Research Paper

Effect of orange peel flour on the quality of bread

ABSTRACT

Previous studies have shown that orange peels have potentials as functional ingredients in food products. This study was carried out to investigate the effects of orange peel flour (OPF) substitution with wheat flour in bread production (substitution levels of 3, 6 and 9%) on the proximate composition, phytochemical content, baking and sensory characteristics. Results revealed that increasing the level of OPF in the bread led to increases in the fibre, ash and phytochemical contents while protein and fat contents decreased. Baking characteristics of bread (weight, volume, specific volume and oven spring) significantly decreased (P =.05) with increasing levels of OPF in the bread. With respect to sensory characteristics, bread made with 3% OPF did not differ significantly from bread made with 0% OPF. Higher levels of OPF reduced the acceptability of the bread. This study shows that orange peel flour has the potential of producing bread with improved health benefits.

Keywords: orange peel flour, fibre, bread, phytochemicals.

1. INTRODUCTION

Citrus is the most abundant crop in the world (Laufenberg *et al.,* 2003); with oranges, grapefruits, lemons being the most common citrus fruits. Sweet orange (*Citrus sinensis*) is the most widely grown of the citrus trees. As of 2010, Brazil was the world's largest producer of oranges, with an output of 18.1 million tons. This was followed by America and India which produced 7.5 and 6.0 million tons respectively (Wikipedia, 2013).Oranges are mainly processed to obtain juice. They are also used to produce jams and marmalade. For some time the food industry has shown a special interest in finding uses for citrus industry by-products (Kohajdova *et al*., 2011). Sweet orange oil is a by-product of the juice industry produced by pressing the peel. It is used for flavouring food and drinks and also in the perfume industry and aromatherapy for its fragrance. The edible portion of the orange is referred to as the endocarp and surrounding the endocarp, is the peel. The peel consists of the flavedo and albedo which could be considered as potential sources of fibre and phytochemicals (Ihekoronye and Ngoddy, 1985). The roles of fibre and phytochemicals in sustaining good health cannot be over-emphasized. The benefits of fibre in diets include promotion of digestive health and weight loss, control of blood sugar levels and prevention of Type 2 diabetes. Other benefits include lowering cholesterol by 10 to 15%, indirectly preventing heart disease and stroke (Cohen, 2010). Phytochemicals are non-nutritive plant chemicals that have either protective or disease protective properties. Dietary intake of phytochemicals may promote health benefits, protecting against chronic degenerative disorders, such as cancer, cardiovascular and neurodegenerative diseases (Prakash *et al*., 2012).

Bread and bakery products are widely consumed throughout the world and bread has been an important food and energy source throughout human history. Wheat flour used in bread production is generally low in fibre and phytochemicals. Since orange peel has been reported to be a source of fibre and phytochemicals, its flour could help in boosting the fibre and phytochemical levels of bread. Babiker *et al.* (2013) studied the effect of orange peel flour on the physicochemical properties of wheat bread. They however did not study its effects on the phytochemical and sensory properties of the bread. This study is therefore aimed at determining the potentials that orange peel flour could have on the fibre, phytochemical contents as well as the sensory quality of bread. The effects of the flour on other quality parameters of bread were also investigated.

2. MATERIALS AND MATERIALS

2.1 Raw materials

Sweet oranges (*Citrus sinensis*), wheat flour and other ingredients used for bread production were purchased from a retail outlet in Abakaliki, Ebonyi State, Nigeria.

2.2 Peel Flour Preparation.

Oranges were thoroughly washed with tap water and peeled. The peels were boiled for 10mins and sundried. Afterwards, the dried peels were ground into flour and sieved to a particle size of less than 0.2mm. The flour was stored at room temperature in plastic airtight containers until needed.

