Egyptian Journal of Food Science
http://ejfs.journals.ekb.eg/

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

Samaa M. Saleh and Salim Ali*
Department of Food Science, Faculty of Agriculture (Saba Basha), Alexandria University, Alexandria 21531, Egypt.

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,

*Corresponding author: salim_2007@yahoo.com
Received: 27/4/2020; accepted: 9/8/2020
DOI: 10.21608/EJFS.2020.28771.1052

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.

Results displayed in Table 3 revealed that a* and b* values were increased by increasing the PPP incorporation level. Slight changes were noticed in a* (7.73–9.46) and b* (35.87–39.57) values of produced biscuits. Generally, all biscuits formulas showed low positive a* values indicating slight redness with high positive b* values reflecting high yellowness. Samples contained higher amounts of PPP were darker in colour compared to those with lower content of PPP. The colour of developed biscuits became gradually darker with the increase of replacement level (Kulkarni and Joshi, 2013). The differences in the colour characteristics of biscuits may be related to the differences in the content of coloured pigments, which in turn depend on the biological origin of the plant (Kaur and Singh, 2005). Moreover, during the baking process, starch and sugars may have been subjected to enhanced caramelization reactions resulted in dark coloured products (Ali et al., 2019). The trends obtained for the effect of PPP incorporation level on the L*, a*, and b* values in the current investigation were in agreement with those obtained by El-Demery (2011) who observed that the L* value was decreased while the a* and b* values were increased by increasing the pumpkin incorporation level.

Functional properties of biscuits

The WAI determines the water holding capacity of starch after dispersion in excess water; it estimates the integrity of the starch in an aqueous dispersion (Ali et al., 2017b). The obtained values of WAI for developed biscuits varied between 1.81 and 2.28 g/g (Table 3). WAI values in this study were similar to those obtained by Toan and Thuy (2018). The control sample showed the highest WAI values whereas the biscuit contained 60% wheat flour plus 40% PPP showed the lowest. The level of PPP incorporation revealed a significant effect ($P < 0.05$) on WAI values of produced biscuit. The WAI values of developed biscuits decreased by increasing the level of PPP incorporation. This may be related to the decrease in starch content with the addition of PPP and competition of absorption of water between PPP and available starch (Altan et al., 2008). The effect of PPP incorporation level on the WAI of biscuits in the current study was in consistence with other reports (Singh et al., 2007 and Altan et al., 2008).

WSI is an indicator of starch conversion and degradation of molecular components; it measures the amount of soluble polysaccharide released from the product (Joshi et al., 2014). The WSI values of developed biscuits ranged from 24.25 to 36.71% (Table 3). Biscuits contained 60% wheat flour plus 40% PPP had the highest WSI values, whereas the control sample had the lowest. It could be observed that WSI values increased significantly ($P < 0.05$) by increasing the level of PPP incorporation. This may be attributed to the modification of fibre, coming from pumpkin peel, on the baking of biscuit causing an increase in WSI (Altan et al., 2009). Also, it could be related to the presence of low molecular weight compounds and therefore, the presence of soluble materials that may increase WSI. The trends obtained for the effect of PPP incorporation level on WSI values in this study were in consistence with those obtained by Altan et al. (2008) who observed that WSI values were increased by increasing tomato pomace replacement level. The increase in WSI is of nutritional importance as the starch becomes more susceptible to enzymatic digestion resulted in increased the digestibility and nutrients availability of the product (Ali et al., 2017a).

TABLE 3. Colour parameters and functional properties of wheat/ pumpkin peel based biscuit.

Sample	Colour parameters			WAI (g/g)	WSI (%)	OAI (g/g)
	L*	a*	b*			
Control	68.89±0.61^{a}	7.73±0.19^{c}	35.87±0.22^{b}	2.28±0.08^{a}	24.25±0.16^{d}	1.94±0.08^{a}
A	66.33±0.58^{b}	8.02±0.26^{bc}	37.65±0.30^{ab}	2.13±0.06^{ab}	27.16±0.23^{c}	1.87±0.09^{a}
B	65.23±0.70^{bc}	8.44±0.21^{b}	38.14±0.28^{a}	2.04±0.07^{b}	32.34±0.20^{b}	1.82±0.06^{a}
C	63.84±0.55^{c}	9.17±0.15^{a}	38.86±0.17^{a}	1.93±0.06^{bc}	35.42±0.31^{a}	1.79±0.07^{a}
D	62.02±0.47^{d}	9.46±0.32^{a}	39.57±0.19^{a}	1.81±0.09^{c}	36.71±0.18^{a}	1.75±0.05^{a}

*All results are expressed as the means ± standard deviation.
Means followed by different superscript letters within each column differ significantly ($P < 0.05$).
WAI, water absorption index; OAI, oil absorption index; WSI, water solubility index.

