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Physical and sensory qualities of composite wheat-pumpkin flour bread with addition of hydrocolloids

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Abstract

Effects of pumpkin flour and hydrocolloids addition on the qualities of bread were investigated. Bead produced from wheat flour partially substituted with pumpkin flour at levels of 10-40% were evaluated for their physical and sensory qualities. When the level of pumpkin flour increased, specific loaf volume decreased but crumb hardness and yellowness of bread increased. Based on the sensory results, the formulation of 80:20 ratio of wheat flour to pumpkin flour was selected for further improvement. Hydrocolloids, i.e. pregelatinized tapioca starch, carboxymethylcellulose, xanthan gum, and guar gum (0.5-3.0%, w/w flour basis) were added to the bread formulation to provide a gluten-like property. The composite bread with 0.5% guar gum was superior in specific volume and bread texture as well as sensory qualities. Although the developed bread had lower overall acceptability than the control wheat bread, it contributed a good nutritive values as high in ash, fiber, and β-carotene contents.

Introduction

Bread consumption increases continuously in Thailand because of the influences of Western culture and expansion of city society which affects the consumption behavior of Thai people. Wheat or wheat flour needed for breadmaking have to be imported, because the climatic conditions and soil do not permit wheat to be cultivated locally in Thailand. The import of wheat has an increasing adverse effect on the balance of trade in the country. The possibility of replacing wheat flour wholly or partly with flour obtained from domestic agriculture products are of interest for breadmaking (Defloor *et al*., 1991; Khalil *et al*., 2000; Hsu *et a*l., 2004). Partial replacement of wheat flour with starches or non-wheat flour showed that other components might play a more significant role than the variations in starch properties when compared among the different non-wheat components (Rasper *et al.*, 1974). The reduced breadmaking potential of wheat flour with partial substitution was explained as a reduced capacity of gluten network to slow down the rate of carbon dioxide diffusion (Khalil *et al*., 2000).

Pumpkin *(Cucurbita moschata)* is an important traditional plant food of indigenous communities. Among cucurbitaceous vegetables, pumpkin has been appreciated by contributing high yield, long storage life and high nutritive values (Dhiman *et al*., 2009). Pumpkin is grown with high yield and available through the year in Kanchanaburi province, Thailand. Pumpkin is not only rich in carotene, pectin, minerals, vitamins and dietary fibers, it also contains other substances beneficial to health such as phenolic phytochemicals (Kwon *et al*., 2007; Dhiman *et al.*, 2009). Simple hot-air drying used in pumpkin flour preparation contributed to stronger antioxidant activities, reducing power, free radical scavenging and metal chelating activities of the resulting flours compared to those obtained from freeze-drying (Que *et al*., 2008). Pumpkin flour is one of the processed products of pumpkin fruit, which can be easily stored for long time and conveniently used in manufacturing of formulated foods. Pumpkin flour could be used to supplement cereal flours in bakery products, soups, and instant noodles to improve nutritional, physical and sensory qualities of these products (Lee *et al.*, 2002; See *et al.*, 2007). Substitution of wheat flour with 5% pumpkin flour resulted in bread with high loaf volume and good overall acceptability (See *et al*., 2007). Large enhancement of loaf volume and organoleptic acceptability of wheat bread were also observed by addition of 0.5% pumpkin powder (Ptitchkina *et al*., 1998). The results were attributed

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to surface activity of the highly acetylated pectin in pumpkin powder in stabilizing gas-cell structure of bread.

Improvement of wheatless bread quality could be promoted by addition of different kinds of additives, especially hydrocolloids. The use of hydrocolloids in breadmaking improves bread quality and its shelf life by keeping the moisture content and retarding the staling (Rosell *et al*., 2001; Guarda *et al.*, 2004). Hydrocolloids contributed to mimic the viscoelastic properties of gluten and improve structure, sensory qualities and shelf life of gluten-free bread (Lazaridou *et al.*, 2007; Anton and Artfield, 2008). The properties of hydrocolloids vary in a great extent depending on their origin and chemical structure. Guar gum and carboxylmethylcellulose have been added in rye bread formulation to improve the bread quality (Mettler and Seibel 1995). The incorporation of viscosity-enhancing agents such as pregelatinized flour (Kulp *et al*., 1974), xanthan gum (Sciarini *et al.*, 2010) in gluten-free bread formulation resulted in an increase in viscosity and led to improving gas retention since the release of the leavening gas is controlled by diffusion. Composite rice-wheat bread with addition of guar gum and *Lepidium sativum* seed gum showed an improvement of dough rheology and bread qualities in terms of specific volume, porosity, and overall acceptability (Sahraiyan *et al*., 2013).

