Mal J Nutr 20(1): 93 - 99, 2014

Effects of Young Corn Ear Addition on Nutritional Composition and Acceptability of Conventional Cake

Chow YN & Wan Rosli WI*

Program in Nutrition, School of Health Sciences, Universiti Sains Malaysia Health Campus Kelantan Malaysia

ABSTRACT

Introduction: Scientific evidence indicates that higher dietary fibre consumption protects against various chronic diseases and leads to recovery enhancement. Young corn ear is very rich in total dietary fibre (TDF). The study objective was to evaluate the effects of young corn ear addition on the nutritional composition, textural properties and sensory attributes of conventional cake. **Methods:** Wheat flour used in the preparation of conventional cake was substituted with different percentages (0%, 5%, 10% and 15%) of young corn ear powder (YCP). Moisture, total ash, fat, protein and TDF content of conventional cake samples were investigated. Textural properties including firmness, cohesiveness, springiness, gumminess and chewiness were examined. The aroma, colour, chewiness, tenderness, flavour and overall acceptance of conventional cake were evaluated via sensory evaluation. **Results:** The conventional cake with addition of 15% YCP recorded the highest moisture content. There was no predictable trend observed in the ash and fat content following the incorporation of YCP. Addition of 15% of YCP increased the protein content significantly while TDF content of conventional cake increased proportionally (1.42%-2.88%) with the level of YCP added. The incorporation of YCP did not produce any trend on all the textural properties of conventional cake. Conventional cake with 10% of YCP was the most preferred manifested by the highest scores in chewiness, tenderness and flavour attributes. **Conclusion:** In conclusion, 10% of YCP could be recommended as the ideal formulation in order to produce a healthier conventional cake without jeopardising acceptability.

Key words: Corn, dietary fibre, functional food

INTRODUCTION

Young corn or baby corn is the ear of the maize plant *(Zea mays* L.) which is harvested young. Due to the fact that there is a lack of knowledge on its nutritional values and possible functional properties, it is seldom utilised as a raw food material (Wan Rosli & Che Anis, 2012). Young corn is very nutritive and its nutritional value is on average even higher than some of the seasonal vegetables (Shobha *et al.*, 2010). *Zea mays* ear extracts and its residues contain several important nutritional elements. Dried young corn has been recorded to contain 30.4g/100g of TDF (Wan Rosli & Che Anis, 2012).

Dietary fibre is referred to as the storage and structural polysaccharides and lignin found in plants which are not digested in

* Correspondence author: Wan Rosli Wan Ishak: Email address: *rosliishak@gmail.com*

both the human stomach and small intestine (Marlett, McBurney & Slavin, 2002). Dietary fibre is regarded as a key component in a healthy diet as it can prevent various diseases (Kaczmarczyk, Miller & Fruend, 2012). People with a higher amount of fibre intake are at lower risk of developing a wide range of diseases and health problems (Whelton *et al.*, 2005; Lairon *et al.*, 2005; Petruzziello *et al.*, 2006) compared to those who consumed less dietary fibre (Anderson *et al.*, 2009).

The Recommended Nutrient Intake (RNI) for dietary fibre is 20-30g/day (NCCFNM, 2005). However, more than half of the Malaysian adults consumed less than 20g dietary fibre daily (Ng *et al.*, 2010). As a consequence, there is an increase in the production of functional foods with enriched or fortified dietary fibre which are beneficial for the health of consumers.

The bakery products produced from refined wheat flour lack the natural bioactive components available in dietary fibre and thus the consumption of these products leads to reduced health benefits compared to the high dietary fibre-contained food products (Kim *et al.*, 2012). Cake is one of the popular bakery products which is usually prepared by using refined wheat flour, sugar, egg, fat, flavouring and leavening agent (Desai *et al.*, 2010). It is also one of Malaysia's favourite foods and ranks among the top ten foods consumed daily in Malaysia (Norimah *et al.*, 2008). According to Tee *et al.* (1997), conventional cake does not contain dietary fibre.

