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Physico-Functional Properties, Nutritional Quality and Sensory Characteristics of Pumpkin Peel Puree Fortified Biscuit

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FUNCTIONAL properties, nutritional quality, and sensory characteristics of wheat flour/ pumpkin peel puree (PPP) based biscuits were investigated. Wheat flour and PPP were mixed in the ratio of 100:0 (control), 90:10, 80:20, 70:30 and 60:40 (weight/weight). Developed biscuits with PPP showed reduced lightness with increased yellowness and redness than control. The increase in PPP incorporation level increased water solubility index and decreased water absorption index and oil absorption index of biscuits. Spread ratio and density of biscuits increased slightly by increasing the PPP incorporation level. The crude fibre, minerals, β-carotene, and vitamin C contents of developed biscuits increased significantly ($P < 0.05$) by increasing the PPP incorporation level. The formula contained 80:20 wheat flour and PPP, respectively, revealed the highest sensory scores among all tested samples. The biscuit made from this formula contained 6.14% moisture, 15.05% fat, 8.91% protein, 1.74% total ash, 1.84% crude fibre, 66.32% carbohydrate, 7.13 mg/100g β-carotene, 2.26 mg/100g Vitamin C, 2.94 mg/100g iron, and energy value of 436.37 Kcal/100g dry matter.

Keywords: Biscuit, Pumpkin peel, Wheat flour.

Introduction

Biscuit is a prominent worldwide spread snack food. The biscuit popularity comes from its unique characteristics i.e. ready to eat, high palatability, high in nutrients, fast source of energy and available in various sizes and forms. Moreover, the formulation of biscuits can be easily modified to improve the nutritional value and to meet consumers' demands (Tyagi et al., 2007 and Toan and Thuy, 2018).

The consumer's acceptance of biscuit is mainly affected by the quality parameters such as colour, taste, flavour, texture, and nutritional value. In few years ago, there have been attempts to improve the nutritional value and the functional properties of biscuit by fortifying wheat flour as it is the base material for biscuit preparation. Wheat flour is an excellent source of energy but limiting in vitamins such as vitamin C and β-carotene (precursor of vitamin A). On the other hand, these vitamins are widely available in different varieties of fruits and vegetables (Tee and Lim, 1991 and Kasaye and Jha, 2015). Thereby, functional and nutritional properties of biscuit can be improved by partial replacement with fruits and vegetables (Gurung et al., 2016).

A lot of efforts are made to meet the challenges for the disposal of wastes produced during food processing. Such wastes can be utilized as raw materials to produce new food products with high nutritional value (Tuck et al., 2012). Pumpkin (*Cucurbita* spp), recently, has been received great attention due to its nutritional value and polysaccharides content (Murkovic et al., 2004). Pumpkin is a good source of vitamins such as vitamin A, C, and E; additionally, it is rich in dietary fibre (Blessing et al., 2011). Pumpkin generates great quantities of wastes during processing, mainly, peel and seeds. The composition of pumpkin fruit was categorized into 10-12% peel, 79-82% flesh, 3-4% pulp,

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and 4-6% seeds according to Nor, (2013). Only, the fleshy part of the pumpkin is used in food processing. Thereby, the produced wastes would be between 18 and 21% (Pham et al., 2017).

Several studies on the evaluation of using the flesh powder of pumpkin have been conducted to prepare and improve the quality of biscuits (Kulkarni and Joshi, 2013 and Toan and Thuy, 2018). On the other hand, there are no more studies on the evaluation of fortified biscuits with pumpkin peel puree (PPP). This investigation was carried out to explore the possibility of adding PPP as an ingredient in the preparation of biscuit to improve its functional and nutritional properties.

Materials and Methods

Raw materials

Wheat flour (72% extraction rate), ripe pumpkin fruits (*Cucurbita moschata*) and the other ingredients required for the preparation of biscuit were obtained from the local market, Alexandria, Egypt. Pumpkin fruits were washed then peeled; the peel was cut into small pieces and chopped using kitchen machine (Braun, Combi Max 700) to get a smooth puree. The chemical composition of wheat flour and pumpkin peel puree (PPP) were determined according to AOAC (2000).

Biscuits preparation

The biscuits were made according to the method described by Manohar and Rao (1997). The standard recipe consisted of refined wheat flour 100 g, powdered sugar 36 g, fat 33 g, baking powder 3 g, milk powder 1 g, sodium chloride 1 g, and vanilla essence 0.25 g. The water was added to the formulas as needed (i.e. 0-18 ml) based on the amount of PPP. For the experiments, biscuits were prepared by replacing wheat flour in the standard recipe with PPP at different levels viz. 0, 10, 20, 30 and 40% (weight/weight). Ingredients used in the preparation of biscuits are presented in Table 1. First, fat and sugar were mixed, and then PPP was added and mixed for about 3 min. Leavening agents were added to the blend and mixed manually for 3 min. Wheat flour was added to the mixture and kneaded for 5 min. The kneaded dough was sheeted and stamped out in a circular shape having a thickness of few mm and around 45 mm diameter using a biscuit cutter. The cut mass was transferred to a greased baking tray and baked in the oven (Binder, ED23, Germany) at 180ºC for 17 min and biscuits were cooled.

