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Physicochemical and Sensorial Evaluation of Biscuit and Muffin Incorporated with Young Corn Powder

(Penilaian Fizikokimia dan Sensori Biskut dan Mufin yang Ditambah Serbuk Jagung Muda)

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ABSTRACT

Various types of natural fibre-rich ingredients are added into bakery-based products to improve their fibre content for health promotional purposes. However, most of these products are frequently added with imported dietary fibre ingredients. The aim of this study was to develop bakery products incorporated with young corn powder (YCP) and to evaluate the effects on physicochemical properties and sensory acceptabilities. Dried young corn was used to substitute wheat flour in biscuit and muffin formulations at different levels (0, 10, 20 and 30%). The effects of YCP incorporation on proximate compositions, physical characteristics, texture profile and sensory evaluation of both bakery products were investigated. The present results showed that YCP had significantly increased protein and total dietary fibre contents of both biscuit and muffin. Hardness attribute of both products increased in line with the level of YCP addition. Interestingly, biscuit and muffin containing 10% YCP received better score than the control and other formulations for most of the sensorial attributes judged. In conclusion, YCP can be potentially be used as an alternative functional ingredient for partial replacement of wheat flour in formulating biscuit and muffin because of its ability to improve the nutritional quality without jeopardizing sensorial palatability.

Keywords: Biscuit; muffin; nutritional composition; sensory evaluation; young corn powder

ABSTRAK

Pelbagai jenis ramuan yang kaya serat secara semula jadi ditambah ke dalam produk makanan berasaskan bakeri untuk meningkatkan kandungan serat dan untuk tujuan promosi kesihatan. Walau bagaimanapun, kebanyakan produk makanan ini kerap kali ditambah dengan sumber ramuan serat yang diimport. Tujuan kajian ini dijalankan adalah untuk membangunkan produk bakeri dengan menambah serbuk jagung muda (YCP) dan menilai kesannya ke atas sifat fizikokimia dan penerimaan sensori. Jagung muda segar dikeringkan, disediakan sebagai serbuk dan digunakan pada tahap yang berbeza (0, 10, 20 dan 30%) sebagai menggantikan tepung gandum dalam formulasi biskut dan mufin. Kesan penambahan YCP ke atas komposisi proksimat, sifat fizikal, profil tekstur dan penilaian sensori telah dikaji. Keputusan kajian mendapati kandungan protein dan jumlah serat dietari bertambah secara ketara. Kedua-dua produk didapati bertambah keras apabila lebih banyak YCP dimasukkan. Biskut dan mufin berformulasi 10% memperoleh skor yang lebih baik berbanding kawalan dan formulasi lain yang lebih tinggi kandungan YCP. Kesimpulannya, penambahan YCP didapati sesuai untuk proses pembuatan produk bakeri dan penggayaan nutrien disebabkan potensinya untuk digunakan sebagai pengganti separa kepada tepung gandum serta sebagai ramuan terfungsi dalam formulasi biskut dan mufin kerana keupayaannya untuk menambah baik kandungan nutrisi tanpa menjejaskan kesedapan.

Kata kunci: Biskut; komposisi pemakanan; mufin; penilaian deria; serbuk jagung muda

INTRODUCTION

Bakery products include biscuit, muffin, cake, bread, pastries and pies. They contain significant amount of flours which are mixed with various other ingredients and ultimately undergo dry-heating process in a baking oven (Cauvain & Young 2007). In Malaysia, consumption of baked products, particularly biscuit and bread, appeared in the list of top ten daily consumed foods based on the Malaysian Adult Nutrition Survey (Norimah et al. 2008). Possible reasons for such wide popularity are broad range of choices, easily available and convenient to be enjoyed as snack. However, majority of bakery products are high in carbohydrate, fat and calorie, but low in fibre content (Mishra & Chandra 2012). These attributes have set them as unhealthy choices for daily consumption. Therefore, manipulating the ingredients used in bakery products with potentially nutritive ingredients would be beneficial to improve the nutritional quality of the baked products. Other than that, the use of wheat flour as one of the major ingredients in bakery products is quite challenging because wheat is imported since Malaysia never produce its own. Increasing demand for wheat-based products will definitely increase importation of wheat flour. For that reason, searching other local source of alternative ingredient to partially substitute wheat flour in bakery products would also give many advantages as to reduce dependent on wheat while at the same time could significantly save foreign exchange.

