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Fibre from Pumpkin (*Cucurbita pepo* L.) Seeds and Rinds: Physico-chemical Properties, Antioxidant Capacity and Application as Bakery Product Ingredients

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ABSTRACT

Introduction: The aims of this study were to determine the proximate composition, functional properties and antioxidant activity of pumpkin seeds and rind. Besides, the effects of dietary fibre in pumpkin seeds and rinds on bread qualities and properties were evaluated. **Methods:** Formulations for bread substituted with 0%, 5% and 10% pumpkin seed and rind, respectively were produced. Sensory evaluation of the prepared bread samples for such attributes as appearance, aroma, flavour, texture and overall acceptability was undertaken. The physical properties of the bread samples, including dough expansion, loaf volume, crumb colour and bread texture, were determined. Proximate analysis and determination of antioxidant activity of the bread samples were also conducted. **Results:** Crude fibre of the pumpkin seeds and pumpkin rinds was high at 31.48% and 14.83%, respectively. The total phenolic compound (TPC) and DPPH radical scavenging activity for the pumpkin rinds were 38.60 mg GAE/ 100 g dry weight and 69.38%, respectively, which were higher than those of pumpkin seeds. A 5% level of pumpkin rind bread gave the best overall acceptability and sensory attributes, followed by 5% pumpkin seed bread. Total dietary fibre, total phenolic compound and DPPH radical scavenging activity in breads substituted with 5% pumpkin seed and 5% pumpkin rind flour were higher than the values in control bread. **Conclusion:** Pumpkin seeds and rinds can be used as dietary fibre sources in bakery.

Keywords: Pumpkin seeds and rinds, dietary fibre, bread, sensory evaluation

INTRODUCTION

Dietary fibre has many functional properties such as water holding, oil holding, emulsifying and gel formation. Dietary fibre can be used in dairy, bakery, jam and meat products (Elluech *et al.*, 2011). Incorporation of dietary fibre into food products helps to modify the textural properties of the food, avoid syneresis and stabilise high fat content food and emulsion (Abdul-Hamid & Luan, 2000).

Total dietary fibres are made up of both soluble and insoluble dietary fibre. Total dietary fibre is an important component in the daily diet where the intake of total dietary

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fibre provides health beneficial effects (Slavin, 2005) such as reducing cholesterolaemia, modification of the glycemic and insulinaemic response and changes in the intestinal function; it also possesses antioxidant activity. Total dietary fibre also has technological functions such as a fat binding, gel binding, chelating and texturising agent (Abdul-Hamid & Luan, 2000). Examples of soluble dietary fibre are pectins, beta glucan, galactomanan gums, and a large range of non-digestible oligosaccharides (Meyer, 2004). Soluble dietary fibre functions in lowering serum cholesterol (Slavin, 2005) and helps in reducing the risk of heart attack and colon cancer (Elluech *et al.*, 2011). Soluble dietary fibre dissolves in the gut and forms viscous gel, which lowers the absorption of the released glucose. Insoluble dietary fibres consist of cellulose, hemicellulose and lignin (Elluech *et al.*, 2011), which prevent or relieve constipation due to the absorption of water from the digestive tract.

Pumpkin seeds and rinds contain high amounts of fibre. Pumpkin seeds contain 24.20 % crude fibre (Nyam *et al.*, 2009). Fibre present in pumpkin seeds and rinds can prevent constipation, reduce blood glucose and cholesterol level, prolong intestinal transit time and provide satiety. Pumpkin seeds flour can be added into food products, such as bakery products to enhance the texture and flavour of the products. Pumpkin rinds have an antifungal effect that treats fungus infection in adults and infants (Park *et al.*, 2010).