The oil absorption index (OAI) of a product is an important parameter as it improves the mouth feel and retains the flavour (Kaur and Singh, 2005). The OAI of developed biscuits ranged from 1.75 to 1.94 g/g (Table 3). The control sample showed the highest OAI values whereas the biscuit contained 60% wheat flour plus 40% PPP showed the lowest. The values of OAI showed insignificant difference ($P > 0.05$) among studied samples. However, a slight decrease of OAI was noticed by increasing the level of PPP replacement. As the protein content of biscuits increased, OAI values showed an increasing trend. The non-polar amino acids available in the proteins may bind the paraffin chains of fats, and therefore increase the OAI (Kinsella and Melachouris, 1976). Our findings in the current study were in agreement with those reported previously (Toan and Thuy, 2018) who found that the OAI was slightly decreased by increasing the pumpkin incorporation level.

Physical properties of biscuits

The physical estimations of biscuits made from wheat flour and PPP with different ratios are displayed in Table 4. Spread ratio is an important factor that affects the quality parameters of the biscuit, i.e. texture, grain finesse, bite, and overall mouth feel (Jothi et al., 2014). The spread ratio of developed biscuits ranged from 12.14 to 14.79. The biscuit contained 60% wheat flour plus 40% PPP showed the highest spread ratio whereas the control sample showed the lowest. It could be observed that the spread ratio of developed biscuits increased significantly ($P < 0.05$) by increasing the level of PPP incorporation. The differences in baking characteristics of developed biscuits could be due to the differences in the quality and quantity of protein in the dough; and also may be related to the gas retention ability of the dough during the baking process (Ramadan et al., 2010). Biscuits contained PPP showed higher spread ratio and lower diameter and thickness than the control sample. Noor Aziah et al. (2012) stated that the formation of gluten net was affected by the protein content in the dough which increases the viscosity and decreases the flow of the dough, and therefore decreases the diameter and thickness.

The density values of developed biscuits varied between 0.81 and 0.88 g/cm^3. The control sample showed the lowest density, whereas the biscuit contained 60% wheat flour plus 40% PPP showed the highest. Results showed that the density of developed biscuits increased significantly ($P < 0.05$) by increasing the level of PPP incorporation. The higher initial moisture content of the PPP increased the moisture content of the dough which in turn increased the loss of water during baking of the biscuits resulted in increased density of the product (Srivastava et al., 2012). However, the low density of biscuits means better crispiness and favourable textural properties. The trends obtained for the effect of PPP incorporation level on the physical properties of biscuits in the current study were similar to those reported earlier (Gurung et al., 2016).

Proximate analysis and nutritional value of biscuits

The proximate composition of developed biscuits is given in Table 5. The moisture content of biscuits samples varied between 5.27 and 7.09%. Biscuits contained various levels of PPP revealed higher moisture content than the control sample. Generally, the moisture content of biscuits increased significantly ($P < 0.05$) by increasing the level of PPP incorporation which could be related to the higher moisture content in pumpkin peel. Fat and protein content in all samples ranged from 14.82 to 15.22 and 7.73 to

TABLE 4. Physical properties of wheat/ pumpkin peel based biscuit.

Sample	Diameter (cm)	Thickness (cm)	Spread ratio	Weight (g)	Volume (cm^3)	Density (g/ cm^3)
Control	5.10±0.05^{a}	0.42±0.01^{a}	12.14±0.15^{d}	8.11±0.09^{a}	10.02±0.25^{a}	0.81±0.04^{c}
A	5.09±0.04^{a}	0.39±0.02^{ab}	13.05±0.21^{c}	7.94±0.11^{ab}	9.62±0.19^{b}	0.83±0.02^{c}
B	5.07±0.04^{a}	0.37±0.01^{bc}	13.70±0.12^{bc}	7.86±0.08^{bc}	9.34±0.21^{c}	0.84±0.01^{bc}
C	5.04±0.06^{a}	0.36±0.01^{bc}	14.00±0.28^{ab}	7.72±0.07^{bc}	8.91±0.10^{d}	0.87±0.01^{ab}
D	5.03±0.05^{a}	0.34±0.03^{c}	14.79±0.16^{a}	7.65±0.08^{c}	8.67±0.07^{e}	0.88±0.02^{a}

*All results are expressed as the means ± standard deviation.
Means followed by different superscript letters within each column differ significantly ($P < 0.05$).

