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The ability of *Zea mays* ears (Young Corn) powder in enhancing nutritional composition and changing textural properties and sensory acceptability of yeast bread

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Abstract

Consumption of dietary fibre-rich food has been associated with various beneficial physiological properties and health effects. Presently, different types of natural fibre-rich ingredients are added into variety of bakery-based products to improve it fibre content for health promotional purposes. However, majority of these products are frequently added with imported dietary fibre ingredients. In the present study, bread samples were prepared with *Zea mays* ear (young corn) powder at the levels of either 2%, 4% or 6%. The bread samples were analyzed for nutritional composition, textural properties and sensory acceptance. Addition of young corn powder (YCP) at the level of 6% increases total dietary fibre (from 3.48% to 5.26%), moisture (from 25.64% to 26.55%), fat (from 4.35% to 4.61%) and protein content (from 9.13% to 9.51%) significantly. However, with the increasing of YCP levels in the bread, the carbohydrate content was decreased significantly (from 59.93% to 58.34%) while the ash content (from 0.95% to 0.99%) was not significantly affected. Results of texture profile analysis indicated that addition of YCP up to 6% not significantly affected the springiness (1.01-1.00) but significantly decreased cohesiveness (0.95-0.82). However, the addition of YCP up to 6% has increased hardness (0.18kg-0.57kg), gumminess (0.17kg-0.47kg) and chewiness (0.18kg-0.47kg) attributes of bread samples. On the other result, the sensory evaluation shows that the flavour score was not significantly affected by addition of YCP up to 4% (4.82-4.52) while the tenderness (4.53-4.42), elasticity (4.75-4.58), aroma (4.40-4.47), colour (4.93-4.55) and overall acceptance (4.80-4.35) scores were not significant affected up to 6%. In summary, breads with 4% addition of YCP were considered to be acceptable and potentially used in improving nutritional composition without changing sensory score.

Introduction

Non-communicable diseases (NCDs) are the leading causes of death worldwide (WHO, 2010). There are 57 million global deaths in 2008 while 36 million (63%) caused by NCDs (WHO, 2010), mainly cardiovascular disease (48%), cancers (21%), chronic respiratory disease (12%) and diabetes (3%) in 2008 (WHO, 2011). In Malaysia, the NCDs also estimated to account for 67% of all death in 2008 (WHO, 2011). Most NCDs have the preventable risk factors and one of them is related to the dietary intake (WHO, 2010).

A diet increase in the amounts and varieties of fibre-containing foods can prevent or treat many of the diseases with public health significant such as obesity, cardiovascular disease and type 2 diabetes (Marlett *et al*., 2002). Dietary fibre is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. This food compound includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Dietary fibres promote beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation (AACC, 2001).

The usual intake for dietary fibre is low, 16g/day (Timm and Slavin, 2008). However, the dietary recommended intakes (DRIs) suggested consumption of 14g of dietary fibre per 1000kcal, which translates into a recommended level of 25g/d for women and 38g/d for men (Timm and Slavin, 2008). Fibre is always added to foods such as bakery products to

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increase the fibre content for health promotion and to improve functional properties (Dalgetty and Baik, 2006). However, besides using the functional fibre, basic ingredients that have high fibre content also can be used to produce the fibre-rich foods (Peressini and Sensidoni, 2009).

Young corn is the ear of maize plant (*Zea mays* L.) harvested young, especially before or just after the silks has emerged and no fertilization has taken place which depends on the cultivar (FAO and UNDP, 2001). It is commonly used as vegetables and has been showed to have high fibre content, that the dried young corn powder contains 30.4% of total dietary fibre (Wan Rosli and Che Anis, 2012).

Bread is an important staple food in both developed and developing countries (Abdelghafor *et al*., 2011). It is included in the top ten food item that consumed daily in Malaysia according to Malaysia Adults Nutrition Survey (Norimah *et al*., 2008). However, the bread is relatively expensive because it is made from imported wheat that is not cultivated in the tropics region for climatic reasons (Edema *et al*., 2005). Several developing countries have encouraged the initiation of programs to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour (Abdelghafor *et al*., 2011).

The present study utilizes the locally grown *Zea mays* ear (young corn) powder to produce the bread with higher fibre content. The aims of the study are to evaluate the ability of *Zea mays* ear (young corn) powder in enhancing nutritional composition and changing textural properties and sensory acceptability of yeast bread.