Young corn is the finger-length ear of corn (*Zea mays*) which appears yellow in colour. It is a unique product of corn since the harvested part is the immature female inflorescence rather than the mature plant or ear (Hallauer 2001). Young corn is usually hand-picked prior to fertilization and before or just after the emergence of the silk. It is frequently consumed in Asia. In many cuisines, the dehusked and desilked young corn is often enjoyed as vegetable, probably due to its crispiness and sweet, juicy and delicious taste. In spite of being freshly consumed on most occasions, young corn is also available as frozen or canned, particularly for export purposes. Nutrient in young corn is comparable with other vegetables like cauliflower, cabbage, tomato, eggplant and cucumber (Anitha & Rajyalakshmi 2005; Yodpet 1979). Other than being nutritious, it is also free from pesticides because the cob is tightly protected in its husk (Chutkaew & Paroda 1994). In Malaysia, young corn cultivation is one of the prominent activities by local farmers which occupied 6390 ha of farming area. Its annual yield in year 2010 is around 36420 metric t or MYR118 million in value (Anonymous 2011). Yet, young corn is highly perishable and freezing technique is usually applied to extend the shelf-life and minimize wastage especially during glut season (Hooda & Kawatra 2011). Besides that, drying may also be considered to stabilize perishable products. By reducing moisture content to a suitable level, undesirable biochemical reaction that lead to microbial spoilage and quality deterioration can be prevented (Uchoa et al. 2009). Thus, young corn may also be processed into powder form and potentially be used as composite flour in various food products.

There was scanty of research and innovation being ventured locally especially in utilizing available high-fibre edible raw material to replace wheat flour and oat. In addition, there was also no effort has been done on the utilization of nutritious young corn into processed foods specifically in bakery-based products. Therefore, the purpose of the present study was to develop biscuit and muffin incorporated with young corn powder and to evaluate the effects on physicochemical properties and sensory acceptance.

Materials and Methods

Young Corn Collection and Preparation

Young corn samples were collected from Pasir Mas, Kelantan, Malaysia. The young cob was separated from silk and husk. Then, they were chopped and dried in oven (Memmert GmbH & Co. KG, Germany) at 55°C for two days. The dried samples were later ground using electric grinder (National MX-895M) to obtain fine young corn powder. Young corn powder (YCP) were kept in screw cap bottle (Scott Duran) and stored at 4°C for further analyses.

Biscuit Formulation and Preparation

Four formulations of young corn biscuit were prepared. Each formulation varied by ratio of wheat flour to YCP (Table 1). Basic formulation comprised 100 g sifted wheat flour, 21 g cornflour, 37 g sugar, 46 g fat, 31 g egg and 1 g baking powder. Fat and sugar were mixed until creamy using hand mixer (Khind HM200). Then, egg was added and mixing was continued for another 2 min. Next, wheat flour, cornflour, baking powder and YCP were put into the mixture of fat, sugar and egg. They were uniformly mixed to obtain a consistent dough. The dough was rolled out to a height of 5 mm and cut into square shape 2.5 × 2.5 cm using biscuit cutter. The biscuits were baked at 160°C in oven (Zanussi ZCG841W) for 20±3 min.

Muffin Formulation and Preparation

In the present study, four different formulations of muffin were prepared. One formulation was prepared without YCP (control) and another three were formulated with YCP at different levels as shown in Table 2. The proportion of ingredients were based on (Sanz et al. 2009) with some modifications. They were divided into dry and wet ingredients. The dry ingredients included wheat flour, baking powder, sugar and YCP. The wet ingredients were egg, milk and oil. The egg was beaten for 2 min prior to addition of milk and oil. In a separate bowl, all dry ingredients were thoroughly mixed. Later, both dry and wet ingredients were combined to obtain mixed muffin batter. Thirty g of batter were filled in each 45 mm diameter paper muffin cup. The muffins were baked at 215°C in oven (Zanussi ZCG841W) for 15±3 min.

