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Effect of cornsilk (*Maydis stigma*) addition in yeast bread: investigation on nutritional compositions, textural properties and sensory acceptability

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Abstract

The proximate compositions, total dietary fibre (TDF) content, textural properties and sensory acceptability of yeast breads formulated with 0%, 2%, 4% and 6% of cornsilk powder (CSP) were studied. The protein, ash and TDF contents of yeast breads were increased in line with the CSP level added whereas moisture content was decreased. Yeast bread added with 6% CSP recorded the highest content of TDF (5.91%), protein (9.76%) and ash (1.03%) compared to other formulation of yeast breads containing lower percentage of CSP. Besides, texture profile analysis (TPA) reported that the firmness, gumminess and chewiness of yeast breads increased directly proportional to the level of CSP added mainly due to higher content of TDF and lower content of moisture. However, for the yeast bread added with 2%CSP, there were no significant differences compared with control yeast bread. Among all cornsilk-based yeast bread, formulation containing 2% CSP had the highest scores for all attributes including overall acceptance and there were no significant differences with control yeast bread. The present study indicated that the addition of 2% CSP could be an effective way to produce functional yeast bread without changing negatively its desirable textural and sensory acceptability.

Introduction

Presently, the incidences of chronic diseases such as heart disease, stroke, cancer, chronic respiratory diseases and diabetes are undoubtedly increasing and becoming a major problem in Malaysia and all over the world (Beaglehole *et al*., 2007; Habib and Saha, 2011). In 2005, 35 million people died from chronic disease (60% of all deaths). Furthermore, total deaths from chronic diseases are projected to increase by 17% over the next 10 years (Habib and Saha, 2011).

There is widespread scientific and public health policy agrees that behavioural factors such as risky drinking of alcoholic beverages, physical inactivity, cigarette smoking and unhealthy dietary practices contribute significantly to preventable chronic disease morbidity and mortality (Khang *et al*., 2010; Habib and Saha, 2011). In order to prevent the incidence of any chronic diseases, intake of dietary fibres from fruit, vegetables and whole grains should be promoted. It is because fruits and vegetables contain flavonoids, carotenoids, vitamins, minerals as well as dietary fibre (Shikany and White, 2000).

Dietary fibre is an indigestible portion of plant foods which consists of the structural and storage polysaccharides and lignin in plants (Marlett *et al*., 2002). Dietary fibre has its benefit effects in preventing obesity, cardiovascular disease, type 2 diabetes mellitus, colon cancer, colonic diverticulitis and constipation. So, it is crucial to add dietary fibre in our diets to prevent those diseases. It is suggested that populations that consume more dietary fibre have less chances to get those chronic diseases (Timm and Slavin, 2008).

Recommended intakes of dietary fibre for adults are 20-35g/day (Pilch, 1987) whereas the recommendation for children older than 2 years is to increase dietary fibre intake to an amount equal to or greater than their age plus 5g/day (Williams *et al*., 1995). Nevertheless, most populations' usual intake for dietary fibre is low, which is only 16g/day (Timm and Slavin, 2008). Therefore, intake of more other sources of dietary fibre should be encouraged.

There are 2 categories of dietary fibre: soluble dietary fibre (SDF) including pectin substances and hydrocolloids and insoluble dietary fibre (IDF) including cellulose, hemicelluloses and lignin. Good sources of SDF are fruits, vegetables, soybeans, oat

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bran and legumes. Whole grains are excellent sources of IDF. Products used to enhance fibre content of foods have traditionally come from cereals such as wheat, oats and corns (McKee and Latner, 2000). One of the agricultural by-products of corn is corn hairs or commonly known as cornsilk.