Even though there are few literatures on the study of the properties of breads supplemented with low levels of pumpkin flour (up to 15% replacement) (Ptitchkina *et al*., 1998; See *et al*., 2007), no information on using hydrocolloids for the improvement of physical and sensory qualities of the composite bread with high level of wheat flour substitution was found. Thus, the objectives of this study were to investigate the physical and sensory properties of wheat bread partially substituted with pumpkin flour and to evaluate the effect of some hydrocolloids, varying in origin and chemical structure on the improvement of composite bread quality. Four types of hydrocolloids namely pregelatinized tapioca starch, carboxymethylcellulose, xanthan gum, and guar gum were used in this study.

Materials and Methods

Materials

Fresh pumpkins were purchased from a local market in Kanchanaburi, Thailand. Commercial breadmaking wheat flour (United Flour Mill Public Co. Ltd., Samut Prakan, Thailand) was used in this study. Hydrocolloids used were pregelatinized tapioca starch (Choheng Rice Vermicelli Factory Co., Ltd., Nakhon Pathom, Thailand), carboxymethylcellulose (Hercules Inc., DE, USA), xanthan gum (CP Kelco US Inc., IL, USA), and guar gum (Main Street Ingredients, WI, USA).

Preparation of pumpkin flour

The peel and seeds of fresh pumpkins were removed and the pulp was washed with tap water and cut into small pieces. The pumpkin pieces were then minced using a mincer (BIRO Model 548, BIRO® Manufacturing Co., Marblehead, OH, USA) and dried in a tray dryer at 50°C overnight. The dried minced pumpkin was ground using a laboratory mill (Brabender® OHG, Duisburg, Germany) and sieved through a 100 mesh sifter to remove course fiber. The pumpkin flour was kept in an airtight container to prevent air oxidation until use.

Preparation of bread

Bread formulation based on 100 g of flour consisted of 1 g salt, 1.25 g dry Bakers' yeast powder, 4 g milk powder, 10 g egg, 18 g sugar, 20 g shortening, and 54 g water. A straight dough process adapted from a method of Kittisuban *et al*. (2014) was conducted for bread preparation. The 30 g dough was hand-molded and placed into an aluminum baking pan (10 cm diameter and 4.7 cm height). The dough was proofed at 37°C for 45 min and then baked at 200°C for 10 min.

Preparation of composite bread

The composite bread was prepared using wheat flour to pumpkin flour ratios of 100:0, 90:10, 80:20, 70:30, and 60:40, which were equivalent to the levels of wheat flour substitution of 0, 10, 20, 30 and 40% (w/w, flour basis), respectively. Other ingredients were fixed to the same amount with the control (100% wheat flour) bread formulation except the amount of water used. The 65 g water was needed to make dough of the composite bread compared to 54 g water for the control one. Hydrocolloids used including pregelatinized tapioca starch, carboxymethylcellulose, xanthan gum, and guar gum were added to the composite bread formulation at different concentrations (0.5, 1.0, 2.0, and 3.0%, w/w flour basis) to provide a gluten-like property and improve textural and sensory qualities of the composite bread.

Chemical analyses

Proximate compositions, i.e. moisture, crude protein, crude lipid, crude fiber, and ash contents of wheat flour, pumpkin flour and the resulting breads were determined according to the AOAC

(1990) method. Nitrogen-free extractives content was determined by difference. Gluten content was determined by washing the dough with water to remove the starch and other soluble compounds from the samples. The rubbery mass remains after washing referred to wet gluten. The wet gluten was heated in an electric oven at 220°C for 25 min to determine dry gluten content. Water activity of bread crumb was analyzed using a water activity meter (AQUA LAB models, Series 3 and 3TE, Decagon Devices, Inc., Pullman, WA, USA). Determination of β-carotene was conducted using HPLC method (Sungpuag *et al*., 1999).