9.85%, respectively. A slight decrease in fat and protein content was noticed by increasing the level of PPP incorporation which could be related to the chemical composition of pumpkin peel. Ash and fibre content of developed biscuits ranged from 0.93 to 2.62 and 0.44 to 3.17%, respectively. Results showed significant ($P < 0.05$) increase in the ash and fibre content of developed biscuits by increasing the level of PPP incorporation. The trends obtained for the effect of pumpkin incorporation on the chemical composition of biscuits in the current study were similar to those reported by other researchers (Ramadan et al., 2010 and Jesmin et al., 2016). The ash content of a food product is of nutritional importance as it reflects the mineral constituents of the food. Dietary fibre has a protective effect against various diseases such as diabetes, cardiovascular diseases, constipation, haemorrhoids, and colon cancer (Toan and Thuy, 2018).

β-carotene and vitamin C in the developed biscuits ranged from 0 to 11.54 and 0 to 3.84 mg/100g, respectively. Since wheat flour is approximately free of β-carotene and vitamin C, the control sample showed a severe deficiency in those vitamins. As the level of PPP incorporation increased, β-carotene and vitamin C contents in the developed biscuits significantly ($P < 0.05$) increased. The trends obtained for the effect of PPP incorporation level on β-carotene and vitamin C contents in the current study were similar to the trends obtained by other researchers (Gurung et al., 2016). Regarding to Fe content, results showed that Fe content increased significantly ($P < 0.05$) by increasing the level of PPP incorporation in the biscuits. The control sample revealed the lowest Fe content whereas the biscuit contained 60% wheat flour plus 40% PPP showed the highest. Our results were in agreement with those reported previously (Ramadan et al., 2010).

Sensory evaluation of biscuits

The mean scores of sensory parameters of biscuits made from wheat flour with PPP at different incorporation levels are displayed in Table 6. The mean scores of appearance and colour of developed biscuits ranged from 6.34 to 8.95 and 7.15 to 8.91, respectively. The biscuit contained 80:20 wheat flour and PPP, respectively, showed the highest appearance and colour scores whereas the biscuit contained 60% wheat flour plus 40% PPP showed the lowest scores. Results showed that the appearance and colour of biscuits improved by adding PPP up to 20%, and after this level of replacement, the appearance and colour scores declined significantly ($P < 0.05$). The colour of the biscuits was improved with the increase in the percentage of PPP due to the increase in carotenoids content. Kulkarni and Joshi (2013) reported that the increase of pumpkin powder incorporation level more than 7.5% reduced the appearance and colour scores as the biscuits became gradually darker with the increase of replacement ratio.

Regarding to texture, results revealed that the texture of biscuits improved by increasing the level of PPP up to 20%, and after this level, the texture scores decreased significantly ($P < 0.05$). Sample B showed the highest texture scores whereas sample D revealed the lowest. Adding more PPP resulted in increased density up to undesirable levels which in turn decreased the texture scores. It was noticed that the odour and taste of biscuits enhanced significantly ($P < 0.05$) by increasing the level of PPP incorporation up to 20%, after this level, the sensory scores of odour and taste decreased by adding more pumpkin, that could be due to the increase in polyphenol content resulting in bitter taste (Lesschaeve and Nobel, 2005).

Generally, the biscuit contained 80:20 wheat flour and PPP, respectively, showed the highest overall acceptability score (8.86) 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. The results of sensory scores reported in the current investigation were in consistence with those reported by other authors (Ramadan et al., 2010; Gurung et al., 2016; Toan and Thuy, 2018).

Conclusion

Developed biscuits with PPP revealed reduced lightness with increased yellowness and redness than the control sample. The increase in PPP incorporation level increased the WSI and decreased WAI and OAI values of biscuits. Spread ratio and density of biscuits increased by increasing the PPP incorporation. The fibre, minerals, vitamin C, and β-carotene content 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. It could be concluded that the low cost ingredients such as pumpkin peel and wheat flour, particularly, in developing countries could be adopted to develop nutritious and acceptable biscuits.

TABLE 5. Proximate values of wheat/ pumpkin peel based biscuit (wet basis).

Sample	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Fibre (%)	Carbohydrate (%)	β-carotene (mg/100g)	Vitamin C (mg/100g)	Fe (mg/100g)	Energy (kcal/100 g)
Control	5.27±0.08^{e}	15.22±0.12^{a}	9.85±0.07^{a}	0.93±0.03^{e}	0.44±0.01^{e}	68.29±0.35^{a}	ND	ND	1.58±0.02^{d}	449.54±9.13^{a}
A	5.62±0.10^{d}	15.14±0.09^{ab}	9.42±0.09^{b}	1.30±0.04^{d}	1.18±0.02^{d}	67.34±0.38^{ab}	3.08±0.07^{d}	1.12±0.03^{d}	2.79±0.06^{c}	443.30±7.22^{ab}
B	6.14±0.09^{c}	15.05±0.14^{abc}	8.91±0.06^{c}	1.74±0.06^{c}	1.84±0.02^{c}	66.32±0.23^{bc}	7.13±0.12^{c}	2.26±0.05^{c}	2.94±0.08^{bc}	436.37±8.46.^{abc}
C	6.63±0.09^{b}	14.93±0.16^{bc}	8.36±0.05^{d}	2.18±0.03^{b}	2.51±0.01^{b}	65.39±0.25^{c}	9.64±0.08^{b}	3.15±0.02^{b}	3.10±0.08^{b}	429.35±7.92^{bc}
D	7.09±0.11^{a}	14.82±0.08^{c}	7.73±0.05^{e}	2.62±0.02^{a}	3.17±0.03^{a}	64.57±0.19^{c}	11.54±0.13^{a}	3.84±0.06^{a}	3.27±0.03^{a}	422.58±10.35^{c}