Cornsilk (a thread which is soft, fine, yellowish color with mild sweetish taste) is a collection of the stigmas from the female flowers of the maize plant (Wan Rosli *et al*., 2007). Cornsilk (also known as *Maydis stigma*) after dried is rich in a variety of chemical composition such as protein (±13.0%), ash (±5.3%), fat (±1.3%) and particularly TDF (±38.4%) (Wan Rosli *et al*., 2011b). Besides that, elemental study performed by Energy Dispersive X-Ray (EDX) showed that oven-dried cornsilk contains Potassium, Calcium Magnesium, Iron, Aluminium and other minerals (Wan Rosli *et al*., 2007).

Traditionally, cornsilk is well known to be used in folk medicine for diuretic treatment. Cornsilk was reported to be useful to treat urinary infection and cystitis (Steenkamp, 2003). Besides, it is also thought to act against gout by inhibiting the xanthine oxidase (XOD) (Jiang *et al*., 2011) and hyperglycemic effect (Li *et al*., 2004). However, kernels of young corn are the only components for consuming purposes while the other parts such as cornsilk are usually discarded during processing of young corn due to the lack of knowledge of its benefits.

Cornsilk which is rich in antioxidants and dietary fibres has grown in the current decade and led to the development of a large market for antioxidant and fibre rich ingredients and products. Cornsilk has already been incorporated into beef and chicken patties to improve nutritional composition (Wan Rosli *et al*., 2011a ; Wan Rosli *et al*., 2011b). Other than that, some local species are consumed as tea, powdered as food additive and flavorings agents in several regions of the world (Yesilada and Ezer, 1989). However, the formulation of consilk in yeast bread has never been studied.

Based on findings from Malaysian Adult Nutrition Survey (MANS), bread and biscuit are in the top 10 list of daily consumed foods among Malaysians (Norimah *et al*., 2008). Since yeast bread is always available, affordable, convenience and easy to consume especially in this competitive society, most of the populations prefer to choose yeast bread in their daily diet instead of fruits and vegetables.

Therefore, the development of yeast bread formulated with CSP with the intention of enhancing its nutritional compositions without affecting its textural and sensory acceptability was investigated. In the present study, yeast bread was formulated with different levels of CSP in order to compare their nutritional compositions, textural properties and sensory acceptability with the control yeast bread.

Materials and Methods

Study design

There are control sample and experimental samples. The control sample is the yeast bread without addition of CSP whereas the experimental samples are the yeast bread added with 2%, 4% and 6% CSP. This experimental design compares the proximate compositions, TDF content, textural properties and sensory acceptability parameters of control yeast bread and yeast breads added with different levels of CSP. There are 4 independent variables: 0%, 2%, 4% and 6% CSP yeast bread.

Preparation of CSP

10 kg of fresh young corns (*Zea mays* L, Poaceae female flowers) were purchased from Pasar Siti Khadijah, Kota Bharu, Kelantan, Malaysia. Upon arrival at the laboratory, the cornsilk (hairs) were separated from the young corn cob manually, cleaned and washed with distilled water. Then, the fresh cornsilks were dried at 55˚C for 2 days using an air-oven (Memmert UE 600, German) until brownish thread and constant weight (~ 10% of weight of fresh cornsilk) were obtained. The brownish dried cornsilk was ground into powder form by using electrical grinder (National brand, MX-895M model) and CSP was sifted by using a siever having diameter of 125µm. CSP was kept in air-tight container at 4˚C before conducting further analysis (Wan Rosli *et al*., 2011a).

Preparation of yeast bread

Wheat flour (1 Malaysia Brand) and active dry yeast (Mauripan brand) were mixed together in a bowl. Then, 400 ml of cold water were added into the mixture and kneaded by using Universal Mixing Machine (Okazawa brand, B-10N model) for 5 minutes. After that, sugar, salt, egg, margarine and milk were added and kneaded for another 15 minutes until a smooth and soft dough was formed. Wheat flour was added slowly if the dough was too sticky. Dough was allowed to rest for about 20 minutes at room temperature. Next, dough was added with cinnamon powder and CSP until they were widely spread to each parts of the dough, the dough was rest again for 15 to 25 minutes. Then, the dough was divided into smaller sizes (60 g) and put on baking sheet which was lightly greased. Dough was put into bread fermenting room for about 1 hour or until double in size at 40^0C and 60% humidity. Lastly, they were