2.3 Bread Making.

Bread was produced by replacing wheat flour with 3, 6 and 9% orange peel flour (OPF). A sample without the addition of orange peel flour (0% OPF) was used as the control. The bread was produced using the straight dough method described by Mepba *et al* (2007). The basic formula included 100g flour, 2.0g of yeast, 5.0g of sugar, 1.5g of salt, 3.0g of margarine, 75ppm ascorbic acid and 54.66ml of water. The dough was fermented for 90 min, followed by proofing for 2h. Baking was at 205°C for 30min.

2.4 Chemical composition of Bread.

The moisture, ash, protein, fibre and fat contents of bread samples were analyzed by AOAC (1990) methods. Carbohydrate content of bread samples were calculated by difference. The energy values of the bread samples were calculated using Atwater conversion factors of 4, 4 and 9 kcal/g for carbohydrates, protein and fat respectively (Merill and Watt, 1973).

2.5 Determination of phytochemicals in bread samples.

Tannins were measured using the Folin-Denis spectrophotometric method as described by Pearson (1976). The gravimetric method as described by Harbone (1973) was used to determine the alkaloid contents of the bread samples while the quantitative method described by Pearson (1976) was used to determine the saponin contents of the bread samples.

2.6 Baking characteristics of Bread.

Loaf volume was measured using the method described by Hallen *et al* (2004) with slight modifications. The loaf was put in a metallic container with known volume (V_C). The container was topped up with rice grains, the loaf removed and the volume of the rice noted (V_R). Loaf volume (V_L) could then be calculated and recorded according to

$$V_L \text{ (cm}^3\text{)} = V_C - V_R$$

After cooling for 1h, the same loaves used for measuring volume were weighed on an electronic balance. Specific volume (V_S) of bread was calculated as:

$$V_S \text{ (cm}^3\text{/g)} = V_L / W$$

Where W = weight of bread.

The pH was determined by directly from the samples using a pH meter. Oven spring was determined by measuring the difference in the height of the sample before and after baking.

2.7 Sensory evaluation.

Sensory evaluation was carried out twenty days after preparation of the bread samples. The sensory panel consisted of habitual consumers of bread who were asked to describe the degree of liking of taste, crust colour, crumb colour, crumb texture and general acceptability of the cookies by assigning a likeness score on a 9-point scale, where 9= like extremely; 5= neither like nor dislike; 1= dislike extremely. A total number of 20 semi-trained panelists evaluated each sample. Each panelist evaluated all the samples prepared for each treatment in one session. Samples which were coded with random 3-digit numbers for identification were monadically presented to the panelists. Water was provided for each panelist to rinse to rinse his/her mouth after testing each sample.

2.8 Statistical Analysis.

SPSS 17.0 was used to conduct one-way analysis of variance (ANOVA) for determining significant differences among means. Statistically significant differences (*P=.05*) among means were separated using the Duncan Multiple Range Test.

3.0 RESULTS AND DISCUSSION

3.1 Proximate composition of Bread

The proximate composition of bread samples produced is shown in Table 1. The moisture content of the bread samples ranged between 24.25 and 27.25%. Bread without OPF had the highest moisture content while bread with 9% OPF had the least value. There was no significant difference in the moisture content of bread samples with OPF. Salgado *et al* (2011) produced bread from wheat and cupuassu peel flour and observed that bread samples produced had moisture content ranging from 25.28 to 28.78%. These values were close to values obtained in this work. Increase in the level of OPF in the bread led to a significant (*P*=.05) reduction in the protein and fat contents of the bread samples. This could be due to the low protein and fat contents of the orange peel. Conversely, increase in OPF resulted in increased levels of fibre and ash which were significant at (*P*=.05). Ash content is an indication of the level of minerals present in a food material. Increased levels of minerals with increase in OPF levels could be due to high levels of minerals in orange peels. This suggests that orange peels can help in boosting the mineral content of wheat bread. Fibre has been reported to have many health benefits; it has been reported to prevent certain cancers and even lower the risk of developing hemorrhoids (Forbes, 2013). The increase in fibre content with increase in OPF level should therefore, attract acceptability by many consumers as most of our diets are low in fibre but high in fats and carbohydrates. Calorie content of the breads ranged between 267.0 and 287.85kcal/100g. Bread produced with 0% OPF had the highest caloric value while that produced with 9% OPF had the least caloric value. Salgado *et al* (2011) observed that bread produced with higher levels of cupuassu peel flour exhibited lower calorie factors when compared to those produced with lower levels of peel flour. They suggested that the low calorie factors observed in bread with high levels of peel flour may be associated with the replacement of carbohydrates from wheat flour by the complex polysaccharide fibre in the fruits peel.