TABLE 1. Formulation of young corn powder (YCP) biscuit

Ingredients (g)	Formulation (WF:YCP)			
	100:0	90:10	80:20	70:30
Wheat flour	100	90	80	70
YCP	0	10	20	30
Cornflour	21	21	21	21
Butter	46	46	46	46
Sugar	37	37	37	37
Egg	31	31	31	31
Baking powder	1	1	1	1

TABLE 2. Formulation of young corn powder (YCP) muffin

Ingredients (g)	Formulation (WF:YCP)			
	100:0	90:10	80:20	70:30
Wheat flour	100	90	80	70
YCP	0	10	20	30
Egg	79	79	79	79
Milk	56	56	56	56
Baking powder	5	5	5	5
Oil	57	57	57	57
Sugar	81	81	81	81

PROXIMATE ANALYSES

Determination of moisture, protein, ash and fat were according to (AOAC 1996). Content of moisture was determined by air-oven method, protein by Kjeldahl method and crude fat by Soxhlet method. Total carbohydrate content was calculated by the difference (Southgate 1991). Calorific values were determined by using IKA Calorimeter System, C200 Basic (IKA Werke GmbH & Co. KG, Staufen, Germany). Total dietary fibre (TDF) was analysed by following enzymatic gravimetric method (AOAC 985.29).

PHYSICAL EVALUATION OF BISCUIT

Measurements of physical characteristics (Saha et al. 2011; Tiwari et al. 2011) were carried out. Five pieces of biscuits from each formulation were weighed simultaneously and the average weight (W) of each piece was noted. They were then placed edge-to-edge and stacked one above the other to measure the diameter (D) and thickness (T), respectively. The biscuits were rearranged and restacked and the average of the measurements was taken. The spread ratio and density of biscuits were derived from weight, diameter and thickness measurements. Spread ratio is equal to D/T. Density was calculated by W/D^2 and expressed as kg/m^2. By following a common technique known as the three-point break (Gaines 1991), breaking strength and fracturability of biscuits were measured. The TX.XTPlus Texture Analyser (Stable Micro Systems Ltd., Surrey, UK) were used to conduct the test. Several established conditions were applied: test mode: compression, pre-test speed: 1 mm/s; test speed: 3 mm/s; target mode: distance; distance: 5 mm and trigger force: 50 g. The peak force (kg) and mean distance at point break (mm) were noted.

TEXTURE PROFILE ANALYSIS OF MUFFIN

Instrumental analysis of muffin textural properties was performed to record hardness, springiness, cohesiveness, resilience and chewiness (Baixauli et al. 2008; Sanz et al. 2009). The test was conducted using TX.XTPlus Texture Analyser (Stable Micro Systems Ltd., Surrey, UK). The soft inner portion of muffin was evaluated. Each muffin was cut into 2.5 cm sided cube, where the upper and lower crusts were eliminated. A 75 mm diameter aluminium plate (P/75) was used for compression. The test was performed under the following states: Test speed: 1 mm/s; strain: 50% and trigger force: 5 g. Muffin cube was compressed twice to obtain the four primary texture parameters (hardness, springiness, cohesiveness and resilience). Chewiness, the only secondary texture parameter, was calculated as the product of hardness × cohesiveness × springiness (Pons & Fiszman 1996).

SENSORY EVALUATION

Sensory evaluation session was conducted based on 7-point hedonic scale (Aminah 2000) where higher score indicates better quality attributes (1, dislike very much and 7, like very much). Sensory attributes such as colour, aroma, appearance, crispiness and flavour of biscuit were evaluated. Meanwhile, for muffin, evaluation was made for the following attributes: Appearance, texture, taste and flavour (Sanz et al. 2009). Each attribute was independently judged by 60 untrained panels based on their likeness. Four samples of each product were served to every panel. Each sample was presented with three-digit code. Random permutation principle was followed to determine serving order.

STATISTICAL ANALYSIS

The results were analyzed using IBM SPSS Statistics Version 19. Data were presented as mean values of three replicates ± standard deviation (SD) which were subjected to one-way ANOVA. For comparison of means, Tukey HSD was used and significant difference was determined at $p<0.05$.