Hence, this study was aimed at evaluating the effects of young corn ear addition on the nutritional composition, textural properties and sensory attributes of the conventional cake in order to produce a healthier cake for consumers.

METHODS

Young corn ear powder (YCP) preparation

The fresh young corn (*Zea mays*) ears were purchased from a wet market in Kelantan, Malaysia. The young corn ears were detached from the husk, tassel, silk and washed under distilled water. Next, the fresh young corn ears were sliced, air dried at room temperature for 3 days and oven dried (Mermert, Germany) at 55°C until brownish threads were obtained. Then, the dried young corn ears were ground into powder and kept in a screw cap bottle at 4°C before further analyses (Wan Rosli & Che Anis, 2012). The YCP was used in the preparation of conventional cake.

Preparation of cake

The ingredients used in conventional cake are shown in Table 1. The ingredients were purchased from a supermarket located near to Universiti Sains Malaysia Health Campus in Kubang Kerian, Kelantan. First, the butter and sugar were creamed together by a hand

Table 1. Types and quantity of ingredients used in conventional cake preparation

	YCP Levels (%)			
Ingredients	*Control (0%)*	*5%*	*10%*	*15%*
Wheat flour (WF) (g)	110.0	103.5	99.0	93.5
YCP (g)	0.0	5.5	11.0	16.5
Self-raising flour (g)	110.0	110.0	110.0	110.0
Castor sugar (g)	125.0	125.0	125.0	125.0
Fresh milk (g)	125.0	125.0	125.0	125.0
Butter (g)	120.0	120.0	120.0	120.0
Vanilla essence (g)	7.0	7.0	7.0	7.0
Egg (nos)	5	5	5	5

mixer (Khind, model HM200) for 2 min. Then the eggs (medium in size) were added one by one with each egg being beaten for 30 sec. Vanilla essence was added, followed by wheat flour (WF), self-raising flour and milk alternatively. The mixing process was continued at slow speed until the batter was well-mixed. WF was substituted with YCP at levels of 0% (100%WF:0%YCP) for control, 5% (95%WF:5%YCP), 10% (90%WF :10% YCP) and 15% (85%WF:15%YCP). The cake was baked in a preheated oven (Zanussi, model ZOE530W) at 170 °C for 40 min.

Overall, there were three batches of conventional cakes prepared for the proximate and TDF analysis, texture profile analysis (TPA) and sensory evaluation respectively.

Nutritional composition

The samples of conventional cake were analysed for moisture (air-oven method), total ash (dry-ashing method), crude fat (Soxhlet method) and protein (semi-micro Kjeldhal method) content based on the methods of the Association of Official Analytical Chemists Methodology (AOAC, 2000). In addition, TDF content was determined by enzymatic gravimetric method (AOAC 985.29, 1990).

Texture profile analysis (TPA)

The firmness, cohesiveness, springiness, gumminess and chewiness of the cake samples were analysed by using a Texture Analyser TA-XT2 (Stable Micro Systems, surrey, UK) which was calibrated prior to the tests. The samples were cut uniformly (40 mm x 40 mm x 20 mm) with the crust removed (Gomez *et al.*, 2008). A 7-mm diameter probe was used (Kalinga, 2010) and it was set to compress the samples twice successively to 50% strain at a constant crosshead speed (1.0 mm/s) (Ahmad *et al.*, 2010) with force of 5g. Each test was done in triplicate. The textural properties were evaluated from the graph (Gomez *et al.*, 2007).

Sensory evaluation

Sensory evaluation was carried out by 50 untrained consumers consisting of students and staff of the School of Health Sciences, Universiti Sains Malaysia Health Campus. All samples were cut into uniform cubes (2 x 2 x 2cm). The acceptability attributes were evaluated by a seven-point hedonic scale based on the intensity of the panellists' preferences (1 = dislike extremely and 7 = like extremely) for the attributes of aroma, colour, chewiness, tenderness, flavour and overall acceptance.