Colour attributes of biscuits at different levels of PPP

The colour parameters of the biscuit samples were measured by a Hunter colorimeter (CR-200, Konica Minolta, Japan). Colour readings were measured in terms of L*, a* and b* where L* value measures lightness (100 = white, 0 = black), the a* value indicates the degree of redness-greenness (+60 = redness, –60 = greenness) and the b* value gives the degree of the yellowness-blueness (+60 = yellowness, –60 = blueness) according to Ali et al. (2019).

Functional properties of biscuits at different levels of PPP

Water absorption index (WAI) and water solubility index (WSI) of biscuit samples were determined by the method described by Ali et al. (2017a). Oil absorption index (OAI) was determined using the method outlined by Eleazu and Ironua (2013).

TABLE 1. Ingredients used in the preparation of biscuit.

Sample	Wheat flour (g)	Pumpkin peel puree (g)	Sugar (g)	Butter (g)	Water (mL)	Baking powder (g)	Milk powder (g)	Salt (g)	Vanillin (g)
Control	100	0	36	33	18	3	1	1	0.25
A	90	10	36	33	9	3	1	1	0.25
B	80	20	36	33	4.5	3	1	1	0.25
C	70	30	36	33	0	3	1	1	0.25
D	60	40	36	33	0	3	1	1	0.25

Physical properties of biscuits at different levels of PPP

Physical properties (diameter, thickness, spread ratio, weight, volume, and density) of developed biscuits were measured according to Baljeet et al. (2014).

Proximate analysis and nutritional value of biscuits at different levels of PPP

Moisture, crude protein, fat, crude fibre, and total ash of developed biscuits were carried out according to the methods of AOAC (2000), while total carbohydrates were determined by the difference. Vitamin C content was determined by using 2, 6 dichlorophenol indophenol titration method according to Ranganna (1986). β-carotene content was estimated according to the method of AOAC (2000) and iron content was measured according to Luten et al. (1996). Total caloric content was calculated by multiplying carbohydrates, protein, and fat contents by 4, 4, and 9 Kcal/100g, respectively (Ali et al., 2017b).

Sensory evaluation

Organoleptic properties of developed biscuits were evaluated after cooling at room temperature for 2 hr. The samples were coded with different numbers and evaluated by 10 panellists for appearance, colour, texture, odour, taste, and overall acceptability using a nine-point hedonic scale (from like extremely = 9 to dislike extremely = 1) according to Ranganna (1986).

Statistical analysis

Data in triplicates were subjected to one-way ANOVA. Duncan's multiple range test was applied to determine the significant differences ($P < 0.05$) between means using statistical software (SPSS Inc., Chicago, USA).

Results and Discussion

Chemical composition of raw materials

The proximate composition of raw materials used in the making of biscuits is given in Table 2. The moisture contents of wheat flour and PPP were 12.07 and 81.04 %, respectively. Wheat flour is a good source of carbohydrate (74.95%) and protein (10.47%) while PPP revealed lower content of both (4.14 and 1.97%, respectively). The PPP showed higher content of crude fibre (7.16%) and ash (5.04%) as compared to wheat flour which had lower content (0.51 and 0.74%, respectively). The PPP is a rich source of vitamin C and β-carotene whereas wheat flour showed a severe deficiency in those vitamins. Our results were in agreement with those obtained by Ramadan et al. (2010).

Colour attributes of biscuits

Results of the colour measurements (L*, a* and b*) of biscuits are presented in Table 3. The results showed that the L* values of biscuits samples ranged from 62.02 to 68.89. The control sample (made from 100% wheat flour with 72% extraction) had the highest L* value, while the biscuit made from 60% wheat flour plus 40% PPP had the lowest. ANOVA revealed a significant effect ($P < 0.05$) of the PPP incorporation level on L* values of produced biscuit. It could be noticed that L* values decreased by increasing the level of PPP incorporation in the biscuit; the higher content of coloured pigments in PPP may be responsible for decreasing L* values of formulas A, B, C, and D. Moreover, the colour of produced biscuits is affected by Maillard reactions between sugars and proteins, formulas' composition, and time of baking (Cronin and Preis, 2000). Similar findings were observed by Kulkarni and Joshi (2013) who found that the increase of pumpkin incorporation level resulted in darker products.

TABLE 2. Proximate compositions of wheat flour and pumpkin peel puree (wet basis).

Parameters	Wheat flour	Pumpkin peel puree
Moisture content (%)	12.07±0.62	81.04±1.02
Crude protein content (%)	10.47±0.35	1.97±0.08
Fat content (%)	1.26±0.09	0.65±0.07
Crude fibre content (%)	0.51±0.06	7.16±0.43
Ash content (%)	0.74±0.08	5.04±0.38
Carbohydrate content (%)	74.95±1.05	4.14±0.31
Fe content (mg/100 g dry matter)	2.63±0.11	4.23±0.27
Vitamin C content (mg/100 g dry matter)	ND	11.23±0.42
β-carotene content (mg/100g dry matter)	ND	36.76±0.86

*All results are expressed as the means ± standard deviation.
ND, not detected.