Materials and Methods

Preparation of Young Corn Powder (YCP)

Fresh young corns of *Zea mays* L. were harvested and collected from Bachok, a coastal district area of Kota Bharu, in the state of Kelantan, Malaysia. The selected young corns were cleaned and the corn silks were removed. Then, the corn silks were gently washed under running tap water. After that, the de-husked young corns were oven dried at 55^{o}C until brownish threads were obtained. The brownish dried young corns were ground into powder form by using electrical grinder (National brand, MX-895M model) and YCP was sifted by using a siever having diameter of 125µm. The YCP was then kept in screw cap bottle at 4^{o}C until further use.

Yeast bread preparation

Yeast bread was formulated by following standard format of Brown (2008) with slight modification. The ingredients used in preparation of samples of yeast bread were dry yeast (Mauripan Brand, 11g), fresh milk (35g), butter (70g), sugar (100g), salt (5g), egg (45g), water (400ml), cinnamon powder (2g), wheat flour and young corn powder (YCP). The samples of yeast bread were prepared by using different mixtures of YCP and the wheat flour. The YCP was mixed with wheat flour at the levels of 2%, 4% and 6%. One hundred percent wheat flour (700g) was used as a control (Table 1).

Table 1. Young corn powder (YCP) and wheat flour composition in bread recipe

	Young corn powder levels (%)			
Ingredient	**Control (YCP 0%)**	**YCP 2%**	**YCP 4%**	**YCP 6%**
Wheat flour (g)	700	686	672	658
Young corn powder (g)	0	14	28	42
Yeast (g)	11	11	11	11
Fresh milk (g)	35	35	35	35
Butter (g)	70	70	70	70
Sugar (g)	100	100	100	100
Salt (g)	5	5	5	5
Egg (g)	45	45	45	45
Water (ml)	400	400	400	400
Cinnamon powder (g)	2	2	2	2

For making the yeast bread, firstly, flour and instant yeast were mixed evenly. Then, the water was stirred into flour mixture and kneaded for 5 minutes. The sugar, salt, egg, butter and milk were stirred and kneaded until smooth and soft. The dough was then allowed to rest for 20 minutes. The YCP and cinnamon powder were then added into the dough and was rest for another 15-25 minutes. The dough was divided (each dough was weight around 60g) and let to rest again for 10-15 minutes. The dough was rolled into the shape of bun and put in the pans brushed with butter. The dough was covered and allowed to rise in warm place (35°C) until it doubled in size, about 1 hour. Finally, it was baked at 150°C for 15-20 minutes (Zanussi brand, ZCG841W model). The baking processed was immediately stopped once the surface colour of bread turned to golden brown. The dimension of bun prepared was fall in diameter ranged from 8.0 to 9.0 cm and height between 3.5 to 4.0 cm.

Proximate analysis

All samples of yeast breads prepared with different levels of YCP were analyzed for moisture (air-oven method), protein (semi-micro Kjeldhal method), crude fat (Soxhlet method) and total ash content (dry-ashing method) according to standard method as described in AOAC (2000). All measurements were carried out in triplicate (n = 3). Total carbohydrates were calculated by the difference: Total carbohydrates = 100 – (g moisture + g protein + g fat + g ash).

Total dietary fibre analysis

Total dietary fiber (TDF) was determined by enzymatic gravimetric method, based on the AOAC (1990).

Texture profile analysis (TPA)

The hardness, cohesiveness, springiness, gumminess and chewiness of the all bread samples were analysed by using Texture Analyser TA-XT. PLUS (Stable Micro Systems, Surrey, UK) that applies mechanical compression on the foodstuff and generates a deformation curve of it response. The texture analyzer was equipped with a 36mm radius cylinder probe (P/36). The operating condition included pre-test speed (2.0mm/s), test speed (2.0mm/s), post-test speed (2.0mm/s), trigger force (20g) and distance (10mm) (Artan *et al*., 2010). One slice of bread with 25mm thickness is with 6.25 compression distance. Three measurements per loaf for a replication were recorded and three replications were done per batch.