There has been increasing interest in the use of wholegrains in food products due to numerous health benefits associated with wholegrain consumption (Carolyn *et al.*, 2012). The health benefits of whole-grain cereal are well recognised and are attributed to the presence of dietary fibre and phytochemicals (Mohammed & Cornelia, 2012). The addition of dietary fibre into bakery products improves the nutritional quality of the products (Byrne, 1997). Therefore, pumpkin seeds and rind flour can be used as substitution of regular flour due to their functional and nutritional properties.

No research has been done on the functional properties of dietary fibre in pumpkin seeds and rinds. Therefore, the objectives of this study were to determine the proximate analysis, functional properties and antioxidant activity in pumpkin seeds and pumpkin rinds. Last but not least, this research also produces an acceptable formulation for bread made of pumpkin seeds and rinds and evaluates the effects of dietary fibre in pumpkin seeds and rinds on bread qualities and properties through sensory evaluation, physical and chemical analysis.

METHODS

A total of 20kg of pumpkin fruits (*Cucurbita pepo* L.) were purchased from Giant Hypermarket located at Saujana Impian Kajang, Malaysia. The weight of each pumpkin was around 1kg.

The pumpkin was cut into half and the seeds were scooped out. The rinds of the pumpkin were peeled off. The seeds and rinds were then washed with distilled water. The pumpkin seeds and rinds were oven dried for 24 hours at 60 °C in MEMMERT Convection Oven. Seeds and rinds were ground using a grinder (SHARP Blender & Mill EM-11, Japan) until a fine particle size of 1 mm was achieved. The seed powder was spread evenly throughout the drying tray and oven dried at 60 °C for 4 hours. The processed seed powder and ground rinds were vacuum packed and kept in a air tight container and stored in a cool and dry cabinet.

Proximate analysis

Moisture, crude protein (micro-Kjeldahl), crude oil (soxhlet), fiber and ash content were determined using the AOCS (1997) Methods Ba 2a-38, Ba 4a-38, Ba 3-38, Ba 6-84 and Ba

5a-49, respectively, and total carbohydrate was determined by difference. Total carbohydrate= 100%- (% moisture+ % crude protein+ % crude oil+ % fibre+ % ash). All determinations were done in triplicate.

Total phenolic compound (TPC) and DPPH radical scavenging activity

Total phenolic compound was determined according to Waterhouse (2002), while the antioxidant activity was determined according to the method by Liu *et al.* (2008) with slight modifications. A sample of 2 g was weighed and added to 10 mL of ethanol and then shaken using the shaker machine (Msion Sseriker, Korea) for 1 h. The mixture was filtered and the filtrate was then evaporated until viscous. 0.5 mL of ethanol was then added into the round bottom flask and shaken vigorously for 1 min. 0.2 mL of the concentrates was added with 2.8 mL of ethanol. Then, 2.8 mL of 0.004% of DPPH in methanolic solution was added and the mixture was shaken vigorously using vortex mixer (Copens Scientific, Japan). The mixture was allowed to stand in a dark environment at room temperature for 30 min. The absorbance of mixture was measured at 517 nm (PRIM SELOMAM Spectrophotometer RS232, France).

Functional properties

Swelling capacity

Swelling capacity was determined according to the modified method of Rosell, Santos & Collar (2009). One gram of sample was mixed with 20 mL of distilled water and allowed to hydrate for 24 h at 25 °C ± 1 °C. The volume of the sample was recorded after 24 h. Swelling capacity was expressed as mL per gram of sample.

Water holding capacity (WHC)

WHC was determined according to the modified method from Sangnark & Noomhorm (2003). One gram of sample was weighed using the analytical balance (Mettler Toledo 'College' B204-S, Switzerland) and mixed with 20 mL of distilled water. The sample was allowed to hydrate for 24 h at 25 °C ± 1 °C. The excess water was filtered off from the sample. WHC was expressed as grams of water held per gram of sample.

