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RESEARCH PAPER

Physico-chemical and Sensory Characteristics of Beet Root Pomace Powder Incorporated Fibre Rich Cookies

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ABSTRACT

Fibre rich cookies were prepared by substituting refined wheat flour with beetroot pomace powder (BPP) at 5%, 10%, 15%, 20% and 25% and evaluated for its physical properties, chemical composition, textural properties and sensory characteristics. The thickness of the cookies increased whereas the diameter, spread ratio and spread factor decreased with the increase in BPP in flour blend except for the cookies with 5 % BPP which showed contrary results. The moisture, crude fibre, protein and ash increased but carbohydrates decreased with the increase in the level of incorporation of BPP. The fat content of the cookies showed no pronounced variation. The hardness of the cookies increased with increase in the level of incorporation of BPP in the flour blends except for the cookies with 5% BPP that showed lower value as compared to the control sample. Incorporation of BPP however, showed detrimental effect on appearance of cookies by imparting it dark colour; texture score decreased with the increase in the level of incorporation. Cookies with 10 % BPP were found to be the most acceptable due to better taste and flavour.

Keywords: Beetroot pomace powder, cookies, fibre, quality, texture

The intake of fibre in the diet of a child or an adult, through various foods (such as wholegrain foods, nuts, fruits and vegetables), plays an important role in reducing the risk and lowering the incidence of numerous diseases. Fibre consumption is associated with high nutritional value and antioxidant status of the diet, enhancing the effects on human health (Maćkowiak *et al.*, 2016). Fruit and vegetable wastes are inexpensive, available in large quantities, characterized by a high dietary fibre content resulting into high water binding capacity and relatively low enzyme digestible organic matter (Serena and Kundsen, 2007). Pomace obtained from fruit and vegetable juice processing industry poses a problem of its disposal and is often used as an animal feed. Čanadanović-Brunet *et al.* (2011) stated that though still rich in betalains and phenols, the beet root pomace from the juice industry (15–30%) is disposed of as feed and manure. Shyamala and Jamuna (2010) reported that beetroot pomace is a good source of dietary fibre, specially the soluble fibre and could be utilized as a source of supplement or further exploited for value addition. Cookies are ideal for nutrient availability, palatability, compactness and convenience. They differ from other baked products like bread and cakes because of having low moisture content, ensure comparatively free from microbial spoilage and confer a long shelf-life of the product (Wade, 1988).

Thus, it is good carrier for valorising it with beet root pomace powder. Earlier, successful attempt was made to incorporate apple pomace- a waste from juice concentrate manufacture into cookies (Kaushal and Joshi, 1995) but there is no report on the beetroot pomace powder (BPP) in the cookies. (Kaushal and Joshi, 1995)

The present investigation was carried out to find out the effect of addition of different proportion of beetroot pomace powder on physical properties, chemical composition, texture and sensory characteristics of fibre rich cookies and the results are presented here in this communication.

MATERIALS AND METHODS

Preparation of beetroot pomace powder (BPP)

Beetroots were washed, de-headed and peeled and subjected to juice extraction. After the extraction of juice, pomace was spread on aluminium trays and kept in a cabinet drier. Drying bed thickness was 0.5 cm.

Drying was carried out at 50 °C for 6 hours. Dry pomace was pulverized using domestic grinder and sifted through sieve of 250 µm particle size and packed in airtight polypropylene jar and stored in a cool and dry place.

Preparation of flour blends

Blends of 5%, 10%, 15%, 20% and 25% were prepared by substitution of refined wheat flour with beetroot pomace powder.

Preparation of cookies

Cookies were prepared, using creamery method for making biscuit dough. The ingredients (g) used in preparation of cookies were flour blends 100, fat 45, sugar 60, baking powder 1.5, sodium bicarbonate 1.5, ammonium bicarbonate 1.5 and water as per the requirement for making dough. Dough was rolled in sheet of 0.5 cm thickness and cut into circular shape with dye.

Physical properties

The weight, diameter, thickness, spread ratio and spread factor of cookies were calculated as per AACC methods (AACC, 1976). Top grain was visually assessed as a function of number of cracks formed over the surface of the cookies.

Chemical composition

Moisture, crude fat, protein (using the factor 6.25 × N), ash and crude fibre content of different samples of cookies were determined as per standard methods (AACC, 2000). Total carbohydrate was obtained by difference.

Textural properties

Stable Micro System *TAXT2 plus* Texture Analyzer was used for texture profile analysis (TPA) of cookies. The test was configured so that the hardness calculated at the time of the test by determining the load and displacement at predetermined points on the TPA curve. S-5 probe with 20 mm/sec. of pre-test and post-test speeds; and 75% compression were selected for TPA analysis. The maximum force required to break the cookies was noted as hardness.