*All results are expressed as the means ± standard deviation.
Means followed by different superscript letters within each column differ significantly ($P < 0.05$).
ND, not detected.

TABLE 6. Sensory evaluation scores of wheat/ pumpkin peel based biscuit.

Sample	Appearance	Colour	Texture	Odour	Taste	Overall acceptability
Control	8.15±0.13^{b}	7.22±0.14^{d}	7.91±0.12^{c}	8.00±0.17^{c}	8.16±0.14^{b}	7.91±0.23^{c}
A	8.21±0.10^{b}	8.31±0.22^{b}	8.71±0.28^{b}	8.65±0.24^{b}	8.70±0.36^{a}	8.50±0.18^{b}
B	8.95±0.15^{a}	8.91±0.18^{a}	8.89±0.16^{a}	8.87±0.31^{a}	8.82±0.19^{a}	8.86±0.13^{a}
C	7.72±0.21^{c}	7.65±0.11^{c}	6.41±0.09^{d}	7.03±0.18^{d}	7.68±0.24^{c}	7.30±0.32^{d}
D	6.34±0.16^{d}	7.15±0.17^{d}	5.64±0.11^{e}	6.45±0.15^{e}	7.00±0.08^{d}	6.53±0.14^{e}

*All results are expressed as the means ± standard deviation.
Means followed by different superscript letters within each column differ significantly ($P < 0.05$)..

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الخصائص الطبيعية والوظيفية والجودة التغذوية والخصائص الحسية للبسكويت المدعم بمهروس قشر القرع العسلى

سماء صالح و سالم علي

قسم علوم الأغذية – كلية الزراعة (سابا باشا) – جامعة الإسكندرية – الإسكندرية - مصر.

تم دراسة الخواص الوظيفية والجودة التغذوية والتقييم الحسي للبسكويت المصنع من دقيق القمح والمدعم بمهروس قشر القرع العسلى (اليقطين). تم خلط دقيق القمح مع مهروس قشر القرع العسلى بنسب استبدال ١٠٠:٠ و ٩٠:١٠ و ٨٠:٢٠ و ٧٠:٣٠ و ٦٠:٤٠ على التوالي. أظهرت نتائج اختبار اللون أن البسكويت المدعم بمهروس قشر القرع العسلى (اليقطين) كان منخفض في درجة البياض مع زيادة درجة الإصفرار والإحمرار وذلك مقارنة بالبسكويت المنتج من دقيق القمح فقط. كما أدت زيادة نسبة التدعيم بمهروس قشر القرع العسلي إلى زيادة مؤشر ذائبية الماء WSI وانخفاض كلا من مؤشر امتصاص الماء WAI ومؤشر امتصاص الزيت OAI في البسكويت. كما زادت نسبة التمدد وكثافة البسكويت بشكل طفيف مع زيادة نسبة التدعيم بمهروس قشر القرع العسلي. كما ازداد محتوى البسكويت من الألياف والمعادن والبيتا كاروتين وفيتامين C وذلك بزيادة نسبة التدعيم بمهروس قشر القرع العسلي وذلك بشكل ملحوظ. كشفت النتائج أن البسكويت الناتج من الخلطة المحتوية على ٨٠٪ دقيق قمح +٢٠٪ مهروس قشر القرع العسلي حصل على أعلى نتائج التقييم في الحسي مقارنة بجميع العينات المختبرة. ويحتوى البسكويت الناتج من تلك الخلطة على ٦,١٤ ٪ رطوبة و ١٥,٠٥٪ دهون و٨,٩١٪ بروتين و١,٧٤٪ رماد و ١,٨٤٪ ألياف خام و ٦٦,٣٢ كربوهيدرات و٧,١٣مجم /١٠٠جم بيتا كاروتين و ٢,٢٦ مجم/١٠٠جم فيتامين C و ٢,٩٤ مجم/١٠٠جم حديد و قيمة الطاقة ٤٣٦,٣٧ كيلو كالوري /١٠٠جم وزن جاف.