RESULTS AND DISCUSSION

PROXIMATE COMPOSITION

The proximate composition results for YCP were 5.73% moisture, 1.28% fat, 21.17% protein, 7.60% ash, 64.22% carbohydrate and 38.73% total dietary fibre (TDF). Fresh young corn contained between 88 and 90% moisture (Anitha & Rajyalakshmi 2005; Hooda & Kawatra 2011; Yodpet 1979). Drying seems to reduce moisture content by approximately 93% of total moisture presented in fresh young corn. Fresh vegetables are prone to spoilage mainly due to high moisture content (Gore & Mangels 1921). Hence, since significant amount of moisture has been removed, YCP may possibly be kept longer than fresh young corn.

In biscuit incorporated with YCP, moisture content ranged between 2.09 and 2.89%. It was established that biscuit should have a low moisture content of 1-5%, excluding any moisture from fillings or icing (Baking Industry Research Trust 2010). There were significant differences in moisture contents of YCP biscuits (Table 3). As concentration of YCP increases and wheat flour decreases, moisture contents notably reduced since wheat flour contains slightly more moisture content (9.00%) than YCP (5.73%). On the other hand, YCP muffins were found significantly moisture compared with control (Table 3). Moisture contents of YCP muffins were recorded between 28.15 and 30.44% while control had 25.23%. Similar finding related to increasing moisture content was also reported in peach dietary fibre muffin (Grigelmo-Miguel et al. 1999). Moisture loss during baking could have been prevented by sucrose. YCP contains 5.40% sucrose, as reported in previous work (Wan Rosli & Che Anis 2012). One of the main constituent in our muffin formulations is sucrose which is estimated around 21 to 22%, suspected to be mainly contributed by the use of castor sugar and also YCP. Therefore, in muffin with more YCP concentration, moisture is higher due to greater sucrose content.

Mean protein content of YCP biscuit and muffin significantly differed from control, where the values were increased from 6.77 to 9.94% and 6.73 to 7.93%, respectively and in line with the level of YCP used. Statistically significant increment in protein content was noted with increase concentration of YCP used to partially replace the wheat flour (Table 3). This might be explained by richer protein content in YCP (21.17%) compared with wheat flour. As declared on the nutritional label, commercial wheat flour used in the present study contains 9.00% protein. Protein difference between YCP and wheat flour is about 12.00%. Typically, all-purpose wheat flour contains 9.50 to 11.50% protein (Figoni 2011). In accordance with other study, crude protein in biscuits were higher with incorporation of pigeon pea dehulled flour (Tiwari et al. 2011) and defatted soy flour (Aleem Zaker et al. 2012). In muffin, contrary result for protein content was found when mango pulp flour (Yee & Noraziah 2009) was supplemented.

Wheat flour substitution with YCP had significantly decreased fat content of the biscuit, ranging between 20.69 and 21.01%. In agreement with other study, fat percentage in sorghum biscuit fortified with soy was 20.5 (Serrem et al. 2011). The values were slightly high as fat content in biscuit usually ranges between 5 and 20% (Hodge 1986). Fat in bakery products provide tenderness. In our biscuit formulation, butter made up 19% of total ingredients. Higher fat contents found in final product could be attributed to the fact that other ingredients such as egg, wheat flour, cornflour and YCP also has minor contribution to fat content. Meanwhile, fat content in muffin also decreased with larger addition of YCP, but statistically significant difference was only noted between control and 70:30 formulation. YCP muffin fat content between 12.12 and 13.43% was lower than mango pulp muffin (14.95-16.33%) (Yee & Noraziah 2009) but higher than apple skin muffin (10.23-11.10%) (Vasantha Rupasinghe et al. 2008). In both biscuit and muffin, total ash increase significantly with higher addition of YCP (Table 3). Ash refers to inorganic residue that left following removal of water and organic matter by heat in the presence of oxidizing agents (McClements 2003). Therefore, content of ash will reflect total amount of minerals; the inorganic components in food. Hence, from nutritional point of view, YCP has the ability to improve mineral contents of bakery products.