Table 1. Yeast bread formulated with different levels of CSP

Items	Ingredients	Quantities			
		Control (0% CSP)	2% CSP	4% CSP	6% CSP
1	Sifted Wheat Flour (1 Malaysia brand) (g)	700	686	672	658
2	Milk (ml)	35	35	35	35
3	Coarse Sugar (g)	100	100	100	100
4	Salt (tsp)	1	1	1	1
5	Active Dry Yeast (Mauripan brand) (g)	11	11	11	11
6	Beaten Egg	1	1	1	1
7	Melted Margarine (g)	70	70	70	70
8	Cinnamon Powder (tsp)	1½	1½	1½	1½
9	CSP (g)	0	14	28	42
10	Cold Water (ml)	400	400	400	400

baked in electrical oven (Zanussi brand, ZCG841W model) at 150^{0}C for 10-15minutes or until desirable brown color was achieved. All the procedures above were repeated for all formulation of yeast bread (0%, 2%, 4% and 6% of CSP). The CSP was added into the yeast bread using the formulations described in Table 1. After developing yeast bread, they were ground into powder form by using electrical grinder (Waring brand, 8010S model) and proceeded to various analyses as described below. Yeast bread was formulated by following standard format of Brown (2008) with slight modification.

Proximate compositions and total dietary fibre (TDF) analysis

Proximate analysis were conducted using AOAC (1996) for moisture (Air-oven method), total ash, crude protein by nitrogen conversion factor of 6.25 (Kjeldahl method) and crude fat content using the semi-continuous extraction (Soxhlet method). TDF was determined by enzymatic gravimetric method, based on the AOAC (1996). All measurements were carried out in triplicate (n = 3).

Texture profile analysis (TPA)

TPA of yeast bread was performed by using a Texture Analyser TA.XTplus (Stable Micro Systems, Surrey, UK) with a 3D extensibility method. The TA.XTplus texture analyzer was coupled with Texture Exponent Software. Slices of yeast bread (approximately 40g) with 25mm in thickness for each sample were put on base of the instrument. Then, the instrument was equipped with an AACC 36mm radius cylinder probe (model P/36R). The operating conditions included pre-test speed (2.0mm/s), test speed (2.0mm/s), post-test speed (2.0mm/s), trigger force (20g), distance between probe and yeast bread (10mm), compression distance (6.25mm or 25% compression) and repeat to count (2) (Mohamud *et al.*, 2010). Firmness, cohesiveness, springiness, gumminess and chewiness were calculated from the curves.

Sensory evaluation

Sensory evaluation (conducted through a pilot study) of yeast bread was carried out by 60 untrained consumers consisting of students and staffs of the School of Health Sciences, Universiti Sains Malaysia Health Campus. Consumers received 4 different formulations of cornsilk yeast breads for sensory test. Approximately 2cm x 2cm of uniform sliced yeast bread were presented to them. The tested samples were coded with 3 digits permuted number. All samples were evaluated according to the 7-hedonic scaling method. Sensory parameters evaluated were aroma, colour, elasticity, tenderness, flavour and overall acceptance on a 7 point scale (1 = dislike the most and 7 = like the most).

Data analysis

Data were analyzed according to one-way ANOVA procedure by using SPSS 19.0 (USA). Results were expressed as mean ± standard deviation. All measurements were carried out in triplicate (n = 3). Significant level was established at $P<0.05$.

Results and Discussions

Proximate compositions and total dietary fibre (TDF) content

The proximate compositions and TDF contents of yeast bread added with different levels of CSP are presented in Table 2. Basically, protein, ash and fat contents were increased directly proportional to the level of CSP added in the formulation of yeast bread. Yeast bread added with 6% CSP significantly ($P<0.05$) recorded the highest protein content (9.76%) followed by yeast bread added with 4% CSP (9.53%). For the formulation of 2% CSP yeast bread, its protein content (9.27%) was significantly ($P<0.05$) reduced compared with 4% and 6% CSP yeast bread. Control yeast bread significantly ($P<0.05$) showed the lowest protein content (9.13%).