Physical analyses

Pasting properties of wheat and pumpkin flours (7.4%, w/w) were determined by a Rapid Visco Analyzer (RVA) (model RVA-4, Newport Scientific Pty. Ltd., Warriewood, Australia) using standard 1 profile. Breads were cut into half of loaves using an electric knife for crumb image observation using a digital camera (PowerShort SD880 IS, Canon Inc., Japan). Color in Hunter L^*, a^*, b^* values of flour and bread crumb samples was measured using a Minolta colorimeter CR-300 (Konica Minolta Business Technologies Inc., Langenhagen/Hannover, Germany). Loaf volume of bread was measured using rapeseed displacement method with some modifications. The sesame seed was used instead of rapeseed for the measurement. Specific volume was calculated by dividing the loaf volume by the loaf weight. Bread crumb hardness was measured using a texture analyzer (TA-XT2i, Stable Micro System, Surrey, UK). Bread was sliced to obtain pieces of 30×30×20 mm dimension, taken from the center of each loaf. The slices were tested for crumb hardness using 10 cm diameter compression probe with a test speed of 1.7 mm/sec and a compression distance of 40% strain. Triplicate measurements were taken.

Sensory evaluation

One loaf of bread was cut into 4 pieces using a bread knife. Sensory evaluation was performed using 30 untrained panelists comprising of undergraduate students and staff members of Mahidol University, Kanchanaburi Campus. The panelists were asked to evaluate for crumb color, odor, taste, texture, and overall acceptability. A 9-point hedonic scale was used where 1= dislike extremely to 9 = like extremely.

Statistical analysis

Data was analyzed using analysis of variance (ANOVA) program. The confidence level was 95%. Significant differences among means (P< 0.05) were analyzed by Duncan's multiple range test using the statistical software package SPSS v. 8.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results and Discussion

Chemical compositions of pumpkin flour and wheat flour

Proximate compositions of pumpkin flour and wheat flour are shown in Table 1.

Table 1. Chemical compositions of pumpkin flour and wheat flour

Components	Pumpkin flour	Wheat flour
Proximate composition (%)[a]		
Moisture	10.30 ± 0.16	9.27 ± 0.15
Crude protein	10.74 ± 0.20	14.68 ± 0.04
Crude lipid	2.76 ± 0.16	0.79 ± 0.15
Ash	3.96 ± 0.03	0.50 ± 0.05
Crude fiber	3.36 ± 0.23	0.10 ± 0.05
Nitrogen-free extractives	79.19 ± 0.15	83.93 ± 0.02
Wet gluten (%)	0.00	34.20 ± 0.04
Dry gluten (%)	0.00	11.23 ± 0.07

[a] Dry basis except for the moisture content

As compared to wheat flour, pumpkin flour was superior in terms of nutritive values as indicated by its higher ash and fiber contents, which is in agreement with Noor Aziah and Komathi (2009). Components in crude fiber could be pectin, cellulose, hemicelluloses, and lignin (Ptitchkina *et al*., 1998). It was reported that pumpkin flour has a good keeping quality and long shelf life due to its low moisture content and water activity (Noor Aziah and Komathi, 2009). No gluten was found in pumpkin flour. Wheat flour contained high protein content of 14.68%, which was suitable for breadmaking. The 34.20% wet gluten and 11.23% dry gluten were also found in wheat flour. The amount of dry gluten was close to that of crude protein indicated that most of protein in wheat flour would be gluten protein.

