in increases diameter. The maximum thickness was noticed in the lower substituted level of radish pomace powder and dragon fruit peel powder control(S_0) cookies (9.80 mm) and lower thickness shown by the highest substituted level of (S_4) sample (6.86 cm). The spread ratio increases from 5.12 to 9.94 mm with increasing proportion of RPP and DFPP. The spread factor of cookies also increases from 100.00 to 193.67 % respectively. Bornare *et al*. (2015), Arun *et al*. (2015).

Table 1: Flow properties of flours

Raw material	Bulk density (g/ml)	Tapped density (g/ml)	Carr's index (%)	Hausner's ratio
Refined wheat flour	0.48± 0.01	0.53± 0.03	9.68± 0.4	1.109 ± 0.05
Radish pomace powder	0.47 ± 0.01	0.51 ± 0.01	8.64 ±1.16	1.094 ± 0.01
Dragon fruit peel powder	0.42 ± 0.02	0.46 ± 0.01	8.45 ±3.97	1.093 ± 0.04

Each value is the mean of three determinations ± standard deviation

Table 2: Functional properties of flours

Properties	Refined wheat flour	Radish pomace Powder	Dragon fruit peel Powder
WAC (%)	139.2 ± 0.23	148.4 ± 0.36	256.7 ± 0.27
OAC (%)	146.9± 0.32	154.2 ± 0.38	167.3 ± 0.30
EA (%)	42.18 ± 0.45	36.16 ± 0.29	38.52 ± 0.42
ES (%)	38.47 ± 0.14	32.25 ± 0.24	36.54 ± 0.26
FC (%)	12.59 ± 0.25	4.46 ± 0.35	6.34 ± 0.36
FS (%)	1.92 ± 0.20	1.15 ± 0.26	1.65 ± 0.28
SI (g/g)	10.1± 0.19	4.13 ± 0.23	6.23 ± 0.021

Each value is the mean of three determinations ± standard deviation

Table 3: Physical parameters of Cookies

Treatments	Weight (gm)	Diameter (mm)	Thickness (mm)	Spread ratio (D/T)	Spread factor (%)
S_0	15.60	50.24	9.80	5.12	100.00
S_1	15.63	53.64	9.74	5.50	107.42
S_2	15.36	58.58	8.60	6.81	133.00
S_3	15.46	63.83	7.14	8.93	174.41
S_4	16.10	68.19	6.86	9.94	194.14
SE ±	0.297	0.273	0.157	0.207	-
CD @5%	0.935	0.860	0.494	0.653	-

Each value is the mean of three determinations

***Chemical parameters*:** The chemical composition of cookies included moisture, ash, crude fat, crude protein, dietary fiber, and carbohydrates total phenol content and antioxidant activity are presented in table 4 and 5. The addition of RPP and DFPP was increases moisture, ash, crude fat, dietary fiber and carbohydrate content. Azami *et al*. (2016) and Yamin *et al*. (2020). The increasing levels of RPP and DFPP increases total phenol content and antioxidant activity of cookies. Antioxidant activity increases as a result of processing, such as baking. This could be owing to the development of brown pigments called melanoidins, which are the result of the maillard reaction (a non-enzymatic browning reaction) that occurs during baking. (Shafi *et al*. 2016)

Table 4: Chemical parameters of cookies

Samples	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Ash (%)	Dietary fiber (%)	Carbohydrates (%)
S_0	2.54	9.78	18.25	0.45	1.84	67.14
S_1	2.84	9.56	18.37	0.85	2.29	66.09
S_2	2.99	9. 45	18.81	1.28	2.98	64.49
S_3	3.16	9.33	19.27	1.48	3.78	62.98
S_4	3.25	9.14	19.40	1.57	4.58	62.06
SE±	0.017	0.010	0.028	0.012	0.014	0.023
CD @5%	0.054	0.032	0.084	0.039	0.044	0.072