Water retention capacity (WRC)

WRC was determined according to the modified method of Chantaro, Devahastin & Chiewchan (2008). One gram of sample was transferred into a 50 mL Falcon tube to which was added 30 mL of distilled water . The tube with sample was allowed to hydrate for 24 h at 25 °C ± 1 °C. The sample was centrifuged at 3000 rpm for 20 min. WRC was expressed as grams of water retained per gram of sample.

Oil holding capacity (OHC)

OHC was determined using the modified method of Vazquez-Ovando *et al.* (2009). One gram of sample was weighed and transferred into a 50 mL Falcon tube. to which was added 20 mL of vegetable oil. The sample was stored in a cabinet for 24 h at 25 °C ± 1 °C. The sample was centrifuged at 2200 rpm for 30 min. OHC was expressed as grams of oil held per gram of sample.

Organic molecule absorption capacity (OMAC)

OMAC was determined according to the modified method of Vazquez-Ovando *et al.* (2009). Three grmas of sample was weighed and transferred into a 50 mL Falcon tube to which was added 10 mL of vegetable oil. The tube with sample was stored in cabinet and allowed to hydrate for 24 hat 25 °C ± 1 °C. The sample was then centrifuged at 2000 rpm for 15 min at 25 °C. OMAC was expressed as grams of oil per gram of sample.

Emulsifying activity (EA) and emulsion stability (ES)

EA and ES were determined according to the modified methods of Vazquez-Ovando *et al.*

(2009). Two grams of sample was weighed and 100 mL of distilled water was added. The mixture was then homogenised for 2 min using IKA Ultra-Turrax T25 Digital Homogeniser (China) and then added with 100 mL of vegetable oil and homogenised for 1 min. The emulsion was immediately transferred into a 50 mL Falcon tube and centrifuged at 1200 rpm for 5 min. The emulsion volume was recorded. EA was expressed as volume of emulsion per 100 mL of the emulsion volume.

ES was determined by heating the prepared emulsion at 80 °C for 30 min. The emulsion was then cooled to room temperature and homogenised for 1 min. The emulsion was transferred into a 50 mL Falcon tube and centrifuged at 1200 rpm for 5 min. The emulsion volume was recorded. ES was expressed as volume of the remaining emulsion per 100 mL of the original emulsion volume.

Preparation of bread

Three formulations of bread were prepared based on 240 g of basic high protein flour as control where no sample powder (0%), 5% and 10% of sample flour were substituted into high protein flour, respectively (Table 1). The control formulation was used as comparison for other formulations substituted with sample flour. The bread mold was baked at 200 °C for 20 min in an electric oven (Pensonic, Model AE-11N, AE-18N, Malaysia).

Physical analysis of bread

Dough expansion was measured according to the method of Sangnark & Noomhorm (2003). The loaf volume was measured according to the method of Abdul-Hamid & Luan (2000). Crumb colour was determined according to the method of Ajila, Leelavathi & Prasada Rao (2008). The bread slice was placed on UltraScan Pro HunterLab Colour Measuring System. The surface colour L (brightness), a (redness) and b (yellowness) was measured.

Bread texture was determined according to the method from AACC (1986). Bread loaf was sliced into 1 cm thick slices and placed on the texture analyser platform. The sliced bread was compressed with a cylindrical probe using 50% strain. Hardness, springiness, cohesiveness, chewiness, and resilience values were tested using TA.XT *plus* Texture Analyser (North America).

Sensory evaluation

A total of 15 trained voluntary panelists were involved in the hedonic test. Each panelist was given a set of sensory evaluation forms and required to taste each bread sample. The panelists were required to rate the sensory attributes of the bread sample tasted, such as appearance, aroma, flavour, texture and overall acceptability. Each sensory attribute was rated according to individual preferences on a nine point hedonic scale of 1 as 'Dislike Extremely', 5 as 'Neither one', and 9 as 'Like Extremely'.