Physical properties of pumpkin flour and wheat flour

The L^*, a^*, and b^* values of pumpkin flour were 76.72, 0.59, and 33.71, respectively and those of wheat flour were 90.08, 0.63, and 9.68, respectively. Pumpkin flour had darker color (lower L^* value) and more yellowness (higher b^* value) than wheat flour. The yellowness of pumpkin could have been caused by carotenoids because pumpkin is a rich source of β-carotene (See *et al*., 2007; Dhiman *et al*., 2009). The RVA pasting profiles of pumpkin flour and wheat

Table 2. Physicochemical properties of composite flour bread[a]

Formulation[b]	Moisture (%)	Water activity	Crumb hardness (N)	Specific volume (cm^3/g)	Crumb color		
					*L**	*a**	*b**
100:0	34.67bc	0.953a	21.68a	2.76a	75.48a	-1.87b	14.14e
90:10	36.17a	0.952a	12.81e	2.24b	72.20b	-3.82e	27.71d
80:20	35.14ab	0.945b	15.45d	1.90c	68.92c	-3.34d	36.40c
70:30	34.46bc	0.944b	18.83c	1.59d	64.98d	-2.23c	39.78b
60:40	33.43c	0.942c	19.19b	1.31e	61.01e	-0.08a	43.52a

[a] Mean values with different letters within the same column are significantly different (P<0.05)
[b] Ratio of wheat flour to pumpkin flour

flour are presented in Figure 1.

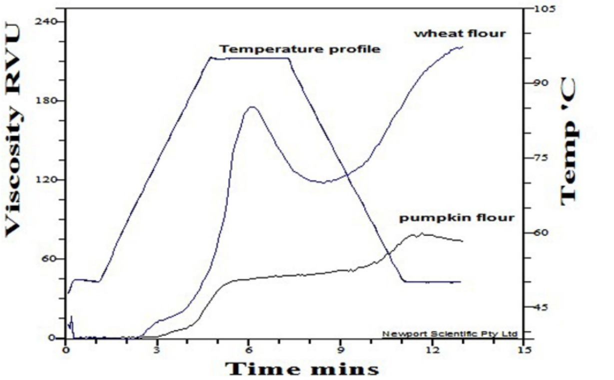

Figure 1. Pasting profiles of pumpkin flour and wheat flour

The peak viscosity, trough, breakdown, final viscosity, and setback of pumpkin flour were lower than those of wheat flour whereas higher pasting temperature was detected for pumpkin flour. Less nitrogen-free extractives (mainly starch) and higher lipid content of pumpkin flour (Table 1) contributed to lower viscosity of pumpkin flour. The undetectable breakdown of pumpkin flour was attributed to the swelling restriction of starch by lipid causing a stronger structure of starch granules. When helical complexes develop between starch chains and lipids, the helices hold amylose and amylopectin molecules together, which restrict granule swelling, increase pasting temperature, decrease the paste viscosity and increase resistance to shear-thinning of paste (Jane *et al*., 2010).

Quality of composite bread

The physicochemical properties in terms of moisture content, water activity, crumb hardness, specific loaf volume, and crumb color of the composite bread are shown in Table 2. Moisture contents of all formulations of bread were similar ranging from 33 to 36%. The high water activities (0.94-0.95) of all bread samples indicated that all breads were susceptible to microbial growing. All the composite wheat-pumpkin flour bread had significantly lower crumb hardness than the control (100% wheat flour) bread, which might be due to the high lipid content of pumpkin flour. Lipid could cause the softer texture of food product. Lee *et al.* (2002) reported that addition pumpkin flour (up to 10%) decreased the hardness of Asian noodles. Increasing the amount of pumpkin flour for wheat flour substitution resulted in decrease of specific volume but increase of crumb hardness of bread (Table 2). Declining the amount of wheat flour in the bread formulation caused the less gluten matrix, resulting in bread with lower specific volume compared to the control bread. See *et al.* (2007) reported that substitution of more than 10% pumpkin flour resulted in lower loaf volume of bread as compared with the control bread. The less gluten matrix and more interaction of other components in pumpkin flour might cause a lower specific volume of bread and a higher firmness of bread crumb. Even though the crumb hardness of 40% pumpkin flour bread was close to that of the control bread, this formulation was not worth further improvement due to its lowest specific volume. The L^* values of bread decreased but b^* values increased as the amount of pumpkin flour increased (Table 2), indicating that the composite bread was darker and more yellowness than the control bread. This could be attributed from the yellow color imparted by pumpkin flour. Figure 2 illustrates the images of cross-sectional views of composite breads.