Each value is the mean of three determinations

Table 5: Total phenol content and antioxidant activity

Samples	Total Phenol content (mg GAE/100gm)	% Inhibition
S0	5.33	14.92
S1	6.62	16.56
S2	9.37	20.21
S3	11.79	23.73
S4	15.33	26.73
SE ±	0.012	0.015
CD@ 5%	0.038	0.047

Each value is the mean of three determinations

Texture profile analysis: The cookies included different parameters hardness, cohesiveness, chewiness, gumminess, crispiness. The increasing level of RPP and DFPP increases hardness of cookies (16.055 to 26.080 g). The cohesiveness of cookies increases from 4.09 to 4.89 The chewiness of cookies decreases gradually from (5.07 to 4.05 mJ). The gumminess of cookies decreases from (9.87 to 9.79 g) because increases fiber content of cookies. The addition of RPP and DFPP in cookies decreases crispiness from (3.10 to 3.0 g). Ulfat Jan *et al*. (2015), Bornare *et al*. (2015).

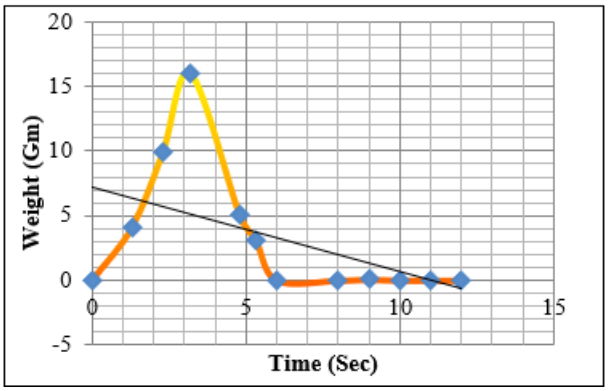

Figure 1: Texture profile of S_0 control sample (100% RWF)

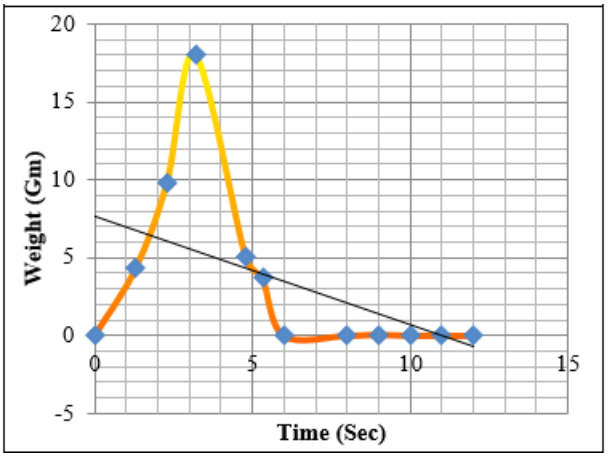

Figure 2: Texture profile of S_1 cookies (90% RWF: 5% RPP: 5% DFPP)

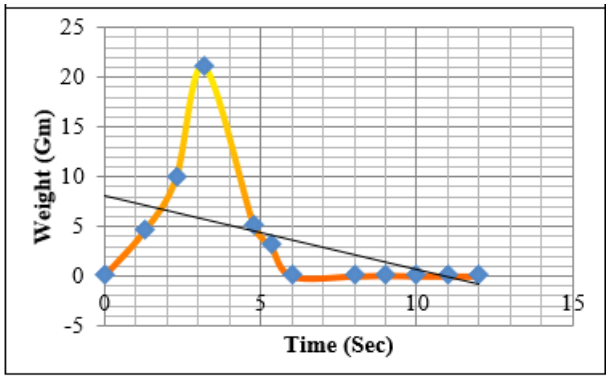

Figure 3: Texture profile of S_2 cookies (80 % RWF: 10% RPP: 10% DFPP)