There were significant differences in total dietary fibre (TDF) content of all YCP-based products. The TDF were also increased proportionally with the level of YCP incorporation (Table 3). The TDF content increased from 0.74 to 7.26% in biscuit and 2.39 to 7.86% in muffin. This finding could be attributed to natural dietary fibre content contributed by YCP (38.73 g/100 g). Moreover, refined wheat flour is occasionally used during baking. Dietary fibre is actually highly found in wheat bran, while refined wheat flour undergoes milling process which eliminates the bran, thus leads to loss of considerable amount of dietary fibre. Hence, this result denotes that YCP could be considered as an alternative food ingredient to increase TDF content of biscuit and other bakery products. Yet, in this study, the increase in TDF of bakery products was still less than the dietary fibre contributed by YCP. This might be due to effects of heating during baking (Chang & Morris 1990).

PHYSICAL PROPERTIES

The physical properties of biscuit has changed upon addition of YCP (Table 4). There were no statistically significant differences between diameters of biscuit with YCP and biscuit without YCP. Mean thickness of control biscuit significantly differed with 70:30 biscuit, in which the control was thicker (5.63 mm) compared with 70:30 biscuit (4.97 mm). Spread ratio was calculated by dividing diameter over thickness. Thus, thicker biscuit will have lower spread ratio than thinner biscuit, provided that the diameters of both biscuits are not significantly different. Influence of YCP addition on spread ratio of biscuit was significant only at 30% level of incorporation. Spread ratio value of 70:30 biscuit was 5.13 while control was 4.61. Cookies with higher value of spread ratio are more desirable (Eissa et al. 2007; Hussein et al. 2011; Kissel & Prentice 1979). On the other result, there were no significant differences between YCP biscuits and control biscuit in terms of breaking strength and fracturability attributes. However, it was noted that breaking strength increases with the higher levels of YCP addition. Breaking strength measures the maximum force applied by the instrument to snap the biscuit into two pieces, thereby indicates the hardness of the biscuit. Hence, higher value indicates that the biscuit is harder. Meanwhile, fracturability is the measurement of biscuit resistance to bending. Distance at which the biscuit breaks was noted as fracturability. Biscuit that breaks at shorter distance has higher fracturability.

TABLE 3. The effect of partial replacement of wheat flour with YCP on proximate composition of bakery products (%)

WF:YCP	Moisture	Protein	Fat	Ash	Total carbohydrate	TDF	Energy (kcal/100 g)
Biscuit							
100:0	$3.35^{a} \pm 0.02$	$6.77^{c} \pm 0.21$	$21.40^{a} \pm 0.12$	$0.80^{d} \pm 0.06$	$67.68^{a} \pm 0.42$	$0.74^{d} \pm 0.07$	$508.93^{c} \pm 1.10$
90:10	$2.89^{b} \pm 0.06$	$7.59^{b} \pm 0.18$	$21.01^{b} \pm 0.24$	$1.06^{c} \pm 0.03$	$67.46^{a} \pm 0.51$	$3.07^{c} \pm 0.18$	$511.70^{b} \pm 1.00$
80:20	$2.21^{c} \pm 0.12$	$8.14^{b} \pm 0.03$	$20.81^{b} \pm 0.08$	$1.32^{b} \pm 0.03$	$67.52^{a} \pm 0.26$	$5.11^{b} \pm 0.03$	$512.67^{b} \pm 0.85$
70:30	$2.09^{c} \pm 0.07$	$9.94^{a} \pm 0.16$	$20.69^{b} \pm 0.06$	$1.78^{a} \pm 0.08$	$65.50^{b} \pm 0.37$	$7.26^{a} \pm 0.07$	$514.83^{a} \pm 0.32$
Muffin							
100:0	$25.23^{f} \pm 0.40$	$6.73^{g} \pm 0.12$	$13.43^{c} \pm 0.22$	$1.22^{g} \pm 0.06$	$53.39^{c} \pm 0.80$	$2.39^{h} \pm 0.22$	$406.48^{e} \pm 4.99$
90:10	$28.15^{e} \pm 0.16$	$7.25^{f} \pm 0.18$	$13.34^{c} \pm 0.16$	$1.34^{fg} \pm 0.13$	$49.92^{c} \pm 0.63$	$4.08^{g} \pm 0.18$	$421.48^{d} \pm 8.64$
80:20	$30.12^{d} \pm 0.40$	$7.71^{e} \pm 0.07$	$12.75^{cd} \pm 0.12$	$1.44^{ef} \pm 0.04$	$47.98^{c} \pm 0.63$	$6.01^{f} \pm 0.33$	$422.76^{d} \pm 4.01$
70:30	$30.44^{d} \pm 0.31$	$7.93^{d} \pm 0.06$	$12.12^{d} \pm 0.85$	$1.56^{e} \pm 0.01$	$47.95^{d} \pm 1.23$	$7.86^{e} \pm 0.32$	$424.84^{d} \pm 4.62$

