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Orange Peel Powder: A Potent Source of Fiber and Antioxidants for Functional Biscuits

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A B S T R A C T

Orange peel is a rich source of dietary fiber and antioxidants. In current life style scenario, people are becoming more aware of functional key ingredients and thus the demand of functional foods is increasing. This study was aimed to develop functional biscuits by incorporating orange peel powder (5, 10, 15 and 20%). Oranges were washed thoroughly, peeled and the fruit peels were cut into small pieces and oven dried (50±5 C) and ground to a fine powder. Developed biscuits were evaluated for sensory characteristics using 9-point hedonic scale. Biscuits were analysed for proximate composition, dietary fiber and antioxidants using standard methodology. Statistically data were analysed by OPSTAT software. The contents of total, insoluble and soluble dietary fibres, total polyphenols and radical scavenging activity were found to be significantly ($p \leq 0.05$) higher in orange peel powder incorporated biscuits than control. Total, insoluble and soluble dietary fiber in orange peel powder supplemented biscuits ranged from 8.33 to 13.33%, 5.43 to 7.36 and 2.82 to 6.00 per cent, respectively whereas contents of same in control biscuits were found to be 2.70, 1.74 and 0.95 per cent, respectively. Orange peel powder can be successfully utilized upto 20 per cent for the development of fiber and antioxidants rich functional biscuits without affecting sensory attributes.

Introduction

One of the major segments of food processing in India is baking industry. Baked products are most popular because of their easy availability, ready to eat convenience and long shelf life. Biscuit is the most commonly used as snacks by children and adults (Dhankar, 2013). Their increasing demand also provides a wider scope for their production, fortification and other nutritional improvement. The purpose of fortification is mainly to maintain the nutritional quality of the products, to keep adequate nutrient levels in order to correct or prevent specific nutritional deficiencies in the population from certain deficiencies, to increase the added nutritional value of a product from a

commercial viewpoint and to provide certain technological functions in food processing (Dukwal, 2004). It has been found that citrus by-products, if utilized fully, could be major sources of phenolic compounds. The peels, in particular, are an abundant source of natural flavonoids, and contain higher amount of phenolics compared to the edible portions (Gorinstein *et al.,* 2001). The contents of total phenolics in peels of lemons, oranges, and grapefruit were 15 per cent higher than those in the peeled fruits. Flavonoids in citrus are a major class of secondary metabolites. The peel contains the highest amount of flavonoids than other parts and those flavonoids present in citrus fruits belong to six peculiar classes according to their structure i.e. flavones, flavanones, flavonols, isoflavones, anthocyanidins and flavanols (Senevirathne *et al.,* 2009). Now a days to improve the nutritional quality of bakery products, whole natural foods and their by products are becoming part of the bakery products which improve their quality and nutritional bioavailability in a cost-effective way. Report had shown that orange peels are rich in phenolic compounds, vitamins, minerals and dietary fiber with good antioxidant properties (Ajila *et al.,* 2007; Omoba *et al.,* 2015). Dietary fiber (DF), which is an important component of orange peel, is the indigestible portion of food derived from plant and it helps in the movement of food and waste efficiently through the digestive system (Tabernero *et al.,* 2011).

Materials and Methods

Orange was acquired in bulk from the fruit market of Hisar. All other ingredients required for the development of bakery products were procured from the local market of Hisar. Oranges were washed thoroughly, peeled and the fruit peels were cut into small pieces and oven dried (50±5 C). Dried peel was converted into fine powder form and packed in airtight plastic container for further use. Control biscuits were prepared using refined flour by creaming method. Refined flour was replaced with 5, 10, 15 and 20 per cent of orange peel powder in experimental biscuits.

Biscuits were organoleptically evaluated by 10 semi trained judges using 9-point hedonic scale. Average of scores for all sensory characteristics, viz., color, appearance, flavor, texture, taste was expressed in terms of overall acceptability..

Nutritional evaluation

Proximate composition i.e. moisture, protein, fat, crude fibre, ash were determined by employing the standard method of AOAC (2010). Total, soluble and insoluble dietary fiber constituents were determined by the enzymatic method given by Furda (1981). Finely ground sample were extracted with 80% methanol for determination of antioxidant activity. The concentration of total phenol of the methanolic extracts was determined by the Folin-Ciocalteau colorimetric method (Singleton *et al.,* 1999). Phenols present in plant extract reacted with specific redox reagent (Folin-Ciocalteau reagent) to form blue chromophore constituted by a phosphotungstic phosphomolybdenum complex which was measured at 750 nm. The antioxidant activity of the extracts, on the basis of the scavenging activity of the stable DPPH free radical, was determined by the method followed by Brand-Williams *et al.,* (1995) as previously described by Tadhani *et al.,* (2009).

