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RESEARCH PAPER

Utilization of orange (*Citrus sinesis*) peel powder as a source of dietary fibre and its effect on the cake quality attributes

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Abstract : Studies were conducted for incorporation of orange peel powder in cake. The orange peel powder was used in various proportion *viz.*, 0, 5, 10, 15 and 20 per cent levels for incorporation in cake by replacing the maida. The orange peel powder and maida was analyzed for the proximate composition. The cakes were prepared and were analyzed for its physical (specific volume, volume and weight), chemical (moisture, protein, fat, ash, fibre) and sensorial characteristics (appearance, colour, flavour, taste, texture). On the basis of overall sensory attributes, cakes prepared with 10 per cent of orange peel powder were recorded higher acceptability as compared to other samples. The increase in powder concentration, the protein and fat content was decreased while the dietary fibre was increased. It was concluded that orange peel powder and refined wheat flour can be substituted upto 10 per cent in refined wheat flour to prepare orange peel powder without adversely affecting quality attributes.

Key Words : Orange peel powder, Sensory evaluation, Quality attributes

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INTRODUCTION

Citrus is an ancient crop, with records of human cultivation extending back to at least 2100 B C. (Moore, 2001). Citrus cultivation dates back to many centuries. This cultivation is said to be started in China as early as 2200 BC. South China and Assam are the origin of many citrus fruits. The citrus fruits include lime, lemons, and oranges. Limes, lemons and citrus reticulate are indigenous to Assam (Bhattacharya and Dutta, 1949). Among the major orange producing countries of the world, Brazil is the country at the first position with production area of 729583 in ha and total production on MT of 18012560. America is at the second position in terms of area and production with 250582 ha and 8166480 Mt in production.China occupies the third position with total area of 475000 in ha and 6500000 MT in production. India is at the fourth position with total production and productivity of orange of 334939 of ha and 3886198 in MT. The other countries having good area and production capacity includes Mexico, Spain and Egypt (NHB, 2015). The all India area, production and productivity of orange

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increased. In 2011-12 the total area (ha) was 329.1 and 3128.5 MT was the production while productivity in MT/ha was 9.5. While in the year 2012-13 total area (ha) was 311.2 and 2906.3 MT was the production while productivity in MT/ha was 9.3. Compared to the previous year in the year 2013-14 the productivity and other things got increased with the total area (ha) was 330.0 and 343.14 MT was the production while productivity in MT/ha was 10.4 (NHB, 2015). The processing industry creates a large amount of waste by-product in the form of peel, seeds, rag (the membranes between the citrus segments) and pulp (juice sacs), representing 50-60 per cent of the whole fruit being discarded after juicing (Siles *et al.*, 2010).

Baking industry is considered to be one of the major segments of food processing in India. Baked products have popularities in the people because of their availability, ready to eat convenience and reasonably good shelf-life (Vijayakumar *et al.,* 2013). Citrus and apple fibres have better quality than other dietary fibres due to the presence of associated bioactive compounds, such as flavonoids, polyphenols and carotenes. An increase in the level of dietary fibre in the daily diet has been recommended (25–30 g/day). Because of this, it is interesting to increase the consumption of all foods that can supply fibre to daily food intake. Fibre incorporation, in frequently consumed food, could help to overcome the fibre deficit (Fernandez-Gines *et al*., 2003).

Dietary fibres are not only desirable for their nutritional properties, but also for their functional and technological properties and because of those they can also be used to upgrade agricultural products and by products for use as food ingredients (Schieber *et al*., 2001). The industry of fruit juice produces significant amounts of by-products which could cause problems in their disposal. Usually, these products are used in animal feeding. However, their high amount of dietary fibre could permit the use of them in developing new natural ingredients for the food industry. The demand for a unique fibre ingredient will continue. With a well established market for dietary fibre it is quite clear that a new ingredient, particularly one that could be linked to the possibility of obtaining nutritional requirements through normal dietary practices, would be very well received (Sloan, 2001).

In view of the impact and economy of waste the present research investigation was carried out to utilize the orange peel powder in baked product like cake and also evaluated physically, chemically and organoleptically.