Sensory Characteristics

The sensory characteristics of cookies were evaluated for its different sensory attributes using ten semi trained panellists. Panellists were given control sample and the treatments along with cookies with 25% oat flour at the time of evaluation. Sensory attributes like colour and appearance, texture, taste, flavour and overall acceptability were evaluated using 9 point hedonic rating (Ranganna, 2011).

Statistical analysis

Completely Randomized Design (CRD) was used to test the significance of results (Panse and Sukhatme, 1984; Nigam and Gupta, 1979).

RESULTS AND DISCUSSION

Effect of incorporation of beetroot pomace powder at various levels on physical properties of the cookies is

presented in Table 1. Weight of the cookies increased progressively from 19.230 g to 19.483 g with increase in the level of supplementation of BPP. Increase in the weight could be due to water binding capacity of BPP. Pinki and Awasthi (2014) reported that the weight of cakes increased with the increase in the level of incorporation of beetroot powder.

The increase in supplementation of BPP upto 5 % in flour blend resulted in an increase in the diameter of the cookies from 60.48 mm to 62.24 mm. Further increase in BPP from 10 % to 25 % resulted (Table 1) in a progressive decrease in diameter and similar progression was observed for spread ratio and spread factor. Thickness of cookies decreased with incorporation upto 5% followed by a progressive increase. Increased spread in cookies with 5 % BPP could be attributed to water soluble pentose content (Jeltema *et al.,* 1983). Further decrease in spread was due to increased water absorption by the fibres in BPP causing decrease in dough viscosity resulting in poor spreading during baking. Chen *et al.* (1998) reported similar results for cookies incorporated with apple fibre.

Table 2 illustrates the chemical properties of cookies incorporated with different level of BPP. Moisture content of the cookies increased with the increase

Table 1: Physical properties of cookies incorporated with beetroot pomace powder

Sample	Weight (g)	Diameter (mm)	Thickness (mm)	Spread ratio	Spread factor (%)	Top grain Development
B_C	19.230	60.48	14.85	4.07	100	Most
B_1	19.272	62.24	12.67	4.91	120.63	Most
B_2	19.314	59.94	15.50	3.86	94.83	Moderate
B_3	19.406	57.44	16.70	3.43	84.27	Rare
B_4	19.441	53.87	17.53	3.07	75.42	Rare
B_5	19.483	52.16	17.39	2.99	73.46	Inappropriate
SE±	0.013	0.068	0.053	—	—	—
CD at 5%	0.039	0.207	0.160	—	—	—

*Each value is average of three determinations

B_C- 0% BPP B_3-15 % BPP
B_1-5% BPP B_4-20% BPP
B_2-10% BPP B_5-25% BPP

Table 2: Chemical composition of cookies incorporated with beetroot pomace powder

Sample	Moisture (%)	Fat (%)	Crude Fibre (%)	Ash (%)	Protein (%)	Carbohydrates (%)
B_C	1.58	23.72	0.40	1.00	5.46	67.84
B_1	1.78	23.68	1.20	1.64	5.68	66.02
B_2	1.96	23.66	1.74	1.72	6.12	64.80
B_3	2.28	23.62	2.20	1.80	6.56	63.54
B_4	2.42	23.68	2.52	1.92	6.88	62.58
B_5	2.70	23.62	2.92	2.02	7.10	61.64
SE±	0.037	0.020	0.034	0.023	0.027	0.039
CD at 5%	0.113	0.060	0.103	0.070	0.083	0.119

*Each value is average of three determinations

B_C- 0% BPP B_3-15 % BPP
B_1-5% BPP B_4-20% BPP
B_2-10% BPP B_5-25% BPP

Table 3: Sensory evaluation of cookies incorporated with beetroot pomace powder

Sample	Colour and Appearance	Texture	Taste	Flavour	Overall acceptability
B_C	8.3	8.4	7.9	7.9	8.0
B_1	7.9	8.4	8.2	8	8
B_2	7.7	8.0	8.4	8.6	8.2
B_3	6.9	7.0	7.6	7.5	7.3
B_4	5.0	6.1	7.2	6.9	6.0
B_5	5.0	6.0	6.3	6.2	5.7
O_5	8.5	8.5	8.3	8.1	8.0
SE±	0.042	0.059	0.047	0.066	0.029
CD at 5%	0.120	0.169	0.134	0.189	0.083

* Each value is average of 10 determinations

B_C- 0% BPP
B_1-5% BPP
B_2-10% BPP
B_3-15 % BPP
B_4-20% BPP
B_5-25% BPP
O_5- 25 % Oat flour

in the level of incorporation of BPP which can be attributed to the hydration property of fibres present in the BPP (Ajila *et al*., 2008).