Table 1. Formulation of pumpkin seeds and pumpkin rinds powder bread

Ingredients (g)	*Control*	*5% seeds*	*10% seeds*	*5% rind*	*10% rind*
High protein flour	240	228	216	228	216
Sample powder	0	12	24	12	24
Active dry yeast powder	2	2	2	2	2
Sugar	14	14	14	14	14
Salt	3	3	3	3	3
Shortening	10	10	10	10	10
Full cream milk powder	5	5	5	5	5
Water	78	78	78	78	78

Control bread and the most preferred bread formulation obtained from the hedonic test for pumpkin seeds and pumpkin rinds flour substituted bread were run for chemical test to determine proximate analysis and antioxidant level in bread product. Crude fibre test was replaced with total dietary fibre test using AOAC 985.29 method (2000).

Statistical analysis

Mean and standard deviation were determined for each analysis and analysed using Minitab Window version 13 (ANOVA). Differences were considered statistically significant at $p < 0.05$.

RESULTS AND DISCUSSION

Table 2 shows the proximate analysis, functional properties and antioxidant activity in pumpkin seeds and pumpkin rind. Moisture in both pumpkin seeds (4.32%) and pumpkin rinds (5.96%) was relatively low. Pumpkin rind (5.77%) had lower content of fat compared to pumpkin seeds (24.27%). Therefore, pumpkin rind are suitable for use as an ingredient in developing low fat baking products that require lower calorie intake. Although the crude fat content in pumpkin seeds is high, given the nutritional contents (vitamin E and phytosterol) in pumpkin seeds oil, it is suitable for incorporation into food products. Oil content in pumpkin seeds is rich in vitamin E (Murkovic *et al.*, 1996) and pumpkin seeds are also rich in plant sterols, which is able to lower serum cholesterol (Jones *et al.*, 2000).

Both pumpkin seeds (20.21%) and pumpkin rind (23.89%) contained a high percentage of protein. Protein in pumpkin seeds has unique functional properties and contains high lysine content that aids in producing high protein bread when incorporated into bakery products (El-Soukkary, 2001) and tryptophan, an essential amino acid that is able to increase brain levels of serotonin, known to fight depression.

Pumpkin seeds also contain cucurbitine which isresponsible for worm expelling effects and only can be found in the seeds of

Table 2. Proximate analysis, functional properties and antioxidant activity in pumpkin seeds and pumpkin rinds

Characteristics	*Pumpkin seeds*	*Pumpkin rind*
Moisture (%)	4.32 ± 0.26^{b}	5.96 ± 0.36^{a}
Crude fat (%)	24.27 ± 0.70^{a}	5.77 ± 0.29^{b}
Crude protein (%)	20.21 ± 0.34^{b}	23.89 ± 0.53^{a}
Ash (%)	0.68 ± 0.11^{a}	0.41 ± 0.08^{b}
Crude fibre (%)	31.48 ± 0.89^{a}	14.83 ± 0.96^{b}
Total carbohydrate (%)	19.04	49.11
Swelling capacity (mL/g)	3.25 ± 0.50^{b}	7.85 ± 0.44^{a}
Water holding capacity (g/g)	2.47 ± 0.19^{b}	5.50 ± 0.33^{a}
Water retention capacity (g/g)	2.58 ± 0.14^{b}	5.70 ± 0.26^{a}
Oil holding capacity (g/g)	4.68 ± 0.22^{a}	3.75 ± 0.29^{b}
Organic molecule absorption capacity (g/g)	1.31 ± 0.13^{a}	0.74 ± 0.10^{b}
Emulsifying activity (g/100g)	46.25 ± 4.33^{a}	35.00 ± 2.89^{b}
Emulsifying stability (g/100g)	38.75 ± 1.44^{b}	43.13 ± 0.72^{a}
Total phenol compound(mg GAE/100 g)	22.92 ± 0.61^{b}	38.60 ± 0.82^{a}
DPPH radical scavenging activity (%)	36.97 ± 1.76^{b}	69.38 ± 1.43^{a}

* Mean and standard deviation (n = 4) values in the same row with different superscripts differ significantly ($p < 0.05$).