Sensory evaluation

The sensory evaluation of the bread samples was conducted by using 60 untrained panellists consisting of students and staff of the School of Health Sciences, Universiti Sains Malaysia. The parameters evaluated by the panellists included colour, aroma, tenderness, elasticity, flavour and overall acceptance. In this sensory evaluation, 7-point hedonic description sensory scale (Aminah and Tan, 2001) was used to determine the palatability of the bread samples prepared with different level of YCP. Approximately 2cm x 2cm of uniform sliced 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 were evaluated on a 7 point scale (1 = dislike the most and 7 = like the most). The sensory evaluation was done on the same day with the bread are prepared.

Data analysis

Result was expressed as the mean ± standard deviation. Data obtained was statistically analyzed using analysis of variance (ANOVA) and the Duncan Multiple range test by SPSS Predictive Analytics Software Statistics (PASW) version 18.0 (SPSS Inc, Chicago, Illinois) (SPSS Inc., 2009). All the measurement was carried out in triplicate (n= 3) analysis. Significant level established at $P \leq 0.05$.

Result and Discussion

Proximate analysis

The proximate compositions of the bread samples added with different levels of young corn powder (YCP) are presented in Table 2. Bread samples containing YCP (2%, 4% and 6%) were observed to have higher moisture content than the control. Increment of YCP levels had been shown to increase the moisture content of bread samples ranged from 25.64% to 26.55%. The reason is probably due to YCP contains appreciate amount of dietary fibre content (30.4%) (Wan Rosli and Che Anis, 2012). According to Nasar-Abbas and Jayasena (2012), high dietary fibre contents may retain water by preventing evaporation during baking. Similar increment in the moisture content was observed in the bread sample prepared with others natural ingredients such as brewers dry grain (Haruna *et al*., 2011), breadfruits flour (Olaoye and Onilude, 2008), breadnuts flour (Malomo *et al*., 2011), pumpkin flour (See *et al*., 2007) and rice bran (Marerat *et al*., 2011).

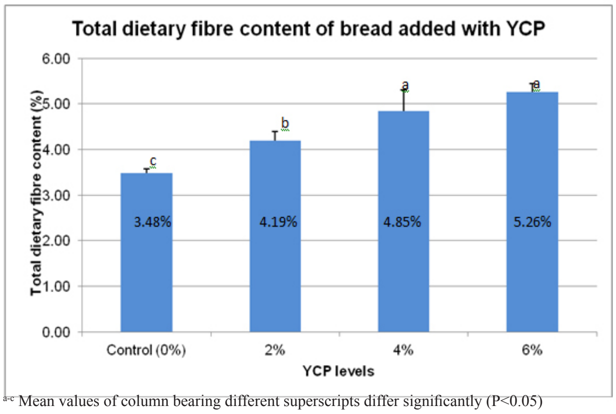
Result showed no significant (P>0.05) differences in protein content between control and 2% YCP bread sample, but a significant increase was observed in both 4% and 6% YCP bread sample as compared to the control respectively. The increase was expected due to YCP contained an appreciable amount of the protein content (25.58%) (Wan Rosli and Che Anis, 2012). This might be also due to the fact that protein content of wheat flour used in bread formulation was approximately 13-14% (Brown 2008). Significant increase in protein content was also observed in the bread supplemented with oats bran (Krishnan *et al*., 1987), Okara (Wickramarathna and Arampath, 2003), brewers dry grain (Haruna *et al*., 2011), full fat and defatted soy flour (Dhingra and Jood, 2002) and Bambara groundnut flour (Alozie *et al*., 2009) as compared to the control.

There was no significant different (P>0.05) in fat content between the control and bread sample added with 2% YCP. However, a slight significant increase in fat content was observed in the bread samples with 4% and 6% of the YCP as compared

Table 2. Effects of young corn powder (YCP) addition on the proximate composition of bread samples

	Young Corn Powder (YCP) Level (%)			
Proximate Composition	Control (0%)	2%	4%	6%
Moisture (%)	25.64±0.25^c	26.17±0.14^b	26.00±0.09^b	26.55±0.06^a
Protein (%)	9.13±0.04^c	9.25±0.10^{bc}	9.33±0.05^b	9.51±0.05^a
Fat (%)	4.35±0.05^b	4.40±0.02^b	4.56±0.02^a	4.61±0.14^a
Ash (%)	0.95±0.06^a	0.98±0.08^a	0.98±0.04^a	0.99±0.01^a
Carbohydrate (%)	59.93±0.24^a	59.20±0.29^b	59.12±0.11^b	58.34±0.11^c