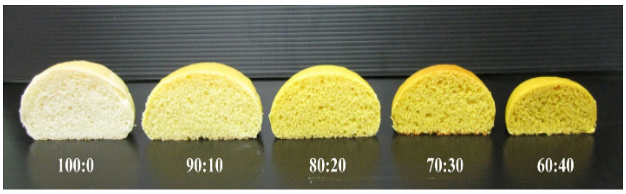

Figure 2. Bread crumb cross-sectional views of composite bread with different ratio of wheat flour to pumpkin flour

With increasing pumpkin flour levels, the specific volumes of bread decreased but yellowness increased. These qualitative results are in agreement with the quantitative results presented in Table 2.

The mean sensory scores of the control and composite breads are presented in Table 3. All sensory

Table 3. Sensory attributes of composite flour bread[a]

Formulation[b]	Crumb color	Odor	Taste	Crumb texture	Overall acceptability
100:0	7.00a	7.00a	7.23a	7.50a	7.60a
90:10	6.50ab	4.70b	5.80b	6.57b	5.97b
80:20	5.90bc	5.23b	5.90b	6.27b	5.87b
70:30	5.23cd	4.63b	5.30b	6.17b	5.57bc
60:40	4.70d	4.63b	5.07b	4.80c	4.83c

[a] Mean values with different letters within the same column are significantly different ($P<0.05$)
[b] Ratio of wheat flour to pumpkin flour

Table 4. Crumb hardness and specific volume of composite flour bread[a] containing different levels of hydrocolloids[b]

Formulation[c]	Hydrocolloid (%, w/w)	Crumb hardness (N)				Specific volume (cm^3/g)			
		PTS	CMC	XG	GG	PTS	CMC	XG	GG
80 : 20	0.00	15.45b	15.45e	15.45e	15.45e	1.90b	1.90c	1.90bc	1.90c
	0.50	14.66b	19.24d	22.54c	21.28d	2.00b	2.06bc	1.71c	2.41b
	1.00	15.32b	21.71c	26.41b	22.53c	1.72b	2.16b	1.82c	2.22bc
	2.00	15.40b	24.49b	28.64a	24.16b	1.93b	1.94bc	1.83c	2.08bc
	3.00	15.75b	28.85a	29.10a	26.66a	1.79b	2.02bc	2.06bc	2.00c
100 : 0	0.00	21.68a	21.68c	21.68d	21.68d	2.76a	2.76a	2.76a	2.76a

[a] Mean values with different letters within the same column are significantly different ($P<0.05$)
[b] Abbreviations of hydrocolloids: PTS, pregelatinized tapioca starch; CMC, carboxymethylcellulose; XG, xanthan gum; GG, guar gum
[c] Ratio of wheat flour to pumpkin flour

attributes of the composite breads had lower scores than those of the control bread. Increasing the level of pumpkin flour resulted in decreasing of sensory acceptability by the panelists. See *et al.* (2007) found that stronger pumpkin odor and aftertaste in the 10% and 15% pumpkin flour breads resulted in a low overall acceptability of bread. It is generally known that increasing levels of wheat flour substitution with other flours progressively reduced the bread quality. The lower gluten content caused a decrease in flour strength and gas retention, resulting in reducing bread volume and sensory attributes of composite bread (Hsu *et al*., 2004). In this study, according to the sensory scores, 20% pumpkin flour would be the maximum level for substitution of wheat flour. The overall acceptability of 10% and 20% pumpkin flour breads was not significantly different and both formulas had the sensory qualities closer to the control bread. The wheat flour to pumpkin flour ratio of 80:20 was therefore selected for further improvement of textural and sensory qualities by adding hydrocolloids. According to the literature, partial replacement of wheat flour up to about 20% with other agricultural fours is possible to produce composite flour bread (Khalil *et al*., 2000; Hsu *et al*., 2004).