* Mean value for total carbohydrate (n = 2), without standard deviation.

Cucurbita species (Bombardelli & Morazonni, 1997). Pumpkin seeds contained 0.68% of ash while pumpkin rinds contained 0.41% of ash. Both pumpkin seeds (31.48%) and pumpkin rind (14.83%) contained a high percentage of crude fibre, exceeding the level found by Leila *et al.* (2012) for *Cucurbita maxima* seed, which belongs to the same botanical family (Cucurbitaceae). This shows that both pumpkins seeds and pumpkin rind are suitable for incorporation into fibre rich food products. Total carbohydrate for pumpkin rind (49.11%) was higher than in pumpkin seeds (19.04%).

Pumpkin rind (7.85 mg/g) had higher swelling capacity compared to pumpkin seeds (3.25 mg/g). This might be due to the fat content present in pumpkin rind and pumpkin seeds. According to Sowbhagya *et al.* (2007), the residual oil trapped inside the fibre matrix of the sample will restrict the entry of water molecules and therefore lead to a lower swelling capacity. Pumpkin rind (5.50 g/g) had higher water holding capacity than pumpkin seed (2.47 g/g). Water holding capacity is related to soluble dietary fibre content and therefore shows pumpkin rind has higher content of soluble dietary fibre. Water retention capacity of pumpkin seeds (2.58 g/g) was lower than in the pumpkin rinds (5.70 g/g) when external force was applied. Pumpkin seeds had better ability in holding oil within the fibre matrix (4.68 g/g) than pumpkin rind (3.75 g/g). The organic molecule absorption capacity for pumpkin seeds (1.31 g/g) was higher than in pumpkin rind (0.74 g/g). This might be due to the higher content of insoluble dietary fibre in pumpkin seeds which has a higher capacity and impact on OMAC. Samples with high OMAC will function efficiently in interacting with fat, bile acids, cholesterol, drugs and toxic compounds in the intestine (Vazquez-Ovando *et al.*, 2009).

Pumpkin seeds (46.25 g/100 g) had a higher emulsifying activity compared to pumpkin rind (35.00 g/100 g). Foods with high emulsifying activity are beneficial to health as they help in absorbing biliar acid and thus limit the acid absorption in the small intestine. Further, it also increases faeces excretion and reduces blood cholesterol level (Vazquez-Ovando *et al.*, 2009). Pumpkin rind had better emulsifying stability compared to pumpkin seeds although pumpkin seeds had better emulsifying activity indicating that pumpkin rind's emulsifying stability is more thermodynamically stable than pumpkin seeds. Pumpkin rind was able to hold the emulsion without breaking down easily into water and oil than pumpkin seeds.

Pumpkin rind (38.60 mg GAE/100 g dry weight) contained higher total phenol compounds as compared to pumpkin seeds (22.92 mg GAE/100 g dry weight). Since pumpkin rind is the outer most layer of the pumpkin and serves as a first line of protective layer, the phenol compounds in pumpkin rinds is high. Pumpkin rinds had higher DPPH radical scavenging activity of 69.38% as compared to pumpkin seeds (36.97%).

Physical analysis of bread

The expansion of dough for larger particle size of flour inhibits dough expansion compared to finer particle size (Sangnark & Noomhorm, 2003). The particle size of pumpkin rind was smaller than that of the pumpkin seeds. Therefore, the higher water absorption capacity of pumpkin rind caused a slightly lower expansion of pumpkin rind dough than pumpkin seeds dough (Figure 1).