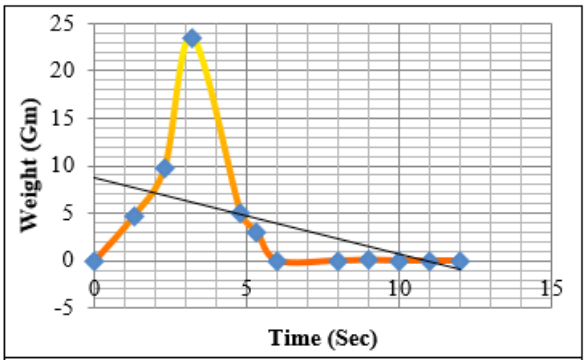

Figure 4: Texture profile of S_3 cookies (70 % RWF: 15 % RPP: 15 % DFPP)

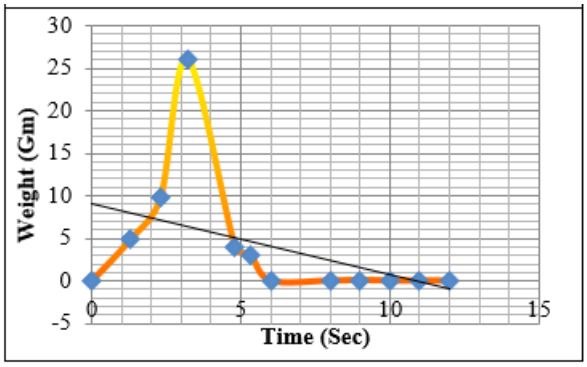

Figure 5: Texture profile of S_4 cookies (60 % RWF: 20 % RPP: 20 % DFPP)

Sensory evaluation of cookies: The data about sensory analysis of cookies incorporated with RPP and DFPP are presented in table 7. The data showed that cookies with 15 % RPP and 15 % DFPP obtained highest scores of colour and appearance (8.32) texture (8.69), flavour (8.57), overall acceptability (8.44).

Table 6: Sensory evaluation of cookies

Samples	Colour and Appearance	Flavor	Texture	Taste	Overall Acceptability
S_0	7.79	8.54	8.28	8.35	8.24
S_1	8.02	8.14	8.25	8.21	8.22
S_2	8.03	8.42	8.28	8.33	8.29
S_3	8.32	8.57	8.69	8.19	8.44
S_4	7.29	7.86	7.18	7.32	7.41
SE±	0.147	0.174	0.161	0.163	0.133
CD@5%	0.422	0.501	0.463	0.468	0.382

Each value is the mean of three determinations

Table 7: Effect of RPP and DFPP incorporation on Antioxidant and dietary fiber contents of cookies

Cookies	Antioxidants (TPC)	% Increases in Antioxidants (TPC)	Dietary fibers	% Increases in Dietary fibers
Control	5.33	-	1.84	-
S_3	11.79	121.2	4.58	148.9

Per cent increase in antioxidant and dietary fiber in standardize cookies The standardize cookies maximal scored cookies for sensory evaluation on addition of RPP and DFPP each at 15 % were assessed for % increase in antioxidant and dietary fiber content. The data are presented in table 7. The antioxidant content was increases from 121.9 % on addition 15 % RPP and 15 % DFPP. The increase in dietary fiber content of standardized cookies was 148.9 %. Damat *et al.* (2019)

4. Conclusion

The high fiber and antioxidant activity can be achieved by substituting radish pomace powder and dragon fruit peel powder for up to 20% of the refined wheat flour in each formulation without impacting overall acceptability. In cookies, replacing refined wheat flour with RPP and DFPP with (5 to 20%) in a cookies 4.58 percent increase in fiber and a 26.73 percent increase in antioxidant activity. The addition of RPP and DFPP enriched antioxidant and dietary

fiber of cookies. The antioxidant content (TPC) increases from 5.33 to 11.79 with the addition of RPP and DFPP each at 15 per cent. The increase in antioxidant content of standardized cookies was 121.2 per cent. The dietary fiber content was increased from 1.84 to 4.58 with the addition of 15 per cent each of RPP and DFPP. The increase in dietary fiber content of standardized cookies was 148.9 per cent.

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