Table 1: Proximate composition of breads produced with different concentrations of orange peel flour

OPF (%)	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrates (%)	Energy (kcal/100g)
0	27.25[a]	8.22[a]	1.65[a]	2.25[a]	0.6[a]	60.03[a]	287.52
3	25.50[ab]	4.40[b]	1.50[b]	3.70[b]	4.7[b]	60.20[a]	271.90
6	24.50[b]	3.40[c]	1.45[c]	3.75[c]	4.9[b]	62.00[b]	274.65
9	24.45[b]	2.65[d]	0.84[d]	4.25[d]	5.8[c]	62.21[b]	267.00

Mean values in the same column with the same superscript are not significantly different at ($p>0.05$)

OPF =Orange peel flour

3.2 Phytochemicals in Bread

The level of phytochemicals in bread produced is presented in Table 2. For all the phytochemicals studied, 0% OPF had the least value while 9% OPF had the highest value. Increased levels of OPF led to increased levels in the phytochemicals. This result confirms reports that orange peels contain phytochemicals (Ihekoronye and Ngoddy, 1985). The presence of phytochemicals in food could provide beneficial health effects to the consumer (Prakash *et al*., 2012).

Table 2: Phytochemical content of breads with different concentrations of orange peel flour

OPF (%)	Tannins (mg/g)	Saponins (mg/g)	Alkaloids (mg/g)
0	3.6[a]	0.90[a]	3.60[a]
3	6.7[b]	0.98[b]	3.80[a]
6	7.7[b]	1.14[c]	4.20[c]
9	8.0[b]	1.40[d]	4.80[d]

Mean values in the same column with the same superscript are not significantly different at ($p>0.05$)

OPF =Orange peel flour

3.3 Baking characteristics of breads

The weight, volume, specific volume, pH and oven spring of the breads decreased with increase in OPF (Table 3). The reason for this trend could be due to the reduction in the amount of gluten and a lower ability of the dough to enclose air (Akobundu *et al*., 1988). It is also possible that the presence of fibre in the flour could puncture expanding gas cells during fermentation, thus producing a reduced loaf volume (Crabtree and James, 1982). Different researchers have also observed reduction in the volume of bread when non wheat flours were incorporated to wheat flour (Hallen *et al*., 2004; Mepba *et al*., 2007; Babiker

et al., 2013). Reduction in these baking characteristics with increase in OPF could lower acceptability of the breads.

Table 3: Baking characteristics of breads with different concentrations of orange peel flour

OPF (%)	Weight (g)	Volume (cm^3)	Specific volume (cm/g)	pH	Oven spring (cm)
0	15.0^a	80.0^a	5.3^a	4.42^a	2.00^a
3	13.0^b	68.0^b	4.8^b	5.13^b	1.10^b
6	12.0^c	55.0^c	4.2^c	5.27^c	0.20^c
9	11.0^c	48.0^c	3.2^c	5.39^c	0.22^c

Mean values in the same column with the same superscript are not significantly different at ($p>0.05$)

OPF =Orange peel flour

3.4 Sensory characteristics of breads

For all the sensory characteristics studied (with the exception of texture), breads from 0% OPF and 3% OPF did not differ significantly. Even though 3% OPF had a lower rating for texture than 0% OPF, it was still liked by the assessors. Bread made with 9% OPF received the lowest ratings for all the attributes. Most of the attributes of 9% OPF bread were disliked slightly. Generally increase in OPF resulted in decrease in sensory scores.