The loaf weight of 10% pumpkin rind bread was the highest among all due to the higher water absorption of pumpkin rind compared to pumpkin seeds (Table 3). With an increased amount of fibre-rich flour, the dough expansion decreased. This was due to the gluten content being diluted by the added fibre, changing the crumb structure, which impaired carbon dioxide retention of dough and affect loaf volume (Hu *et al.*, 2009). According to Tosh & Yada (2010),

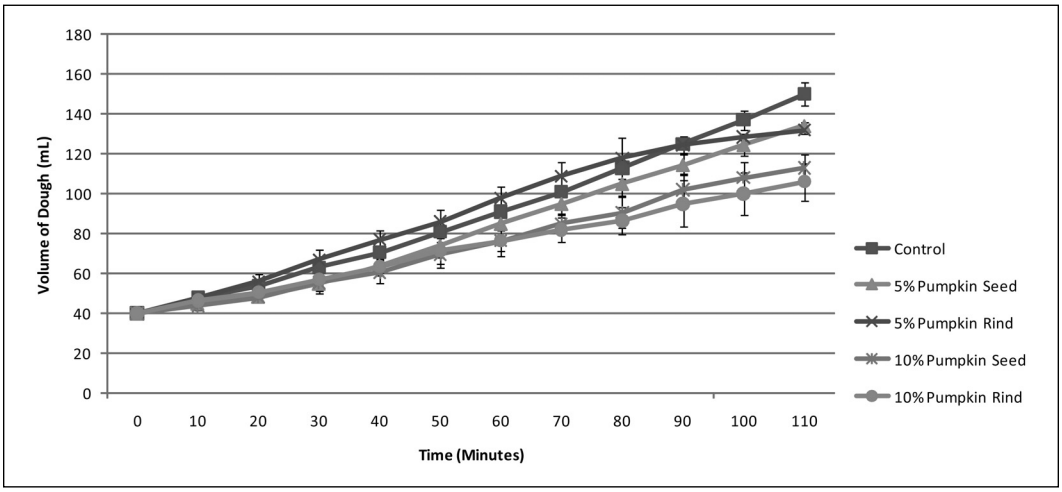

Figure 1. Dough expansion for five bread samples
*Based on mean value (n = 4)

increasing the amount of fibre rich flour in bread formulas tends to decrease loaf volume and specific volumes. This in agreement with the reduction in volume of 10% pumpkin seeds and pumpkin rind breads compared to control bread. Besides, water partitioning and gluten elasticity also affects loaf volume.

The darkness of crumb was directly related to the increase in fibre content in the formulation (Abdul-Hamid & Luan, 2000). For a* values, 5% pumpkin rinds bread (3.15) and 10% pumpkin rinds bread (3.12) were redder than control bread (0.03). Whereas 5% pumpkin seeds bread (-0.62) and 10% pumpkin seeds bread (0.00) were greener than control bread. Bread with 5% pumpkin rinds was the yellowest followed by 10% pumpkin rind bread, 10% pumpkin seeds bread, 5% pumpkin seeds bread and lastly the control bread.

The hardness of bread was reduced with the addition of pumpkin seeds and pumpkin rind flour into bread formulas (Table 3). This is due to the higher moisture content in breads added with fibre rich flour (See, Wan Nadiah & Noor Aziah, 2007**),** which have higher water holding capacity and water retention capacity in the fibre matrix compared to bread flour (Sunday & Dickson, 1992). The addition of pumpkin seeds and pumpkin rind flour had no effect on the springiness and cohesiveness of breads. Chewiness of the bread samples was reduced with the addition of pumpkin seeds and pumpkin rind flour. Control bread had the highest resilience score of 0.41.

Sensory evaluation

Bread consisting of 5% pumpkin rind had the highest score among all five samples, indicating that panelists preferred bread samples added with pumpkin rind flour (Table 4). The panelists preferred the redder and darker crumb colour of pumpkin rind bread over greenish brighter crumb colour.

The tea scent of pumpkin rind bread proved that pumpkin rinds contain catechins, which are flavonoids usually present in tea leaves and cocoa beans (Yilmaz, 2006). These results show that the bread substituted with 5% pumpkin seeds and 5% pumpkin rind flour are almost equally preferred and accepted by panelists as the control bread.