Values are mean ± standard deviations
Mean in the same column with different letter differ significantly ($p<0.05$)
a-c = for biscuits; d-h = for muffin

TABLE 4. Effect of YCP on physical characteristics of biscuit

WF:YCP	Diameter (D) (mm)	Thickness (T) (mm)	Weight (g)	Spread ratio (D/T)	Density (kg/m^3)	Breaking strength (kg)	Fracturability (mm)
100:0	$25.94^{a} \pm 0.28$	$5.63^{a} \pm 0.18$	$2.86^{a} \pm 0.12$	$4.61^{b} \pm 0.10$	$754.86^{b} \pm 8.75$	$0.89^{a} \pm 0.27$	$0.28^{a} \pm 0.08$
90:10	$25.31^{a} \pm 0.38$	$5.51^{a} \pm 0.16$	$2.81^{ab} \pm 0.15$	$4.59^{b} \pm 0.06$	$795.70^{a} \pm 4.50$	$1.31^{a} \pm 0.52$	$0.32^{a} \pm 0.11$
80:20	$25.49^{a} \pm 0.28$	$5.63^{a} \pm 0.08$	$2.80^{ab} \pm 0.10$	$4.53^{b} \pm 0.01$	$765.23^{ab} \pm 0.40$	$1.40^{a} \pm 0.43$	$0.31^{a} \pm 0.08$
70:30	$25.49^{a} \pm 0.20$	$4.97^{b} \pm 0.14$	$2.57^{b} \pm 0.02$	$5.13^{a} \pm 0.10$	$796.43^{a} \pm 28.74$	$1.79^{a} \pm 0.30$	$0.32^{a} \pm 0.06$

Values are mean ± standard deviations
Mean in the same column with different letter differ significantly ($p<0.05$)

The incorporation of YCP increased hardness attribute of muffin (Figure 1). Nevertheless, significant difference was only observed at 30% YCP incorporation. Reduce in fat content may possibly cause the increase in hardness. In other study, replacement of wheat flour by peach dietary fibre in muffin has increased hardness due to increase in density and reduce number of air pockets (Grigelmo-Miguel et al. 1999). Springiness and resilience were found to worsen by gradually decreasing with higher level of YCP incorporation. Muffin with 70:30 formulation had lower springiness, which significantly differed from control. Meanwhile, springiness of 90:10 and 80:20 muffins did not differ significantly from control. Decrease in springiness has been related to reduce number of muffin air bubbles and the presence of a denser matrix (Sanz et al. 2009). Springiness is a vital quality characteristic of muffin which indicates the ability of the sample to recover its height during the time that elapses before the end of the first compression and the start of the second. Difference in resilience values between control and YCP muffins were significant. Resilience depicts the ability of the product to recover after deformation and decrease in resilience upon supplementation of YCP may be due to denser matrix of the product (Baixauli et al. 2008). Cohesiveness measures the sensory crumbliness and perceptions related to denseness of muffin as well as the energy needed to chew the food piece (Sanz et al. 2009). YCP muffins were significantly less cohesive than control, which indicates that the former is better than the latter. Based on our observation, muffins with higher concentration of YCP crumbled easier during handling. Chewiness of muffin was not substantially affected by YCP. Even though YCP has reduced the quality of some textural attributes of muffin, the alterations are highly acceptable as evidenced by sensorial evaluation score for texture attribute, 5.00±1.37 for 90:10 formulation compared with 3.82±1.74 for control formulation.