$^{a-c}$ Mean values within the same row bearing different superscripts differ significantly (P<0.05)



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

Figure 1. Effects of young corn powder (YCP) addition on the total dietary fibre content of bread samples

Table 3. Effects of young corn powder (YCP) addition on the textural characteristics of bread samples

	Young Corn Powder (YCP) Level (%)			
Texture Characteristics	**Control (0%)**	**2%**	**4%**	**6%**
Hardness (kg)	$0.18{\pm}0.01^d$	$0.36{\pm}0.07^c$	$0.46{\pm}0.00^b$	$0.57{\pm}0.03^a$
Cohesiveness	$0.95{\pm}0.02^a$	$0.87{\pm}0.03^b$	$0.86{\pm}0.01^b$	$0.82{\pm}0.02^b$
Springiness	$1.01{\pm}0.00^a$	$1.00{\pm}0.00^a$	$1.00{\pm}0.00^a$	$1.00{\pm}0.00^a$
Gumminess (kg)	$0.17{\pm}0.01^d$	$0.31{\pm}0.05^c$	$0.39{\pm}0.01^b$	$0.47{\pm}0.04^a$
Chewiness (kg)	$0.18{\pm}0.01^d$	$0.31{\pm}0.05^c$	$0.40{\pm}0.01^b$	$0.47{\pm}0.04^a$

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

to the control bread sample. This might be attributed to the presence of fat in YCP. Wan Rosli and Che Anis (2012) reported that YCP contained 3.67% of fat. Meanwhile, high protein wheat flour containing fat at less than 1.0% (Brown, 2008).

Similar results have been previously reported in breads added with brewers dry grain (Haruna *et al*., 2011), breadnuts flour (Malomo *et al*., 2011), Okara (Wickramarathna and Arampath, 2003), full fat soy flour (Dhingra and Jood, 2002) and rice bran (Marerat *et al*., 2011) where higher fat content was observed in the supplemented bread.

The total carbohydrates content of bread samples showed a decreased (59.93-58.34%) with increasing levels YCP addition. According to Sanful (2011) and El-Soukkary (2001), incorporation of taro flour and roasted pumpkin seed meal also caused a decrease in the carbohydrate content in the bread. Carbohydrate content of wheat flour used in bread formulation was within the range of 70-80% while YCP was 66.0%.

No significant differences (P>0.05) was found in ash content between the control bread samples and bread samples added with YCP (2%, 4% and 6%). It might be due to only small amount of YCP was added into the bread samples. Similar result was observed in research work of Krishnan *et al*. (1987) which demonstrated that addition of large particles size oats bran up to 10% not significantly affect the ash content of the bread samples. Ash content of wheat flour used in bread formulation was approximately 0.45 to 0.50 (Brown, 2008).

Total dietary fibre (TDF) analysis

The TDF content of the bread samples added with different levels of YCP are presented at Figure 1. Increasing the levels of YCP at 0% to 6% in the bread formulations has increased the total dietary fibre content (3.48%-5.26%). This could be attributed to the high total dietary fibre at 30.4% of YCP (Wan Rosli and Che Anis, 2012). Similar observation was reported when bread samples was supplemented with brewers dry grain (Haruna *et al*., 2011), pumpkin flour (See *et al*., 2007), rice bran (Marerat *et al*., 2011) and Bambara groundnut flour (Alozie *et al*., 2009). There was approximately 10.5% TDF content of wheat flour commonly used in bread formulation. From the present data, proximate composition and TDF of control bread were fall within the range of commercial yeast bread.

Texture profile analysis

The textural characteristics of the bread samples added with different levels of YCP are presented at table 3. The hardness attribute (0.18kg-0.57kg) of bread samples was increased significantly (P<0.05) and proportionally with the levels of YCP in the bread formulations. The increase in hardness might be attributable to higher water absorption of fibre-rich incorporated dough which is explained by an interaction between water and hydroxyl groups of polysaccharides through hydrogen bonding (Mildner-Szkudlarz *et al*., 2011). The result was in agreement with the research work using sorghum flour as additives in pan bread (Abdelghafor *et al*., 2011) and grape by-products as additives in sourdough mixed rye bread (Mildner-Szkudlarz *et al*., 2011) where the hardness of baked products showed significant increase with increasing level of the additives. Textural properties of control yeast bread were also fall within the range of commercial yeast bread.