A total of 5% pumpkin rind bread had a higher score in terms of texture compared to

Table 3. Effect of pumpkin seeds and pumpkin rinds flour substitution on physical characteristics of bread

Characteristics	*Control*	*5% seeds*	*10% seeds*	*5% rind*	*10% rind*
Loaf weight (g)	373.80 ± 1.98^{e}	385.83 ± 1.00^{d}	394.99 ± 0.43^{b}	388.70 ± 1.44^{c}	397.48 ± 1.07^{a}
Loaf volume (cm^3)	1187.00 ± 4.76^{b}	1305.50 ± 6.40^{a}	1103.00 ± 3.46^{d}	1314.00 ± 4.90^{a}	1144.50 ± 6.40^{c}
Specific volume (cm^3/ g)	3.17 ± 0.00^{a}	3.38 ± 0.02^{a}	2.79 ± 0.01^{c}	3.38 ± 0.02^{a}	2.88 ± 0.00^{b}
Colour					
L*	73.64 ± 0.62^{a}	72.56 ± 0.94^{a}	64.37 ± 0.29^{b}	64.58 ± 0.37^{b}	61.13 ± 1.31^{c}
a*	0.03 ± 0.02^{c}	-0.62 ± 0.21^{e}	3.15 ± 0.05^{a}	0.00 ± 0.09^{d}	3.12 ± 0.19^{b}
b*	11.07 ± 0.22^{e}	14.14 ± 0.27^{d}	17.82 ± 0.14^{a}	14.92 ± 0.17^{c}	16.84 ± 0.72^{b}
TPA parameters					
Hardness	2038.60 ± 12.50^{a}	844.30 ± 78.50^{c}	1753.60 ± 50.40^{b}	1790.10 ± 376.60^{b}	1696.60 ± 19.60^{b}
Springiness	1.00 ± 0.00^{a}	1.60 ± 0.84^{a}	1.00 ± 0.00^{a}	1.02 ± 0.01^{a}	1.00 ± 1.00^{a}
Cohesiveness	0.73 ± 0.02^{a}	0.80 ± 0.06^{a}	0.71 ± 0.03^{a}	0.72 ± 0.05^{a}	0.75 ± 0.01^{a}
Chewiness	1484.00 ± 45.60^{a}	1068.00 ± 541.60^{b}	1246.10 ± 10.10^{b}	1300.00 ± 167.10^{b}	1272.90 ± 26.80^{b}
Resilience	0.41 ± 0.01^{a}	0.38 ± 0.00^{b}	0.34 ± 0.00^{b}	0.36 ± 0.01^{b}	0.37 ± 0.02^{b}

* Mean and standard deviation (n = 4) int the same row with different superscript means differ significantly ($p < 0.05$).

Table 4. Sensory attributes of 5 different formulations of bread samples in hedonic test

Sensory attributes	*Control*	*5% seeds*	*10% seeds*	*5% rind*	*10% rind*
Appearance	5.87 ± 0.99^{a}	5.73 ± 1.39^{a}	5.80 ± 0.94^{a}	6.47 ± 1.36^{a}	6.07 ± 1.44^{a}
Aroma	5.80 ± 1.15^{a}	5.87 ± 1.25^{a}	5.73 ± 1.22^{a}	5.93 ± 1.10^{a}	5.73 ± 1.71^{a}
Flavour	5.87 ± 1.25^{ab}	5.87 ± 1.25^{ab}	5.27 ± 1.28^{b}	6.67 ± 0.98^{a}	6.00 ± 1.15^{ab}
Texture	6.13 ± 0.74^{ab}	5.40 ± 1.50^{cd}	4.80 ± 1.21^{d}	6.60 ± 1.24^{a}	5.60 ± 1.40^{bc}
Overall acceptability	6.07 ± 0.96^{ab}	5.87 ± 1.30^{ab}	5.27 ± 1.28^{b}	6.60 ± 0.99^{a}	6.27 ± 1.16^{a}