SENSORIAL ATTRIBUTES

The statistical results showed that sensorial attributes scores of biscuit and muffin at 10% YCP incorporation were significantly better than controls (Figures 2 & 3). Overall acceptance score of biscuit and muffin formulations at 90:10 ratio of wheat flour to YCP had the highest hedonic score (5.27±1.02 and 5.12±1.22, respectively) among all formulations. Control muffin scored significantly less (4.13±1.44) than muffin supplemented with YCP (4.97±1.19) in term of flavour. YCP incorporation at 90:10 had also improves the flavour acceptance score of biscuit, 5.28±1.18 compared with 4.92±1.34 of control biscuit. Appearance score of biscuit and muffin at 90:10 did not differ significantly from control. This finding was in agreement with other study, where the researchers found that sensory acceptance of young corn products, i.e. several Indian snack foods and savouries, sweet products and pickles were higher than control (Anitha & Rajyalakshmi 2005). On the contrary, biscuit formulations of 80:20 and 70:30 ratio of wheat flour to YCP has lower scores for most attributes compared with control and 90:10 formulations. Concurrently, other study on muffin blended with corn by-products had also reported that 10% blending level was highly acceptable, yet significant decrease in score was noted for higher percentage of blending level (Sharma et al. 2012).

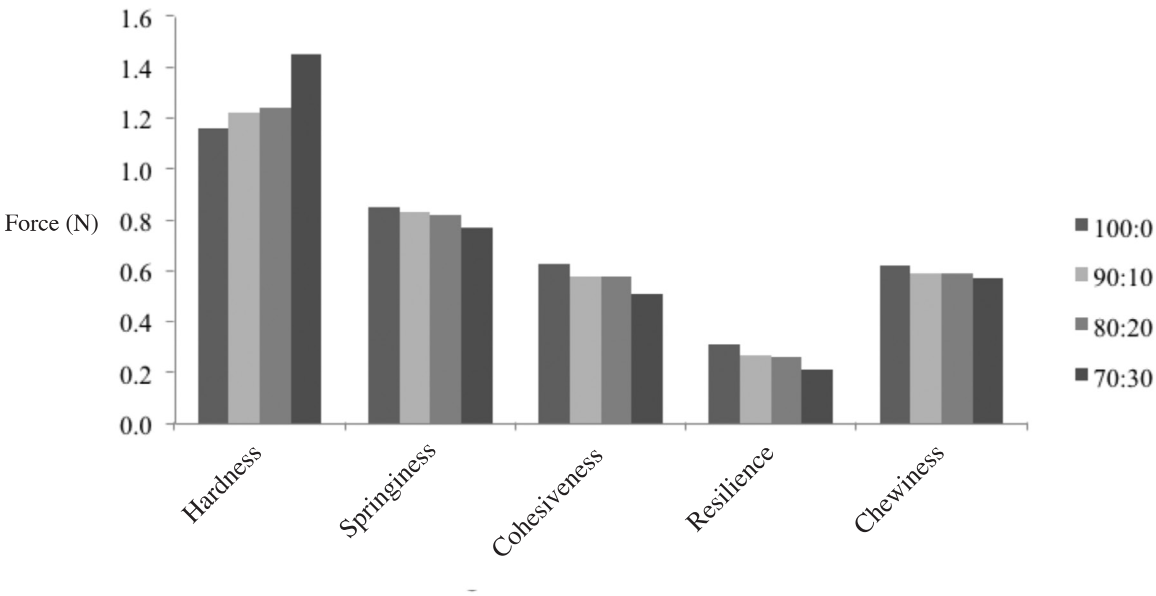

FIGURE 1. Effect of YCP in instrumental hardness, springiness, cohesiveness, resilience and chewiness