MATERIAL AND METHODS

The research work was carried out at Department of Food Engineering, College of Food Technology, Vasantarao Naik Marathwada Krishi Vidhyapeeth Parbhani-Maharashtra, in the year 2016. The oranges (Var. Nagpur) were procured from the local market of the Nagpur, Maharashtra. Wheat flour and other ingredients used in biscuits preparation were purchased from the local market of the Parbhani.

Preparation of orange peel powder :

Orange peel were obtained after extraction of juice from the orange fruit and obtained peel was dried in an oven at 50°C for 24 h to improve citrus by-products shelf-life without addition of any chemical preservative. A grinder mill and sieves were used to obtain a powder particle size of less than 0.2mm.

Preparation of cakes :

Cakes were prepared using the standardized recipe and method given by (Sharoba *et al.,* 2013). The formula used was as follows: 150 g wheat flour, 75 g sugar, 31.83 g oil, 6.81 g of baking powder, 39.75 g fresh whole egg, 14.76 g skim dry milk, 1.5 g vanilla and 40 - 42 ml water. The oil was beaten thoroughly, the sugar was added to butter and mixed until got smooth like cream and then a well blended egg with vanillia were added and mixed together. The blends soft wheat flour (72%) with dietary fibre sources (orange peel powder) these by-products were replaced with wheat flour at 5, 10, 15 and 20 per cent levels, baking powder were stirred together and added alternately to the egg mixture. The mixture was whipped until got smooth. The dough transferred to a greased pan was baked for 25 min. at 200±5ºC then was cooled at room temperature. Cakes were prepared according to the formula is shown in Table A.

Table A: Cake formulae

Weight (g)	Ingredients
150	Wheat flour
6.81	Baking powder
3.4	Salt
75	Sugar
31.83	Oil
39.75	Fresh whole egg
14.76	Skim dry milk
1.5	Vanilla

Table B : Different levels of addition of orange peel powder in cake

Sample	Fortification levels of orange peel powder
OPP5	Orange peel powder 5%
OPP10	Orange peel powder 10%
OPP15	Orange peel powder 15%
OPP20	Orange peel powder 20%

OPP: Orange peel powder

Analytical methods :

Determination of dietary fibre contents :

Total dietary fibre (TDF), soluble dietary fibre (SDF) and insoluble dietary fibre (IDF) contents of samples were determined with an enzymatic–gravimetric procedure according to AOAC (1999).

Proximate chemical composition :

Moisture, crude protein, crude lipid, ash and carbohydrate contents were determined using the appropriate AOAC (1999). Carbohydrates were determined by difference from the total dietary fibre, lipids, protein and ash contents (Chau and Huang, 2003).

Functional properties :

Water and oil holding capacity :

The water and oil holding capacity was measured by the method given by Nassar *et al.* (2008).

Swelling capacity (SWC) :

Swelling capacity (SWC) was measured using the bed volume technique described by Kuniak and Marchessault (1972). Approximately 0.2 g of the sample material was weighed into a 50 ml graduated glass cylinder. After making up the volume to 50 ml with de-ionized water and the mixtures were then vigorously stirred, the material was left overnight at room temperature for equilibration. The volume of the swollen sample was noted. Results of SWC were expressed as the ratio of volume (ml) of swollen sample to the weight (g) of dry initial sample. Triplicate measurements were taken for all WHC, OHC and SWC.

Physical characteristics for cakes :

The weight (g) for cake was determined individually within one hour after baking the average was recorded. The volume (cm^3) of different types of produced cakes was determined by rape seeds displacement method according to (AACC, 2000). Specific volume was calculated according to the method of (AACC, 2000), using the following equation:

$$\textbf{Specific volume} = \frac{\textbf{Volume (cm}^3\textbf{)}}{\textbf{Weight (g)}}$$

Organoleptic quality of cake :