* Mean and standard deviation (n = 15) in the same row with different superscript means differ significantly ($p < 0.05$)

Table 5. Proximate analysis and antioxidant activity in control, 5% seeds and 5% rind bread samples

Characteristics	*Control*	*5% seeds*	*5% rind*
Moisture (%)	39.23 ± 0.10[a]	40.62 ± 0.09[b]	41.02 ± 1.07[b]
Crude fat (%)	2.51 ± 0.17[a]	4.18 ± 0.37[b]	2.40 ± 0.16[a]
Crude protein (%)	7.00 ± 0.29[a]	8.14 ± 0.34[b]	9.10 ± 0.29[c]
Ash (%)	0.85 ± 0.03[a]	0.93 ± 0.04[b]	0.94 ± 0.04[b]
Total dietary fibre (%)	2.3	4.3	3.0
Total carbohydrate (%)	48.11	41.83	43.54
Total phenol compound (mg GAE/100 g)	15.21 ± 1.99[a]	35.66 ± 1.11[b]	42.34 ± 1.14[c]
DPPH radical scavenging activity (%)	17.11 ± 0.92[a]	23.61 ± 1.72[b]	36.67 ± 1.31[c]

* Mean and standard deviation (n = 4) in the same row with different superscript means differ significantly ($p < 0.05$).
* Mean value for total carbohydrate and total dietary fibre (n = 2), without standard deviation.

control bread. This was due to the smooth and firm texture of 5% pumpkin rind bread with higher water holding capacity than bread flour. Bread with 10% pumpkin seeds was the least preferred bread among all five bread samples, followed by control, 10% pumpkin rind, 5% pumpkin seeds and 5% pumpkin rind. Therefore, both 5% pumpkin seeds and 5% pumpkin rind bread samples were selected. The proximate analysis and antioxidant analysis of these two formulations of breads were tested and compared with control bread.

Proximate analysis and antioxidant activity in control, 5% seeds and 5% rind bread samples.

The addition of pumpkin seeds and pumpkin rinds flour into bread increased the moisture content (Table 5). This might be due to the higher water absorption capacity in the pumpkin seeds and pumpkin rind flour, which were high in fibre compared to wheat flour (Sunday & Dickson, 1992). Pumpkin seeds flour and pumpkin rind flour are suitable for incorporation into bread formulas so as to increase protein content in bread. The addition of pumpkin seeds and pumpkin rind flour into bread improves its protein, inorganic matter and mineral content. Total dietary fibre in pumpkin seeds bread was the highest among all three bread samples. This was due to the high crude fibre content in pumpkin seeds (31.48%) compared to pumpkin rind (14.86%), which affects the total dietary fibre content in bread samples. Bread flour is the main contributor for total carbohydrate content in bread. The addition of pumpkin seeds flour and pumpkin rind flour will reduce the carbohydrate content in bread and provide lower calories than control bread.

Breads, which were substituted with pumpkin seeds and pumpkin rind flour showed a higher TPC value. Results showed a 37.99 % increase in DPPH radical scavenging activity in pumpkin seeds bread and a 114.32 % increase for pumpkin rind bread compared to control bread. This shows that DPPH radical scavenging activity of both pumpkin seeds and pumpkin rinds breads were not totally destroyed by the high temperature of 200 °C.

CONCLUSION

The high fibre content of both pumpkin seeds and rind can be used in the preparation of high fibre foods. Its use will reduce the total carbohydrate of the end product, as it is replaced in part by the fibre content thus also reducing total calories of the product. Pumpkin seeds and pumpkin rind flour can

be added into bakery products to enhance the texture, flavour and nutritional value of the food product.

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