The results also showed that the gumminess (0.17kg-0.47kg) and chewiness (0.18kg-0.47kg) increased significantly (P<0.05) with increasing levels of YCP in the bread samples. Similar results were reported in other studies. The addition of grape by-products in sourdough mixed rye bread (Mildner-Szkudlarz *et al*., 2011) and lupin flour in muffin (Nasar-Abbas and Jayasena, 2012) caused an increase in the gumminess and chewiness of baked products.

A slight significant decrease of the cohesiveness attributes was observed in bread samples prepared with 2%, 4% and 6% of YCP as compared with the corresponding control bread samples. This is similar to the findings of Abdelghafor *et al*. (2011) that added sorghum flour in pan bread and Mildner-Szkudlarz *et*

Table 4. Effects of young corn powder (YCP) addition on the sensory attributes of bread samples

	Young Corn Powder (YCP) Level (%)			
Sensory Attributes	**Control (0%)**	**2%**	**4%**	**6%**
Aroma	4.40±1.09[a]	4.57±1.20[a]	4.47±1.33[a]	4.47±1.61[a]
Colour	4.93±1.09[a]	4.48±1.33[a]	4.68±1.27[a]	4.55±1.43[a]
Tenderness	4.53±1.33[a]	4.60±1.12[a]	4.47±1.29[a]	4.42±1.25[a]
Elasticity	4.75±1.24[a]	4.63±1.18[a]	4.43±1.27[a]	4.58±1.20[a]
Flavour	4.82±1.30[a]	4.43±1.18[ab]	4.52±1.43[ab]	4.27±1.55[b]
Overall acceptance	4.80±1.04[a]	4.60±1.06[a]	4.62±1.34[a]	4.35±1.35[a]

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

al. (2011) that added grape by-products in sourdough mixed rye bread in their research works where the cohesiveness attributes decreased with increasing levels of additives.

For springiness attribute, no significant differences ($P>0.05$) was found in bread samples added with YCP at 2%, 4% and 6% as compared to the control bread samples. This result is similar to the previous studies. The springiness of sourdough mixed rye breads did not change till 8% of grape by-products added (Mildner-Szkudlarz *et al*., 2011) while the springiness of pan bread did not change till 20% of sorghum flour added (Abdelghafor *et al*., 2011).

Sensory evaluation

The sensory attributes of the bread samples added with different levels of YCP were presented in table 4. The results of sensory evaluation implied that the tenderness (4.53-4.42), elasticity (4.75-4.58), aroma (4.40-4.47), colour (4.93-4.55) and overall acceptance (4.80-4.35) scores of bread samples prepared with 2%, 4% and 6% YCP were not significant different ($P>0.05$) compared to the control bread sample. While for the crumb colour, it might be attributed by the original colour of the YCP which is light yellow and this colour is quite similar with the original colour of bread crumb. Addition of the sweet potatoes up to 20% (Idolo, 2011) and Dolichos lab lab up to 10% (Kunyanga and Imungi, 2010) into the bread showed similar result where the addition of these additives do not significant affected the aroma, colour, texture and overall acceptance attributes of the bread.

The flavour score was not significantly affected by the addition of YCP up to 4% (4.82-4.52) but further addition of YCP up to 6% significantly decreased the flavour scores of bread samples as compared to the control. This might due to the unusual strong young corn flavour and the after taste of YCP. This is similar to the finding of Giami and Amasisi (2003) that addition of the African breadfruits seed flour up to 5% into the bread does not significant affect the flavour of the bread, but further addition decrease the flavour scores significantly. Besides, the incorporation of soybean flour into whole-wheat bread also resulted in significant decrease in the flavour scores which was mostly due to the beany flavour and aroma from the soy flour in the composite breads (Ndife *et al*., 2011).

Conclusion

The bread with addition of YCP at 4% was found to have higher moisture, protein, fat and TDF content while not affect the sensory attributes included tenderness, elasticity, aroma, colour, flavour and overall acceptance scores. However, addition of YCP significant affected most of the textural characteristics of the bread including hardness, gumminess, chewiness and cohesiveness. As a conclusion, addition of YCP at 4% into yeast bread resulted in increasing the nutritional composition of the bread without jeopardizing sensory attributes. Therefore, further researches to improve the textural characteristics of the yeast bread added with YCP are recommended.

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