Data analysis

The data obtained were analysed for significance by using Analysis of Varians (ANOVA) and Tukey test (SPSS Inc., Chicago, IL, USA). Significance level was established at $P < 0.05$.

RESULTS AND DISCUSSION

Nutritional composition

Dried YCP used in the present study recorded a moisture content of 1.00%. In relation to other nutrients, dried YCP contained a significant amount of total dietary fibre (TDF, 38.0%), protein (25.58%) and small quantities of fat (3.67%) and ash (3.74%), respectively.

Table 2 shows that the moisture content of cake samples incorporated with YCP increased significantly compared to the control (0%). The samples with 15% of YCP recorded the highest moisture content (37.88%), followed by 10% of YCP (35.88%) and samples with 5% of YCP (35.13%) whereas the control (0%) contained the lowest moisture content (34.86%). The increased dietary fibre content from YCP led to a higher water binding capacity (Lebesi & Tzia, 2011).

Meanwhile, the reduced moisture content observed in cake added with 15% YCP was similarly observed in another study where moisture loss was found to be

Table 2. Proximate composition and total dietary fibre (TDF) content of conventional cake with different levels of YCP addition

YCP level	*0%*	*5%*	*10%*	*15%*
Moisture	34.86 ± 0.08[d]	35.13 ± 0.09[c]	35.88 ± 0.08[b]	37.88 ± 0.12[a]
Ash	1.30 ± 0.10[a]	1.28 ± 0.15[a]	1.36 ± 0.01[a]	1.33 ± 0.01[a]
Fat	24.30 ± 0.31[a]	24.31 ± 0.24[a]	23.80 ± 0.03[a]	24.30 ± 0.05[a]
Protein	8.47 ± 0.19[b]	8.91 ± 0.50[ab]	9.86 ± 0.72[ab]	10.14 ± 0.79[a]
TDF	1.42 ± 0.28[b]	2.44 ± 0.26[a]	2.58± 0.41[a]	2.88 ± 0.27[a]

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

Table 3. Textural properties of conventional cake with different levels of YCP addition

YCP level	*0%*	*5%*	*10%*	*15%*
Firmness (kg)	2.80 ± 0.16[a]	2.88 ± 0.02[a]	2.66 ± 0.26[a]	2.79 ± 0.14[a]
Cohesiveness	0.86 ± 0.02[a]	0.84 ± 0.01[a]	0.85 ± 0.02[a]	0.88 ± 0.09[a]
Springiness	0.98 ± 0.01[a]	1.89 ± 0.78[a]	0.97 ± 0.02[a]	0.98 ± 0.00[a]
Gumminess (kg)	2.41 ± 0.10[a]	2.40 ± 0.02[a]	2.25 ± 0.17[a]	2.45 ± 0.20[a]
Chewiness (kg)	2.36 ± 0.11[a]	4.55 ± 1.91[a]	2.18 ± 0.14[a]	2.40 ± 0.20[a]

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

higher in cake added with 15% of corn bran (Singh, Liu & Vaughn, 2012). The decrease in moisture content could be due to other molecules from the wheat flour, such as arabinogalactan peptides which can interact with gluten resulting in a reduction in water absorption (Autio, 2006).

The addition of YCP did not significantly affect the ash content of cake samples. The current result is in agreement with the results of a study which incorporated YCP into bread (Lim & Wan Rosli, 2013). There was no significant difference between the fat content of control and cake added with YCP at 5%, 10% and 15%. These results were similarly observed in a study which incorporated 10%, 20% and 30% of YCP into a butter biscuit recipe (Wan Rosli & Che Anis, 2012).

There was a significant increase in protein content in cake samples with 15% of YCP compared to the control (0%). A significant increase in protein content following the addition of 4% and 6% YCP was observed in bread (Lim & Wan Rosli, 2013) as well as in cookies 10%, 20% and 30% YCP) (Wan Rosli & Che Anis, 2012).