Statistical analysis

The data obtained were subjected to analysis of variance in a complete randomized design by OPSTAT software developed by Sheoran

and Pannu (1999). Mean, standard error and CD (critical difference) were calculated for analysis of data.

Results and Discussion

Sensory acceptability

The mean sensory scores given to control biscuits developed using 100 per cent refined flour were ranged from 8.60 to 9.00 for color, appearance, aroma, texture, taste and overall acceptability and these biscuits were adjudged as 'liked extremely'. With the increased level of fortification (5, 10, 15 and 20%) of orange peel powder in biscuits, a slight decrease in the scores was observed however, this decrease was not significant. The scores given to overall acceptability of orange peel powder incorporated biscuits ranged from 7.30 to 8.30 and as a result, these biscuits were adjudged between 'liked moderately' to 'liked very much' (Table 1).

Nutritional evaluation

Results presented in Table 2 indicated that moisture content in control biscuits was 2.30 per cent while that of Type-I, Type-II, Type-III and Type IV biscuits ranged from 2.40 to 4.30 per cent. The protein and fat contents in control biscuits were 9.23 and 19.66 per cent, respectively which were decreased significantly at each level of inclusion of orange peel powder. The ash and crude fibre contents in refined flour (control) biscuits were 0.73 and 0.66 per cent, respectively which increased significantly ($P \leq 0.05$) in all types (Type-I to Type-IV) of biscuits from 0.90 to 1.36per cent and from 0.76 to 0.93 per cent, respectively as the level of incorporation of orange peel powder was increased in biscuit formulation.

Dietary fibre

Result presented in Table 3 showed that total and soluble dietary fibre content of refined flour biscuits was 2.70 and 0.95 per cent, respectively which was increased to 8.30 to 13.33 and 2.82 to 6.00 per cent in orange peel powder fortified biscuits. Maximum total and soluble dietary fibre was observed in Type-IV biscuits i.e. 13.33 and 6.00 per cent and minimum was 8.30 and 2.82 per cent in Type-I biscuits. Control biscuits contained 1.74 per cent of insoluble dietary fibre which was ranged from 5.43 to 7.36 per cent in orange peel powder fortified biscuits. There was a significant increase in the total, insoluble and soluble dietary fibre content of biscuits as the level of incorporation with orange peel powder increased from 5 to 20 per cent.

Table.1 Mean sensory scores of orange peel powder fortified biscuits

Biscuits	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Control (WF 100%)	9.0±0.000	8.7±0.153	8.6±0.221	8.6±0.221	8.6±0.221	8.7±0.163
Type-I	8.6±0.163	8.5±0.167	8.4±0.400	7.7±0.300	8.2±0.389	8.3±0.284
Type-II	7.9±0..314	7.8±0.291	8.2±0.291	7.4±0.306	7.5±0.401	7.8±0.321
Type-III	7.7±0.260	7.4±0.371	7.7±0.367	7.4±0.340	7.4±0.340	7.5±0.336
Type-IV	7.5±0.307	7.3±0.367	7.8±0.416	7.1±0.277	7.0±0.394	7.3±0.352

Values are mean ± SE of ten observations
Type-I (95:5), Type-II (90:10) Type-III(85:15) Type-IV(80:20)
RF = Refined Flour, OPP = Orange peel powder

Table.2 Proximate composition of orange peel powder fortified biscuits (%, on dry matter basis)

Biscuits	Moisture*	Protein	Fat	Ash	Crude fibre
Control (RF 100%)	2.30±0.058	9.23±0.088	19.66±0.882	0.73±0.033	0.66±0.033
Type-I	2.40±0.058	8.73±0.240	17.33±0.333	0.90±0.058	0.76±0.033
Type-II	5.53±0.120	7.70±0.751	16.33±0.333	1.10±0.058	0.81±0.017
Type-III	5.83±0.033	7.43±0.884	16.00±0.577	1.30±0.058	0.86±0.033
Type-IV	6.30±0.231	7.36±0.928	15.33±0.333	1.36±0.033	0.93±0.033
CD (p≤0.05)	0.436	0.423	1.880	0.167	0.099