Quality of composite bread with hydrocolloids addition

Hydrocolloids used including pregelatinized tapioca starch (PTS), carboxymethylcellulose (CMC), xanthan gum (XG) and guar gum (GG) at concentrations of 0.5, 1.0, 2.0, and 3.0% (w/w of total flour weight) were added to the 20% pumpkin flour bread to provide a gluten-like property. All breads obtained in this study had moisture content and water activity in the ranges of 32.52-36.41% and 0.945-0.953, respectively (data not shown). This indicated that all samples were susceptible to microbial spoilage due to their high moisture content and water activity. The 20% pumpkin flour breads without added hydrocolloids had lower crumb hardness and specific loaf volume than the control wheat flour bread (Table 4). The crumb hardness and specific volume of composite flour bread containing different levels of hydrocolloids are shown in Table 4. The results showed that the crumb harness and specific volume of the composite breads with PTS addition at different concentrations were not significantly different from those of the composite bread without PTS addition. This might be due to the low levels (up to 3%) of PTS addition. Kulp *et al*. (1974) found that quality of gluten-free bread from wheat starch was

Table 5 Mean sensory scores of composite flour bread[a] containing different levels of hydrocolloids[b]

Formulation[c]	Hydrocolloid (%, w/w)	Texture				Overall acceptability			
		PTS	CMC	XG	GG	PTS	CMC	XG	GG
80 : 20	0.00	6.27b	6.27b	6.27b	6.27b	5.87c	5.87c	5.87c	5.87c
	0.50	6.90ab	6.13b	6.43b	7.10a	6.67b	6.27bc	6.67b	6.67b
	1.00	6.20b	6.40b	6.07b	6.47ab	6.40b	6.20bc	6.20bc	6.33bc
	2.00	5.80b	6.47b	6.83b	5.87b	6.07bc	6.30bc	6.57b	5.63c
	3.00	6.18b	6.40b	6.43b	6.20b	6.03bc	6.22bc	5.93c	5.90c
100 : 0	0.00	7.50a	7.50a	7.50a	7.50a	7.60a	7.60a	7.60a	7.60a

[a] Mean values with different letters within the same column are significantly different ($P<0.05$)
[b] Abbreviations of hydrocolloids as expressed in Table 4.
[c] Ratio of wheat flour to pumpkin flour

enhanced by adding 14% pregelatinized wheat starch as a viscosity-enhancing agent and 3.2% glyceryl monostearate as a surface-active material. Defloor *et al*. (1991) produced gluten-free bread using 80% cassava flour and 20% defatted soy flour. These authors reported that replacing 12-15% of the cassava flour with prehydrated extruded or pregelatinized corn starch had an improving effect on the crumb structure and volume of the bread.

Addition of CMC resulted in increasing crumb hardness of the composite bread. At 1% CMC addition, the composite bread had no significant difference in crumb hardness compared to the control, however its specific volume was still lower than that of the control. CMC had a preferred interaction to gluten (Collar *et al*., 2001), which provided the stronger structural bread. XG significantly increased crumb hardness but did not significantly affect the specific volume of the composite bread (Table 4). Mezaize *et al*. (2009) reported that there was no positive effect of CMC or XG on specific volume of gluten-free bread. The incorporation of XG into gluten-free bread did not improve the loaf volume (Lazaridou *et al*., 2007). The XG-added dough exhibited high resistance to deformation causing a limited and slow expansion of the gas cells during proofing (van Vliet *et al*., 1992; Lazaridou *et al*., 2007), and in turn leading to lower loaf volume of bread. In contrast, Rosell *et al*. (2001) reported an improvement of specific volume of wheat bread by adding 0.5% XG to wheat bread formulation. In this study, an increase in the crumb hardness of XG added composite bread to values which even higher than that of the control (Table 4) could be the consequence of the thickening effect on the crumb walls surrounding air spaces (Rosell *et al*., 2001; Guarda *et al*., 2004). XG improves a strengthening of wheat dough due to a strong interaction between XG and proteins.

Like XG, addition of GG resulted in an increase in the crumb hardness of composite bread with increasing levels of GG added (Table 4). The composite bread containing 0.5% GG showed no significant difference in crumb hardness compared to the control bread. It showed the highest specific volume among the other composite breads with or without hydrocolloids addition, however its specific volume was still lower than that of the control bread. At higher levels (1-3%) of GG addition, the specific volume of composite bread decreased, which related to an increase in crumb hardness (Table 4). Ribotta *et al*. (2004) found that addition of 0.5% GG in wheat bread resulted in bread with higher specific loaf volume than the bread without GG addition. The increased loaf volume of bread with GG addition might be attributed to a high water absorption capacity of GG. During baking, this water evaporated and thus the vapor pressure increased, resulting in an improvement of loaf volume of bread (Rodge *et al*., 2012). GG is a high molecular weight polysaccharides of galactomannans which consists of a linear chain of (1,4)-linked β-D-mannopyranosyl units backbone with (1,6)-linked α-D-galactopyranosyl residues as side chains. It generally has the mannose to galactose in the ratio of 2:1 (Rodge *et al*., 2012). The highly side chained molecule allows more water absorption due to hydrogen bonding. Sahraiyan *et al*. (2013) found that the specific volume and porosity of composite rice-wheat bread increased with the incorporation of GG (up to 1%). This might be due to the dough rheology improvement as high water absorption and dough stability and viscosity.