There was an escalating trend in TDF content in parallel with the increasing percentage of YCP. The control contained the lowest TDF (1.42%) and the sample with 15% YCP recorded significantly the highest TDF (2.88%). Lim & Wan Rosli (2013) also reported that incorporation of YCP into bread increased TDF content of the bread.

Textural properties

Table 3 shows the textural properties of the cake samples with the addition of four different percentages of YCP. There was no predictable trend or significant differences exhibited for firmness, cohesiveness, springiness, gumminess and chewiness of the cake samples. Nonetheless, the addition of 5% of YCP into the cake showed the highest values in firmness, springiness and chewiness attributes. Meanwhile, the gumminess of cake decreased in line with the percentage of YCP added but increased following the incorporation of 15% of YCP.

According to Dadkhah, Hashemiravan & Seyedain-Ardebili (2012), the cohesiveness and springiness could be an indicating tool for increased bond development within the three dimensional protein network in the cakes. The insignificant difference observed might be due to the equal amounts of total solid matter present in all the samples.

In terms of the increased springiness following 5% addition of YCP into the cake, this was similarly observed in a study which involved the addition of inulin in sponge cake (Rodriguez-Garcia *et al.*, 2012). This denoted the increased strength of the three-dimensional crumb network bond in the products studied (Rodriguez-Garcia *et al.*, 2012). However, YCP addition of beyond 5% led to a less springy conventional cake. This observation is supported by Rodriguez-Garcia *et al.* (2012). This is attributed to a reduced quantity of air bubbles and the presence of a denser matrix which results in a lack of bubble expansion in the batter (Rodriguez-Garcia *et al.*, 2012; Sanz *et al.*, 2009).

In a study conducted by Lim & Wan Rosli (2013), the addition of YCP at 2%, 4% and 6% into bread significantly increased hardness, gumminess and chewiness. Meanwhile, the cohesiveness of YCP added bread at 2%, 4% and 6% decreased significantly compared to the control (0%). Nonetheless, no significant difference was observed in the springiness of bread and this is in agreement with the present finding. On the other hand, Singh *et al.* (2012) reported that firmness of cake increased with increased addition of corn bran. However, springiness was reduced as the percentage of corn bran was increased.

Sensory attributes

Table 4 shows the scores of sensory attributes of the cake as perceived by the sensory panellists. There was no significant difference for all the sensory attributes within all treatments. The results also showed that the panellists preferred cake incorporated with 10% YCP. This was confirmed by the highest values in overall acceptance (4.88), chewiness (4.68) and tenderness (4.50) in comparison to all other samples. This could be probably due to the pleasant flavour contributed by young corn manifested in the highest score for flavour (4.76).

On the other hand, cake incorporated with 5% of YCP received the highest score for aroma attribute (4.88) whereas the control recorded the highest score for colour (4.68). The highest score recorded for aroma implied that 5% YCP (highest percentage) added in cake produced the most favourable aroma. Meanwhile, the highest score of colour attribute received by the control (0%) cake may be due to the slightly creamy brownish colour of the cake's crumb preferred by sensory panellists' instead of the strong brownish colour after the addition of YCP. The changes in colour were a result of the Maillard reaction between the reducing sugar, fructose (found in young corn ear) and

Table 4. Sensory attributes of conventional cake with different levels of YCP addition

YCP level	*0%*	*5%*	*10%*	*15%*
Aroma	4.54 ± 1.45[a]	4.88 ± 1.02[a]	4.80 ± 1.13[a]	4.66 ± 1.06[a]
Colour	4.68 ± 1.29[a]	4.48 ± 1.05[a]	4.60 ± 1.11[a]	4.18 ± 1.30[a]
Chewiness	4.54 ± 0.89[a]	4.50 ± 1.02[a]	4.68 ± 1.12[a]	4.36 ± 1.01[a]
Tenderness	4.42 ± 1.13[a]	4.26 ± 1.16[a]	4.50 ± 1.11[a]	4.38 ± 1.12[a]
Flavour	4.50 ± 1.27[a]	4.60 ± 1.13[a]	4.76 ± 1.18[a]	4.34 ± 1.08[a]
Overall Acceptance	4.52 ± 1.07[a]	4.76 ± 0.94[a]	4.88 ± 0.94[a]	4.44 ± 1.05[a]

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

amino acids when the thermal process was applied during the preparation of cakes.