The sensory evaluation was done on point hedonic scale as per the method given by Hooda and Jood (2005). The sensory evaluation of prepared cake was carried out by a 25 member trained panel comprising of postgraduate students and academic staff members of faculty who had plenty previous experience in sensory evaluation of bakery products. The panel members were requested to measure the terms identifying sensory characteristics and in use of the score. Judgments were made through rating products on a 9 point Hedonic scale with corresponding descriptive terms ranging from 9 'like extremely' to 1 'dislike extremely'.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Proximate composition of refined wheat flour :

Compositions of refined wheat flour were determined to signify its suitability in preparation of biscuits. The obtained results are summarized in Table 1. The refined wheat flour contained 11.87 per cent of crude protein while 8.72 per cent of gluten content was observed. The other results with respect to moisture, fat, ash and total carbohydrate were found to be 13.20, 1.38, 0.53 and 68.17 per cent, respectively. The obtained results for the proximate composition and gluten content of wheat flour were similar to that of results reported by other scientist Gopalan *et al.* (2004).

Table 1 : Proximate composition of refined wheat flour (g/100g DW)

Sr.No.	Parameter (%)	Refined wheat flour
1.	Moisture	13.20
2.	Protein	11.87
3.	Crude fat	1.38
4.	Total ash	0.53
5.	Total carbohydrate	68.17
6.	Gluten content	8.72

*Each value is average of 3 determinations

Chemical composition and functional properties of orange peel powder :

Although interest in fibre as a food ingredient has waned in recent years, the importance of fibre cannot be overlooked. The health benefits coupled with functional properties such as water and fat holding capacity properties have created a renewed interest in fibre, particularly in the nutaceuitical industry. Many of the fibre supplements which have been researched are obtained from by products resulting from the processing of fruits and vegetables. Increased use of fibre supplementation would, therefore, not only improve the health benefits but also functional properties of many foods.

Data in Table 2 represent the proximate chemical composition of fruits and vegetables wastes, the results are in agreement with results obtained by Sosulski and Wu (1988); Camire and Flint (1991); Ralet *et al.* (1993); Camire *et al.* (1997) and Chantaro *et al.* (2008).

Table 2 : Proximate composition and functional properties of orange peel powder (g/100g DW)

Sr. No.	Parameter (%)	Orange peel powder
1.	Moisture	7.78
2.	Protein	6.14
3.	Crude fat	1.98
4.	Carbohydrate	80.27
5.	Total dietary fibre	74.14±3.0
6.	Indigestible dietary fibre	55.47±2.14
7.	Digestible dietary fibre	19.1±1.1
8.	Water holding capacity g/g	5.9
9.	Oil holding capacity g/g	4.0
10.	Swelling capacity	20.74

Proximate composition of orange peel powder :

Proximate composition of orange peel powder presented in Table 2 revealed that it contained 7.78 per cent moisture, 6.14 per cent protein, 74.14 per cent total dietary fibre, 80.27 carbohydrate and 1.98 per cent fat, these results are comparable with findings reported by Humaira *et al.* (2013).

It is well known that the functional properties of dietary fibres have the greatest effect on their functions in foods (El-Refai *et al.,* 2006). The functional properties of plant fibre depend on the IDF/SDF ratio, particle size, extraction condition, structure of the plant polysaccharides and vegetable source. The water holding capacity (WHC) is the quantity of water that remains bound to the hydrated fibre following the application of an external force (pressure or centrifugation), also WHC is the ability of a moist material to retain water when subjected to an external centrifugal gravity force or compression. It consists of the sum of bound water, hydrodynamic water and mainly, physically trapped water (Raghavendra *et al.*, 2006). It is an important property of DF from both a physiological and technological point of view. The results of the water and oil holding capacity are found comparable with findings reported by Nassar *et al.* (2008).