The content of ash in all formulation of yeast bread ranged from 0.89 – 1.03% with yeast bread added with 6% CSP significantly ($P<0.05$) recorded the highest content of ash (1.03%). Ash content (0.96%) of yeast bread added with 4% CSP were found to be slightly lower compared with 6% CSP yeast bread, but no significant difference ($P>0.05$). However, for the control yeast bread and yeast bread added with 2% CSP (0.92%), their ash content were reported significantly ($P<0.05$) lower compared with 6% CSP yeast bread (0.89%).

Yeast bread added with 6% CSP significantly ($P<0.05$) recorded the highest fat content (4.49%), whereas control yeast bread had the lowest fat content

Table 2. Proximate compositions and total dietary fibre (TDF) content of yeast bread added with CSP

CSP level	Content (%)				
	Protein	Ash	Fat	Moisture	TDF
Control (0%)	9.13 ± 0.05[d]	0.89 ± 0.03[b]	4.18 ± 0.25[b]	25.64 ± 0.25[a]	3.35 ± 0.09[d]
2%	9.27 ± 0.01[c]	0.92 ± 0.02[b]	4.28 ± 0.01[ab]	24.65 ± 0.10[b]	4.51 ± 0.36[c]
4%	9.53 ± 0.09[b]	0.96 ± 0.08[ab]	4.35 ± 0.05[ab]	23.12 ± 0.02[c]	5.00 ± 0.17[b]
6%	9.76 ± 0.10[a]	1.03 ± 0.04[a]	4.49 ± 0.03[a]	22.58 ± 0.21[d]	5.91 ± 0.04[a]

[a-d] Mean values within the same column bearing different superscripts differ significantly (P<0.05)

Table 3. Textural properties of yeast bread added with CSP

CSP level	Firmness (kg)	Springiness	Cohesiveness	Chewiness (kg)	Gumminess (kg)
Control (0%)	0.16 ± 0.01[c]	1.01 ± 0.01[a]	0.91 ± 0.03[a]	0.14 ± 0.02[c]	0.14 ± 0.01[c]
2%	0.15 ± 0.00[c]	1.01 ± 0.01[a]	0.95 ± 0.04[a]	0.15 ± 0.00[c]	0.15 ± 0.00[c]
4%	0.39 ± 0.02[b]	1.00± 0.00[a]	0.92 ± 0.01[a]	0.36 ± 0.02[b]	0.36 ± 0.02[b]
6%	0.50 ± 0.03[a]	1.01 ± 0.01[a]	0.92 ± 0.01[a]	0.46 ± 0.03[a]	0.46 ± 0.02[a]

[a-c] Mean values within the same column bearing different superscripts differ significantly (P<0.05)

(4.18%), they were significant difference with each other (P<0.05). In comparison to the control yeast bread, yeast breads containing 2% and 4% CSP gave higher values in fat content, with 4.28% and 4.35%, respectively. However, the difference was not significant between the control and the two formulations (2% and 4%) of yeast breads (P>0.05).

The study showed that the higher the CSP added into yeast bread, the higher contents of protein, ash and fat. It is because CSP used in this study possesses protein (13.0%), ash (5.3%) and fat contents (1.3%) (Wan Rosli *et al*., 2011b). However, wheat flour used in this study contains lower protein (9%) and fat contents (1%) as compared with CSP. Due to this reason, CSP improves the nutritional contents of yeast bread.

Similar findings were documented by Wan Rosli *et al*. (2011a) and Wan Rosli *et al*. (2011b), who have employed CSP in formulations of chicken and beef patties. The tested patties with 6% CSP were found to be significantly (P<0.05) increased in protein and ash contents. Besides, our present findings are in agreement with Sidhu *et al*. (1999).