Values are mean ± SE of three independent determinations; RF = Refined Flour
Type-I (95:5), Type-II (90:10) Type-III (85:15) Type-IV (80:20) Orange peel powder

Table.3 Dietary fibre content of orange peel powder fortified biscuits (%, on dry matter basis)

Biscuits	Dietary fibre		
	Total	Soluble	Insoluble
Control (WF 100%)	2.70±0.058	0.95±0.076	1.74±0.031
Type-I	8.30±0.058	2.82±0.065	5.43±0.058
Type-II	9.66±0.088	4.06±0.033	5.60±0.058
Type-III	11.43±0.088	5.00±0.058	6.40±0.058
Type-IV	13.33±0.088	6.00±0.058	7.36±0.033
CD (p≤0.05)	0.212	0.200	0.178

Values are mean ± SE of three independent determinations; RF = Refined Flour
Type-I (95:5), Type-II (90:10) Type-III (85:15) Type-IV (80:20) Orange peel powder

Table.4 Anti-oxidant activity of orange peel powder fortified biscuits (%, on dry matter basis)

Biscuits	Total phenols (mgGAE/100gm)	Antioxidant activity by DPPH(mgTE/100gm
Control (RF 100%)	65.19±0.37	19.26±0.54
Type-I	100.73±0.55	26.09±0.58
Type-II	136.66±0.64	33.04±0.58
Type-III	172.40±1.16	40.06±0.58
Type-IV	208.15±0.59	46.69±0.35
CD (p≤0.05)	2.628	0.442

Values are mean ± SE of three independent determinations
Type-I (95:5), Type-II (90:10) Type-III(85:15) Type-IV(80:20)
RF = Refined Flour, OPP = Orange peel powder

Plate.1 Orange peel powder fortified biscuits

Antioxidants

Total phenols and DPPH radical scavenging activity of control and fortified biscuits has been presented in Table 4. Control biscuits had l65.19mgGAE/100g of total phenols and 19.26mgTE/100g of DPPH radical scavenging activity.

Total phenols and DPPH radical scavenging activity of orange peel powder fortified biscuits were significantly ($P \leq 0.05$) higher than that of control biscuits. Type-I and Type-II biscuits contained polyphenols 100.73 and 136.66 mgGAE/100g, and radical scavenging activity was 26.09 and 33.04mgTE/100g, respectively while Type-III and Type-IV value added biscuits contained polyphenols 172.40 and 208.15mgGAE/100g, and radical scavenging activity 40.06 and 46.69mgTE/100g, respectively.

The mean score of overall acceptability of the control biscuits was 8.70 which fell in the category of "Liked extremely" whereas that of orange peel powder fortified biscuits varied from 8.3 (liked very much) to 7.3 (liked moderately). Results of sensory acceptability observed in present study are in close agreement with the findings of Kohajdova *et al.*, (2011) and Nassar *et al.*, (2008) who reported that orange peel powder supplemented biscuits scored less for sensory acceptability as compared to control, however these were acceptable. Citrus peel is rich in nutrients such as soluble sugars, proteins and minerals. It contained antioxidants such as flavonoids (2.685±0.062 g/100 g) and vitamin C (0.105±0.003 g/100 g). They also observed that orange peel powder fortified products contained less amounts of protein and fat as compared to control products. However the content of ash was higher in orange peel powder fortified products (Raj and Masih, 2012; Okpala *et al.*, 2014; Hiri *et al.*, 2015). Younis *et al.*, (2016) developed cookies with different percentages of *mosambi* peel powder, 4, 6, 8, 10 and 12 per cent and observed that total dietary fibre as well as soluble and insoluble dietary fibre of cookies increased with increasing levels of *mosambi* peel powder in control formulation. The differences in the total anti-oxidant activity of control and orange peel powder fortified biscuits were due to higher contents of anti-oxidants present in orange peel powder. The

results of present study are in agreement with those of other workers Awad *et al.*, (2008) and Abd El-aal and Halaweish (2010).

From the present study, it may be concluded that fiber and antioxidants rich biscuits could be developed with incorporation of orange peel powder up to 20 per cent without compromising the sensory acceptable. The developed orange peel value added biscuits which were found to be rich in antioxidants, minerals and dietary fibres of all types should be commercialized and promoted so that of orange peels will be utilised which are otherwise going to waste. Such value added products also serve to manage the problem of malnutrition and hidden hunger among the population especially vulnerable groups. Development and consumption of such products also can help in improving the nutritional status of growing children.

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