Table 4: Sensory characteristics of breads with different concentrations of orange peel flour

OPF (%)	Taste	Crust colour	Crumb colour	Texture	Loaf Appearance	General Acceptability
0	8.2^a	8.0^a	7.7^a	8.0^a	7.7^a	8.6^a
3	8.0^a	7.6^a	7.5^a	6.9^b	7.0^a	8.3^a
6	5.1^b	5.4^b	5.4^b	5.7^c	5.2^b	7.2^b
9	4.4^b	4.8^b	5.0^b	4.9^c	4.4^c	6.8^b

Mean values in the same column with the same superscript are not significantly different at ($p>0.05$)

OPF =Orange peel flour

4. CONCLUSION

The addition of OPF to wheat flour increased the fibre and phytochemical contents of breads produced. However only bread produced with 3% OPF had acceptable sensory quality. This bread had sensory quality comparable to bread made with 0% OPF. The use of OPF in bread production will not only add value to food but also reduce environmental pollution.

REFERENCES

Akobundu, ENT, Ubbaonu, CN, Ndupuh CE. Studies on the baking potential of non-wheat composite flours. *J. Fd Sci. Technol.* 1998; 25, 211-214.

A.O.A.C. (1990): Official Methods of Analysis of Association (15th edition) of Official Analytical Chemists, Washington DC.

Babiker WAM, Sulieman AME, Elhardallou SB, Khalifa EA. Physicochemical properties of wheat bread supplemented with orange peel by-products. *Int'l J. Nutr. Fd Sci.* 2013; 1,1-4

Cohen B Why is fiber important in your daily diet. Available at www.livestrong.com/article/250289/-why-is-fiber-important-in-your-daily-diet/ 2010; (Assessed on 6, Apr., 2013)

Crabtree J, James AW. Composite flour technology TPI's experience and opinions on the planning and implementation of national programmes. *Trop. Sci.* 1982; 24, 77-84

Forbes. Ten health benefits of fiber. Available at http//:www.forbes.com 2013 (accessed on 7 Apr., 2013)

Hallén E, İbanoğlu S, Ainsworth P. Effect of fermented/germinated cowpea flour addition on the rheological and baking properties of wheat flour. *J. Fd Eng.* 2004; 63, 177-184.

Harbone IB. Phytochemical methods. A guide to modern techniques of plant analysis. 2nd edition Chapman and Hall, New York 1973

Kohajdova Z, Karovicova J, Jurasova M, Kukurova K. Application of citrus dietary fibre preparations in biscuit preparation. *J. Fd Sci. Nutr. Res.* 2011; 50, 182-190.

Laufenberg G, Kunz K, Nystroem M. Transformation of vegetable waste into value added products: (A) the upgrading concept; (B) practical implementation. *Biores. Technol.* 2003; 87, 167-198

Mepba HD, Eboh L, Nwaojigwa SU Chemical composition, Functional and Baking Properties of Wheat-Plantain Composite Flours. *Afr. J. Fd Agric. Nutr. Dev.* 2007; 7, 1-22

Merill AL, Watt BK. Energy value of foods: Basis and deviation. United States Dept. of Agric, Washington, D.C. 1973

Pearson DA Chemical Analysis of Food. 7th edition Dahhua Printing Press Co ltd. 1976; 43-61

Prakash D, Gupta C, Sharma G Importance of phytochemicals in nutraceuticals. *J. Chi Med Res. Dev.* 2012;1, 70-78

Salgado JM, Rodrigues BS, Donado-Pestana CM, Morzelle MC. Cupuassu (*Treobroma grandiflorum*) peel as potential source of dietary fiber and phytochemicals in whole bread preparations. *Plant Fd Hum. Nutr.* 2011; 66, 384-390

Wikipedia: Orange (fruit). Free Encyclopaedia on the web. Available at: http:// www.wikipedia.com (accessed on 7, Apr. 2013).