The results of sensory evaluation of the composite bread containing different levels of hydrocolloids are presented in Table 5. Addition of any of these hydrocolloids, except 0.5% GG addition, did not significantly affect the sensory scores for the textural attributes of the composite bread, which were significantly lower than that of the control wheat bread.

The 0.5% GG addition gave the highest sensory score for texture of the composite bread with no significant difference from that of the control wheat bread. This result correlated well with the crumb hardness data of the 0.5% GG-added composite bread (Table 4). Hydrocolloid addition did not significantly improve the overall acceptability of the composite bread, except the 0.5-1.0% PTS, 0.5-2.0% XG, and 0.5% GG additions. However, the overall acceptability of all composite breads was significantly lower than that of the control wheat bread. This might be due to the aftertaste of bread containing pumpkin flour. Addition of higher levels (2.0-3.0%) of hydrocolloids, except PTS, significantly increased crumb hardness to values which were higher than that of the control wheat bread (Table 4), resulting in their lower sensory scores. It was concluded that the 0.5% GG addition provided the composite bread with good textural and sensory qualities, almost comparable to the control wheat bread. Our results are in good agreement with those reported in the literature. Rodge *et al.* (2012) reported that GG had positive effects on improvement of dough and bread properties. They found that wheat bread with up to 1% GG addition presented greater sensory qualities than the control. Ćurić *et al.* (2007) found that GG addition gave better improvement of dough rheological properties, bread volume, and sensory attributes of gluten-free bread than those with XG addition. The overall acceptability of composite rice-wheat bread increased with GG addition might be due to the high specific volume and porosity of GG-added composite bread (Sahraiyan *et al*., 2013).

Chemical compositions of developed bread

Chemical compositions of the developed bread of 0.5% GG-added composite bread compared to the control wheat bread are shown in Table 6.

Table 6. Chemical compositions of developed composite flour bread with 0.5% guar gum addition and control wheat bread

Components	Composite flour bread with 0.5% guar gum	Wheat bread
Proximate composition (%)[a]		
Moisture	35.13 ± 0.84	34.67 ± 0.98
Crude protein	11.38 ± 0.00	13.45 ± 0.66
Crude lipid	16.81 ± 0.19	15.00 ± 0.30
Ash	1.83 ± 0.01	1.04 ± 0.08
Crude fiber	1.94 ± 0.00	0.97 ± 0.12
Nitrogen-free extractives	68.04 ± 0.18	69.53 ± 1.16
β-carotene (μg/100 g)	94.93 ± 1.02	0.00

[a] Dry basis except for the moisture content

The increment in crude lipid, ash, and crude fiber contents of the developed bread was observed. The developed bread with higher ash (mineral) and crude dietary fiber contents indicated a nutritional improvement of the bread (Noor Aziah and Komathi, 2009). The β-carotene content of 94.93 μg/100 g was obtained by addition of pumpkin flour in the developed bread (Table 6). Usha *et al.* (2010) reported that incorporation of pumpkin flour increased energy, fat, protein, β-carotene, fiber, and antioxidant levels in a weaning mix.

Conclusion

Wheat flour substituted with 20% pumpkin flour and 0.5% GG addition produced the most acceptable composite flour bread, considering based on physical and sensory qualities compared to the other levels of substitution and hydrocolloids addition. Even though its overall acceptability was lower than that of the control wheat bread, its nutritive values were higher as evidenced by higher ash, fiber, and β-carotene contents. Addition of GG at a proper level improved the loaf volume and texture of the composite wheat-pumpkin flour bread.

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