The fat content of the cookies showed no pronounced variation. Crude fibre and ash content of the cookies increased linearly with the increase in the BPP content in the cookies. The crude fibre content increased at different levels of replacement (0% - 25 %) ranging from 0.40 % - 2.92 %. Protein content of the cookies increased with the increase in BPP in the cookies which might be due to higher protein content of BPP in comparison to the refined wheat flour. High protein content of BPP can be associated with the presence of nitrogenous betalains in BPP. Carbohydrate content of the cookies decreased progressively with the increase in BPP content.

Sensory properties of cookies with different level of incorporation of BPP are presented in Table 3. Sensory scores for colour and appearance decreased with the increase in the level of BPP in flour blend. Addition of BPP imparted maroon tinge to the cookies and cookies appeared dark with the increase in the level of BPP. Heating of betalain produces a gradual reduction of red colour, and eventually the appearance of a light brown colour (Agarwal *et al*., 2013) which resulted in dark cookies. The inner colour of the cookies was found to be darker as compared to surface colour.

Cookies with 5 % BPP (B_1) maintained same textural properties as that of control sample (B_C). However, further increase in BPP decreased the textural properties of the cookies. Increase in level of BPP resulted in hardness and decrease in the crispness of the cookies.

Increase in taste score was observed at 10 % level of supplementation due to the presence of peculiar beetroot taste in the cookies. Further, increase in the level of incorporation resulted in a decrease in the sensory score for taste which might be due to development of bitter taste which could be attributed to high tannin content of BPP. Similar progression was observed for flavour score. The improvement in flavour could be attributed to peculiar beetroot flavour BPP imparted to the cookies. Decrease in flavour score was due to dominance of earthy and woody flavour by further addition of BPP.

Overall acceptability scores of the cookies increased upto 10 % BPP followed by decrease. In comparison to cookies with 25 % oat flour (O_5), cookies with 25% BPP (B5) showed pronounced decrease in sensory scores.

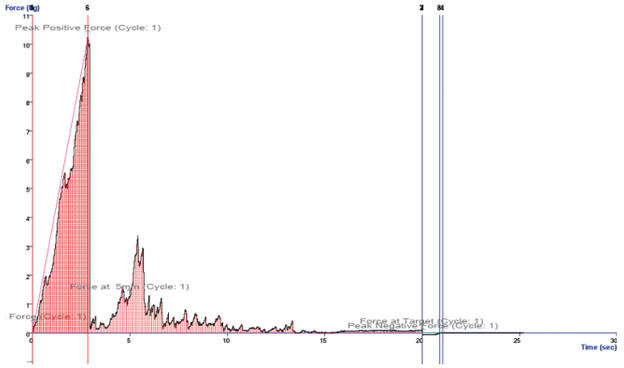
The textural characteristics of blended cookies show that the hardness of the cookies increased with increase in the level of incorporation of pomace powder in the flour blends except for the cookies with 5% BPP (B_1) where the hardness decreased (7.267 Kg) as compared to the control cookies (10.232 Kg). The decrease in hardness might be due to increase spread in the cookies (B_1) and resultant decrease in thickness as compared to the control cookies.

Addition of pomace powder results in protein matrix and starch granules without full development due to adhering of fibre particles to starch granules and protein fibrils (Hernández-Ortega *et al.*, 2013). Very high values of hardness were obtained for the cookies with higher level of incorporation of pomace powder. This could be attributed to relatively higher water content of incorporated doughs (Ajila *et al.*, 2008). Doughs having higher water content produce an extensive gluten structure and resulted in harder cookies (Gaines, 1990; Labuschagne *et al.*, 1996; Smith, 1972).

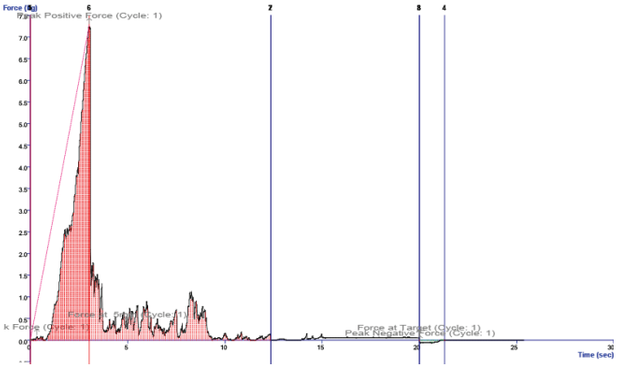
Table 4: Texture Profile Analysis of cookies incorporated with beetroot pomace powder

Sample	Hardness (Kg)
B_C	10.232
B_1	7.267
B_2	13.393
B_3	15.942
B_4	19.772
B_5	22.963