Physical properties of produced cake :

Data presented in Table (3) show that, the addition of orange peel powder increased volume of cake under investigation, these results indicated the important of

Table 3 : Physical properties of cake

	Physical properties			
Sr.No.	Specific volume (cm^3)/g)	Volume (cm^3)	Weight (g)	Substitute level (%)
1.	2.378	1083.97	453.98	0
2.	2.585	1178.52	455.89	5
3.	2.765	1256.32	456.32	10
4.	2.987	1378.85	458.99	15
5.	3.214	1487.20	462.41	20

Table 4 : Chemical composition of orange peel powder substituted cake g/100g dry weight basis

Sample (%)	Protein	Fat	Ash	Carbohydrate	TDF	IDF	SDF
Control	9.78	9.79	0.9	71.87	3.14	2.10	1.04
5 OPP	8.14	8.45	1.2	73.65	8.21	5.41	2.8
10 OPP	7.52	8.10	1.34	76.10	10.01	6.15	3.86
15 OPP	6.20	7.38	1.91	78.47	11.85	6.8	5.05
20 OPP	6.01	8.20	2.42	80.21	13.41	7.17	6.24

TDF: Total dietary fibre IDF: Insoluble dietary fibre SDF: Soluble dietary fibre

adding dietary fibre sources on the volume of cake. Also, addition of dietary fibre sources increased specific volume. The trend of increasing in the specific volume gone high after adding dietary fibre sources. These results are in agreement with that of Saeed (2010).

Chemical composition of orange peel powder substituted cake g/100g dry weight basis :

The values (Table 4) show that protein and fat contents decreased with increasing orange peel powder concentration, this is due to replacing the refined wheat flour and vegetable fat which are major source of the protein and fat. On the other side, for cake carbohydrate, total insoluble and soluble dietary fibre contents increased by increasing the level of orange peel powder and reached to 13.41, 7.17 and 6.24 per cent at level 20 per cent for orange peel powder, respectively, as from the proximate composition of the orange peel powder it is clear that peel powder is a major source of the dietary fibres. The obtained results for the proximate composition and dietary fibres were similar to the results reported by Nassar *et al*. (2008) and Bandyopadhyay *et al.* (2014).

Sensory evaluation :

Sensory evaluation of cake containing different levels of orange peel powder as compared to the control cake is shown in Table 5. The data revealed that incorporation of orange peel powder had marked improvement in colour, appearance and textural profile of prepared cake upto concentration of 10 per cent while further increase in concentration results in drastic reduction in appearance, colour, flavour and texture as well as taste characteristics. The overall acceptability of cake was determined by taking average of all the values pertaining to appearance, colour, flavour, texture and taste. It was found that sample containing 10 per cent of peel powder found to secure maximum score (8.5) followed by OPP5 (8.0) and control (8.0) while least overall acceptability was observed in sample containing 20 per cent of powder. On the basis of overall acceptability of cake, it could be concluded that incorporation of orange peel powder in preparing cake upto the level of 10 per cent was superior to all other treatments and control sample and hence, 10 per cent peel powder incorporation in preparation of cake could considered optimum with respect to sensorial quality characteristics.

Conclusion :

This study demonstrated the feasibility of using some by product from food industry be used as a food ingredient. The results showed that the sources of dietary fibre had significant effects on the dietary fibre composition and technological properties. Moreover, the high effect on hydration properties which would affect the further application in real food system. Furthermore, orange fibres had high WHC and SWC values, which are good for food applications. Overall, the results suggested that orange waste could be used as a good raw material to produce dietary fibre powders. From industrial point of view, the fibre sources which are the residues from processing could be further processed to add value to the products food industries.

It can be concluded that incorporation of orange peel upto the level of 10 per cent in formulating cake preparations enhanced the nutritional value particularly with respect to dietary fibre, physical quality and overall acceptability of cake.

Table 5 : Sensory evaluation of cake

Sample code	Sensory attributes					
	Colour	Appearance	Texture	Taste	Flavour	Overall acceptability
Control	8.0	8.0	8.0	8.0	8.0	8.0
OPP5	8.0	8.5	8.0	7.5	8.5	8.0
OPP10	9.0	8.9	8.5	7.5	9.0	8.5
OPP15	7.0	7.5	6.5	6.5	7.0	7.0
OPP20	6.5	6.0	7.0	6.5	6.0	6.5
S.E.±	0.12	0.12	0.13	0.13	0.14	0.11
C.D. (P=0.05)	0.33	0.34	0.35	0.36	0.38	0.31

*Each value represents the average of ten determinations

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