On the other hand, the content of moisture in yeast bread was decreased inversely proportional to the levels of CSP added. Yeast bread added with 6% CSP significantly (P<0.05) recorded the lowest moisture content (22.58%). This trend was due to dried CSP only contains ≤ 1% of moisture (Wan Rosli *et al*., 2011b). Moreover, sugar and dietary fibre contents in CSP may absorb a large amount of water, consequently resulting in decreased in moisture content (Gill *et al*., 2002; Mohamed *et al*., 2010). The findings were in line with the previous studies (Sidhu *et al*., 1999; Peressini and Sensidoni, 2009; Gennaro *et al*., 2000; Wan Rosli *et al*., 2011a; Wan Rosli *et al*., 2011b).

In this present study, addition of 2%, 4% and 6% CSP in yeast bread resulted in a significant increase in content of TDF (Table 2). There was significant (P<0.05) increment in TDF content in yeast bread added with 6% CSP (5.91%) followed by yeast bread added with 4% CSP (5.00%) whereas control yeast bread significantly (P<0.05) showed the lowest (3.35%). According to Varo *et al*. (1983), some of the water-soluble fibre from CSP may be lost during baking of yeast bread at high temperature. In addition, some dietary fibre may be hydrolyzed by enzyme from the yeast used. On the other hand, the proximate compositions and TDF content of control yeast bread were fall within the range of commercial yeast bread.

Collectively, these results revealed that CSP is good for use as fibre-enriching agents in bread-making. It is because CSP originally contains high amount of TDF content (38.4%) (Wan Rosli *et al*., 2011b). The same trends of increased TDF content were documented in yeast bread incorporated with different levels of rice bran hemicelluloses B and also with rice bran insoluble fibre (Hu *et al*., 2009) and bread formulated with red and white bran (Sidhu *et al*., 1999).

Textural properties

Generally, all textural attributes investigated were influenced by CSP incorporation, except springiness and cohesiveness attributes (Table 3). The firmness of yeast bread increased directly proportional to the level of CSP added. Cornsilk-based yeast bread recorded firmness ranging from 0.16kg to 0.50 kg with yeast bread added with 6% CSP significantly (P<0.05) recorded the highest degree of firmness (0.50kg). There were no significant differences (P>0.05) in term of firmness between control yeast bread and 2% CSP yeast bread. Similar trend was also recorded in chewiness (product of firmness, springiness and cohesiveness) and gumminess (product of firmness and cohesiveness) of yeast bread. Apart from that, the textural properties of control yeast bread were fall within the range of commercial yeast bread.

Generally, breads made with low moisture content were firmer than those made with high moisture content (Gill *et al*., 2002). This hardness increment could be attributed to the lower moisture content of dough after addition of dried CSP. However, there was water retention obtained in yeast bread with added 2% CSP resulting in unchanged textural properties. Other than that, high dietary fibre content obtained in yeast bread after addition of 4% and 6% CSP contributed to greater firmness because dietary fibre component from CSP could tightly bind

Table 4. Sensory acceptability of yeast bread added with CSP (N= 60)

CSP level	Aroma	Colour	Elasticity	Tenderness	Flavour	Overall Acceptance
Control (0%)	4.60 ± 1.24^{a}	5.13 ± 1.44^{a}	4.75 ± 1.17^{a}	4.82 ± 1.36^{a}	4.90 ± 1.27^{a}	4.98 ± 1.19^{a}
2%	4.57 ± 1.13^{a}	4.97 ± 1.18^{a}	4.50 ± 1.21^{a}	4.47 ± 1.19^{ab}	4.43 ± 1.28^{ab}	4.68 ± 1.08^{a}
4%	4.23 ± 1.31^{ab}	4.23 ± 1.06^{b}	4.42 ± 1.17^{a}	4.20 ± 1.26^{b}	4.23 ± 1.29^{b}	4.20 ± 1.07^{b}
6%	4.00 ± 1.52^{b}	4.25 ± 1.40^{b}	4.37 ± 1.12^{a}	4.48 ± 1.20^{ab}	3.97 ± 1.43^{b}	4.08 ± 1.18^{b}

[a-b] Mean values within the same column bearing different superscripts differ significantly (P<0.05)

appreciable amounts of water, thus making it less available for the development of the gluten network, resulting in an underdeveloped gluten network. This, in turn, would limit the extent of dough inflation and gas cell stability during proving, hence leading to a more compact loaf with a reduced loaf volume and increased firmness (Symons and Brennan, 2004).