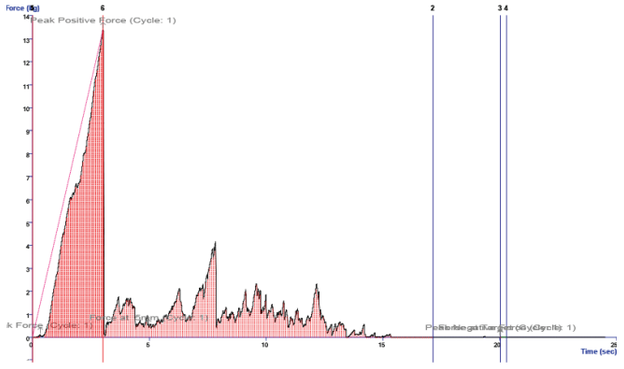
B_C- 0% BPP
B_1-5% BPP
B_2-10% BPP
B_3-15 % BPP
B_4-20% BPP
B_5-25% BPP



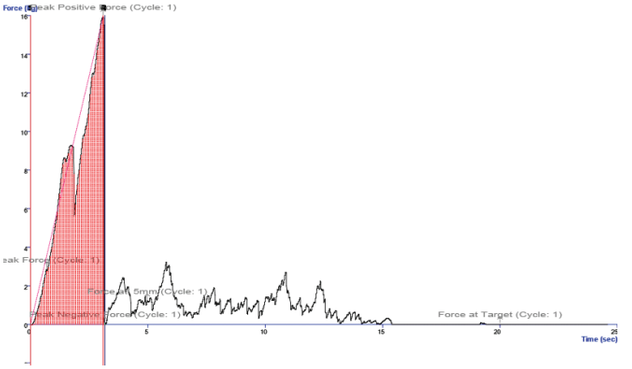
1.1 Representative TPA graph of Control Sample (0 % Incorporation)



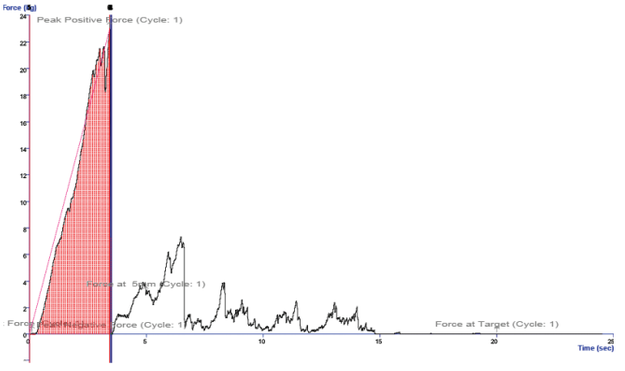
1.2 Representative TPA graph of B_1 (5 % BPP)



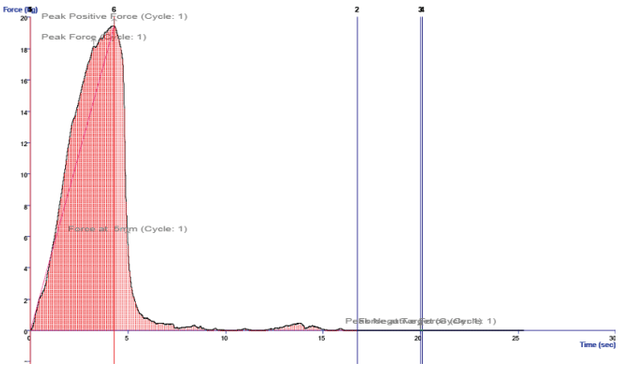
1.3 Representative TPA graph of B_2 (10 % BPP)



1.4 Representative TPA graph of B_3 (15 % BPP)



1.5 Representative TPA graph of B_4 (20 % BPP)



1.6 Representative TPA graph of B_5 (25 % BPP)

It is evident from graphs (Fig. 1) that there was decrease in the number of peaks before peak positive force with the increase in the level of incorporation of beetroot pomace powder representing decrease in the crunchiness of the cookies.

CONCLUSION

Beetroot pomace is an underutilized by-product which is rich source of dietary fibre and can be utilized for developing fibre rich bakery products. Incorporation of BPP resulted in progressive decrease in the spread of cookies except for 5% level of incorporation where the spread ratio was more than the control sample. Cookies with 10 % level of incorporation of BPP were found to be most acceptable level due to improved taste and flavour. However, it was found that incorporation at high level adversely affected the colour and appearance, and texture of the cookies thus, reducing overall acceptability of the cookies. Hardness of the cookies increased with the increase in level of incorporation beyond 5 %. Incorporation of BPP resulted in increase in the fibre content of cookies. Thus, BPP can be considered as alternative dietary fibre source or speciality ingredient for valorisation of bakery products.

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