In comparison to the effect of YCP addition on bread acceptance, there was no significant difference observed in aroma, colour, tenderness and overall acceptance. This supports the present findings. However, incorporation of 6% YCP into bread caused a significant decrease in the flavour of bread (Lim & Wan Rosli, 2013).

A recent study on incorporation of corn flour obtained different results compared to the present study in which the incorporation of 10% of corn bran in cake scored the lowest overall acceptance compared to control (0%) and the sample with 20% corn bran whereas for taste, the cake with 10% corn bran was least preferred (Singh *et al.*, 2012). The different results obtained for acceptability could bdue to a different part of the corn being used for formulating the food product.

In conclusion, 15% of YCP added into conventional cake significantly increased the moisture, protein and TDF. Conventional cake with 10% of YCP was not significantly affected in terms of textural properties and was most preferred by the panellists. Therefore, 10% of YCP addition in conventional cake can be recommended as the ideal formulation to produce a healthier conventional cake without jeopardising the acceptability of consumers. This study reveals the potential usage of YCP as an alternative dietary fibre ingredient to replace whole wheat flour and oat bran since YCP significantly enhances TDF and protein content in finished conventional cakes. In addition, the utilisation of YCP in food productions will reduce the dependency on importation of dietary fibre sources. However, it is advised that a comparative study be undertaken to confirm whether YCP is better than other DF sources.

ACKNOWLEDGEMENTS

The authors would like to thank the grant from Universiti Sains Malaysia(USM) (1001/PPSK/813057) and all the staff and post-graduate students in the School of Health Sciences, Health Campus, USM, involved in sensory evaluation.

REFERENCES

Ahmad I, Imran-ul-Haq, Ashraf M & Saeed MK (2010). Profile analysis (TPA) of cakes supplemented with soy flour. *Pakistan J Sci* 62: 1-5.

Anderson JW, Baird P, Ferreri S, Knudtson M, Koraym A, Waters V & Williams CL (2009). Health benefits of dietary fibre. *Nutr Rev* 67(4): 188-205.

AOAC Method 985.29 (1990). Total dietary fibre in foods. Enzymatic-gravimetric method. Official Methods of the Analysis of the Association of Official Analytical Chemists (15th ed.) The Association: Arlington, VA.

AOAC (2000). Official Methods of Analysis of Aoac International (17th ed). AOAC International, Gaithersburg, Maryland.

Autio K (2006). Effects of cell wall components on the functionality of wheat gluten. *Biotech Advances* 24:633–35.

Dadkhah A, Hashemiravan M & Seyedain-Ardebili M (2012). Effect of shortening replacement with nutrim oat bran on chemical and physical properties of shortened cakes. *Ann Biol Res* 3(6): 2682-2687.

Desai AD, Kulkarni SS, Sahoo AK, Ranveer RC & Dandge PB (2010). Effect of supplementation of malted ragi flour on the nutritional and sensorial quality characteristics of cake. *Adv J Food Sci Technol* 2(1): 67-71.

Gómez M, Oliete B, Rosell CM, Pando V & Fernández E (2008). Functionality of different hydrocolloids on the quality and shelf-life of yellow layer cakes. *Food Hydrocolloid* 21(2): 167-173.

Gomez M, Ronda F, Caballero PA, Blanco CA & Rosell CM (2007). Effect of batter freezing conditions and resting time on cake quality. *Food Sci Technol-Leb* 44: 911-916.