Elevated amounts of sugar content contributed by levels of CSP added had direct effect on water migration from other bread components, such as protein and gelatinized starch, thus causing bread stiffness. This moisture distribution and trapping by the sugar were the causes of higher firmness (Mohamed *et al*., 2010). Furthermore, high protein content in 4% and 6% CSP yeast bread was observed to have negative effects on bread quality. High amounts of protein probably interfere with starch by disrupting the uniformity of the starch gel during baking, resulting in bread firmness (Hüttner *et al*., 2010).

The firmness of bread was similar to those reported in the literature (Hu *et al*., 2009). All dietary fibre-supplemented breads had significantly firmer texture than control bread (no added fibre). Moreover, Wang *et al*. (2002) also stated that inulin-supplemented wheat bread had firmer crumb structure than control bread. Furthermore, parameters such as firmness, gumminess, and chewiness showed a certain increase as the content of durum wheat kernels replacement increased (Baiano *et al*., 2009).

However, the springiness and cohesiveness of control yeast bread, yeast bread added with 2%, 4% and 6% CSP were no significant differences (P>0.05). The same trend was observed in a study published by Wang *et al*. (2002), they revealed that values of springiness and cohesiveness from the TPA did not show important changes between control wheat bread and wheat bread added with different types of fibre such as carob fibre, inulin and pea fibre.

Sensory acceptability

Sensory evaluation scores for yeast bread added with different levels of CSP are shown in Table 4 below. Control yeast bread recorded the highest score for all attributes. Among all cornsilk-based yeast bread treatments, yeast bread containing 2% CSP had the highest scores for all attributes including overall acceptance and there were no significant differences with control yeast bread (P>0.05). It could be believed that 2% CSP yeast bread had milder CSP flavour and softer crumb, similar to that of control yeast bread. In the case of 6% CSP, consumers assigned a lower score than the control yeast bread due to higher crumb hardness and stronger cornsilk flavour. However, the scores for all sensory attributes of the yeast bread were still at acceptable values. In addition, consumers were unable to differentiate elasticity of yeast bread added with different levels of CSP.

In 2011, Wan Rosli *et al*. reported that there were no significant difference (P>0.05) between control patty and all other formulations of cornsilk-based patties even though the scores of all attributes were decreased with the levels of CSP added in patty formulations. Another literature revealed that the general acceptability of bread containing 5% hazelnut testa significantly better than bread containing other higher level of hazelnut testa. There was a clear relationship between the sensory scores and forms of added hazelnut testa (Anil, 2007). The study showed the similar results in which fewer consumers reported satisfaction toward the higher level of dietary fibre added into bread. Therefore, this present study has indicated that addition of 2% CSP could be an effective way to produce functional yeast bread without changing negatively its desirable sensory acceptability.

Conclusion

Incorporation of CSP resulted in increased protein, TDF and firmness but decreased sensory acceptability of yeast bread. In this study, 2% CSP yeast bread slightly increased protein, ash and TDF content meanwhile their textural properties and sensory acceptability were unchanged as compared with control yeast bread. On the other hands, yeast bread with 6% cornsilk-added showed the highest content of protein, ash and TDF content but adversely affected the textural and sensory acceptability. This could be attributed to the stronger cornsilk flavour and higher degree of bread firmness. The most possible reasons of bread firmness are low moisture content, high TDF content and high protein content. Therefore, further study can be done in the future in relation to this matter.

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