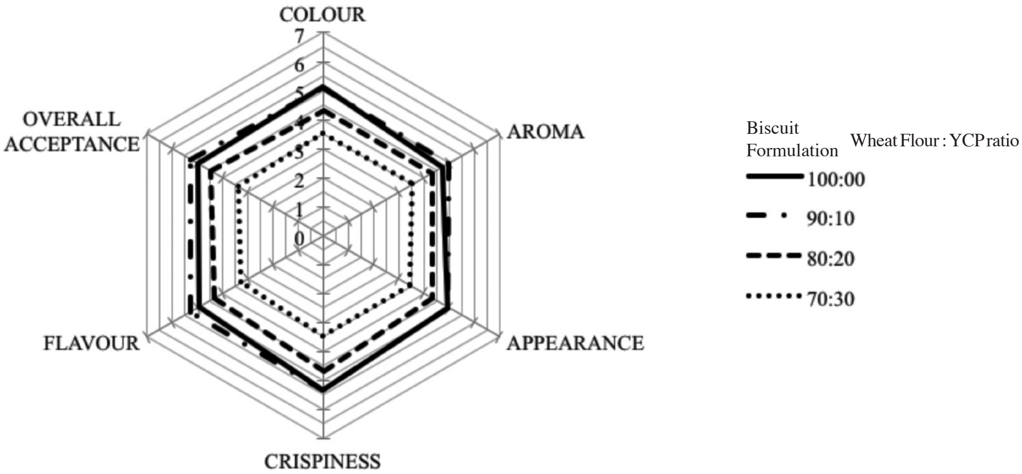

FIGURE 2. Sensory acceptance (maximum score of 7) of YCP incorporated biscuit (score 1=dislike very much, 7=like very much)

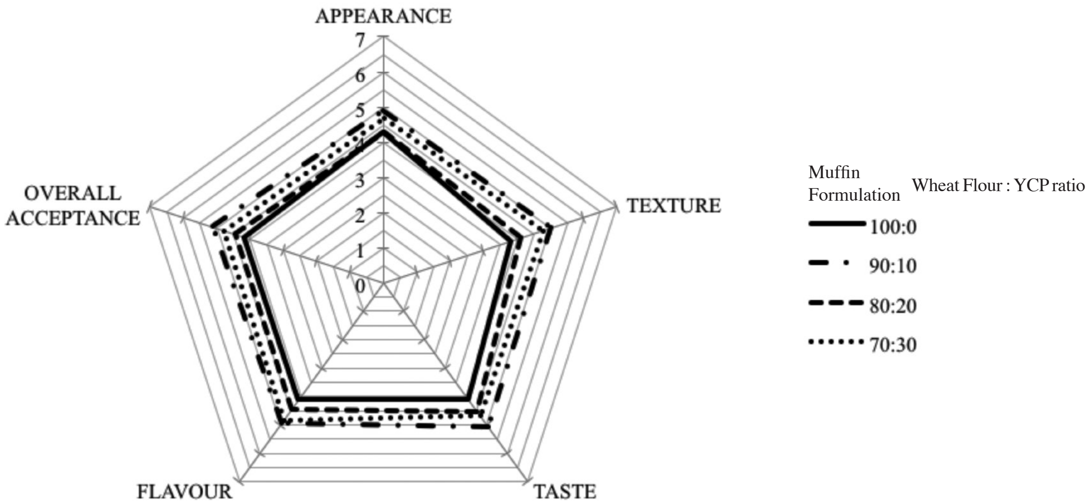

FIGURE 3. Sensory acceptance (maximum score of 7) of YCP incorporated muffin (score 1=dislike very much, 7=like very much)

CONCLUSION

This study showed that protein and dietary fibre contents significantly increased as more YCP was incorporated. The results also suggested that YCP is potentially added into carbohydrate-based foods such as biscuit and muffin due to its higher acceptance score. The sensorial attributes of biscuit and muffin with YCP substitution at 10 g/100 g in relation to wheat flour content were more preferred than controls even though YCP slightly increased the hardness of biscuit and muffin and decreased the springiness and resilience muffin. Thus, the supplementation of YCP in baked products formulation is suitable for baking process and enrichment, since it is possibly be used as partial ingredient for substitution of wheat flour as well as being a functional ingredient in formulated bakery products because of its ability to improve the nutritional quality without ignoring the palatability.

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