Kaczmarczyk MM, Miller MJ & Freund G (2012). The health benefits of dietary fibre: beyond the usual suspects of Type 2 Diabetes Mellitus, cardiovascular disease and colon cancer. *Metabolism* 61(8): 1058-1066.

Kalinga DN (2010). Delivering beta-glucan via selected bakery systems: cake. Master of Science, Victoria University, Australia.

Kim JH, Lee HJ, Lee HS, Lim EJ, Imm JY & Suh HJ (2012). Physical and sensory characteristics of fibre-enriched sponge cakes made with *Opuntia humifusa*. *Fd Sci Technol* 47(2): 478-484.

Lairon D, Arnault N, Bertrais S, Planells R, Clero E, Hercberg S & Boutron-Ruault MC (2005). Dietary fibre intake and risk factors for cardiovascular disease in French adults. *Am J Clin Nutr* 82: 1185–1194.

Lebesi DM & Tzia C (2011). Effect of the addition of different dietary fibre and edible cereal bran sources on the baking and sensory characteristics of cupcakes. *Food Bioprocess Tech* 4(5): 710-722.

Lim JY & Wan Rosli WI (2013). The ability of *Zea mays* ears (young corn) powder in enhancing nutritional composition and changing textural properties and sensory acceptability of yeast bread. *Intern Food Res J* 20(2): 799-804.

Marlett JA, McBurney MI & Slavin JL (2002). Position of the American Dietetic Association: health implications of dietary fiber. *J Am Diet Assoc* 102(7): 993-1000.

National Coordinating Committee on Food and Nutrition (NCCFNM) (2005). Recommended Nutrient Intakes for Malaysia. A Report of the Technical Working Group on Nutritional Guidelines. Ministry of Health Malaysia, Putrajaya.

Ng TK, Chow S, Chan L, Lee C & Lim S (2010). Recommended nutrient intake for dietary fibre bar set too high for Malaysians? *Mal J Nutr* 16(2): 271-280.

Norimah A, Safiah M, Jamal K, Siti Haslinda Zuhaida H, Rohida S, Fatimah S, Siti Norazlin, Poh BK, Kandiah M, Zalilah, MS, Wan Manan WM, Fatimah S & Azmi MY (2008). Food consumption patterns: findings from the Malaysian adult nutrition survey (MANS). *Mal J Nutr* 14(8): 25 - 39.

Petruzziello L, Lcopini F, Bulajic M, Shah S & Costamagna G (2006). Review article: uncomplicated diverticular disease of the colon. *Alim Pharm Therap* 23: 1379–1391.

Rodriguez-Garcia J, Puig A, Salvador A & Hernando I (2012). Optimisation of a sponge cake formulation with inulin as fat replacer: structure, physicochemical, and sensory properties. *J Food Sci* 77(2): C189-197.

Sanz T, Salvador A, Baixauli R & Fiszman SM (2009). Evaluation of four types of resistant starch in muffins. The effects in texture, colour and consumer response. *Eur Food Res Technol* 229(2): 197-204.

Shobha D, Sreeramasetty TA, Puttaramanaik & Gowda KTP (2010). Evaluation of maize genotypes for physical and chemical composition at silky and hard stage Karnataka. *J Agri Sci* 23(2): 311-314.

Singh M, Liu SX & Vaughn SF (2012). Effect of corn bran as dietary fibre addition on baking and sensory quality. *Biocatal Agric Biotechnol* 1: 348-352.

Tee ES, Mohd Ismail N, Mohd Nasir A & Khatijah I (4th ed). (1997). Nutrient Composition of Malaysian Foods. Institute for Medical Research, Kuala Lumpur.

Wan Rosli WI & Che Anis J (2012). The potential of *Zea mays* ears and it extracts as an alternative food nutritive ingredients. *APCBEE Procedia* 2: 141-47.

Whelton S, Hyre A, Pedersen B, Yi Y, Whelton P, & He J (2005). Effect of dietary fibre intake on blood pressure: a meta analysis of randomised, controlled clinical trials. *J Hypertens* 23 : 475-481.