

*Research Article*

**Physicochemical properties and acceptance of high fibre bread incorporated with corn cob flour**

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**Abstract**

Currently, people look for convenient and healthy food to cope with their hectic lifestyles. Therefore, food, especially that with high fibre becomes one of their priorities. Corn cob is a major waste (40%) obtained from the corn industry. Hence, this study was performed to optimize the usage of corn cob in developing high fibre bread by combining it with whole meal flour. This study was conducted to determine the physicochemical properties and sensory acceptance of high fibre bread incorporated with corn cob flour at four different corn cob flour percentages, which were 0 (control), 5, 10 and 15%. Chemical composition (moisture, ash, protein, fat, fibre and carbohydrate) and physical properties (volume, firmness and colour) were determined for all bread formulations. Sensory acceptance was evaluated based on attributes i.e. colour, aroma, cell uniformity, firmness, taste and overall acceptance. An increase of corn cob flour incorporation in high fibre bread formulations significantly increased the fibre content and decreased the protein content of the bread ( $p < 0.05$ ). However, it did not have an impact on the other chemical compositions such as moisture, ash, fat and carbohydrate content. The increment of corn cob flour incorporation significantly reduced bread volume and increased bread firmness ( $p < 0.05$ ). In addition, an increase in top crust bread colour, including lightness and yellowness, were observed with increased percentages of corn cob flour incorporation. Sensory evaluation indicated that high fibre bread with 5% corn cob flour incorporation was the most accepted by panels as it did not show significant differences ( $p > 0.05$ ) for most of the attributes (except colour) as compared to the high fibre bread with 100% whole meal flour. Overall, this study showed that incorporation of corn cob flour in producing high fibre bread is applicable. However, further studies have to be carried out regarding bread formulation in order to increase the portion of corn cob flour in high fibre bread development with acceptable final product quality.

**Keywords:** nutrition, chemical composition, waste, sensory, Malaysia.

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## Introduction

Recently, health authorities all around the world have recommended an increase in cereal intake, which is an important source of dietary fibre [1]. This is because dietary fibre intake has been associated with reduced risk for colon cancer and a number of cardiovascular diseases including hypertension, stroke, as well as heart disease [2]. It also provides consumers with a sense of satiety and fullness. To meet the requirement for dietary fibre, the development of enriched bread with a higher dietary fibre content will be another alternative to increase the fibre intake [1]. High fibre bread has become a healthy diet trend nowadays and some of the widely available high fibre bread in the market are whole meal bread and multi-grain bread.

When corn reaches maturity, the edible part for consumption is only around 60% and approximately 40% of the corn cob has become waste. Normally, corn cob is used in soup cooking for its sweetness properties. Many studies had been carried out on the usage of corncob in producing corncob pipe and as a biomass fuel source [3]. However, few reports are available on the usage of corn cob in food production. As a result, it will contribute to a major loss in food industries without considering the valuable fibre that is readily available in corn cob. Therefore, it is a good idea to impart corn cob in the production of high fibre bread. Hence, besides whole meal bread, this will eventually add another variety of high fibre food source for consumers and can also produce a value added product obtained from corn cob.

## Materials and Methods

Ingredients for the development of high fibre bread such as whole meal flour, bread flour, instant yeast, sugar, salt, shortening, non-fat milk powder and bread improver were obtained from a local market at Kuala Terengganu.

### *Corn cob flour preparation*

Corn cob flour was prepared using a modification of breadfruit flour procedures [4]. The corn cobs were cut into 2 cm thick pieces and underwent steam blanching for 5 minutes. Next, the corn cobs were dried in oven at 60°C for 15 hours. The dried corn cobs were then cooled at room temperature for one hour. After cooling, the corn cobs were ground using Warring blender. The ground corn cobs were then sieved at different sizes of < 125 µm, 125 - 249 µm, 250 - 499 µm and 500 - 999 µm by using sieve shaker. The milling and sieving process were then repeated until the required amounts of respective flour sizes were obtained.

### *High fibre bread production*

High fibre bread was prepared using straight dough methods [5], with slight modifications. In producing corn cob bread, the amount of whole meal flour was modified where it was mixed with corn cob flour at three different formulations i.e. 5%, 10% and 15%. To reduce the particle size error between corn cob flour and original source of fibre, which was the whole meal flour, a preliminary study was carried out which aimed to determine the portion of different particle sizes of whole meal flour (data not shown). Hence for the actual formulations of high fibre bread, different portions of corn cob flour with different particles sizes were applied.

An oven was preheated to 220°C and all the ingredients were weighed. Whole meal flour, bread flour, corn cob flour, yeast, sugar and salt were added and mixed with a mixer. Shortening was then added after 5 minutes and kneading continued for 5 minutes. The dough was allowed to ferment for 40 minutes. Next, the dough was pounded, kneaded and let rest for 10 minutes. The dough was placed in a greased pan and baked at 180°C for 25 minutes. The loaves were taken out of the tins and cooled at ambient temperature for 2 hours prior to physical and proximate analysis.

### ***Chemical analysis***

Chemical analysis including determination of moisture, ash, crude protein, crude fat, fibre and carbohydrate content were determined by using AOAC methods [6]. Moisture content was determined by oven drying for 6 hours at 105°C, ash content was determined by dry combustion method, protein content was determined using Kjeldahl method, fat content was determined by Soxhlet method and fibre content was determined by Fibertec<sup>®</sup>2021 FiberCap<sup>™</sup> System. Carbohydrate content was determined by deducting all values with 100%. All samples measurements were carried out in triplicate.

### ***Physical analysis***

Firmness of high fibre bread was determined using texture analyzer (TA.XTPlus, Stable Micro System Ltd, UK) with a P36/R probe and 5kg load cell. The bread was sliced in 25 mm thickness and the firmness value was measured after two hours cooling at room temperature. Colour properties evaluation of the top crust including lightness (L\*), redness (a\*) and yellowness (b\*) were determined using Minolta Colorimeter. Three readings were taken for each slice of bread. The volume of high fibre bread was determined using rapeseed displacement method [7]. All physical analyses was carried out after the high fibre bread had gone through cooling at room temperature and all measurements were carried out in triplicate.

### ***Sensory analysis***

The acceptability of high fibre bread with four (4) formulations was evaluated using Sensory Affective Test. The bread was cut into 2x3x4 cm sizes using a bread knife and served to the panellists without carrier. The evaluation was carried out by 30 untrained panellists consisting of the students and staff of Universiti Malaysia Terengganu. A 7-point hedonic rating scale ranging from 1 (dislike very much) to 7 (like very much) were applied for rating based on six sample attributes such as crust colour, aroma, cell uniformity, firmness, taste and overall acceptance.

### ***Statistical analysis***

All analyses except for sensory evaluation were carried out in triplicates. The data for chemical and physical analysis were subjected to one way analysis of variance (ANOVA). Duncan Multiple Range Test (DMRT) was used to determine the data with significant difference between high fibre bread formulations. For sensory evaluation, test of normality was carried out. ANOVA and Kruskal Wallis analysis was used for the data that was normally and not normally distributed, respectively. All tests were conducted at 5% significance level and were carried out using SPSS (Version 17.0) statistical software package.

## **Results and Discussion**

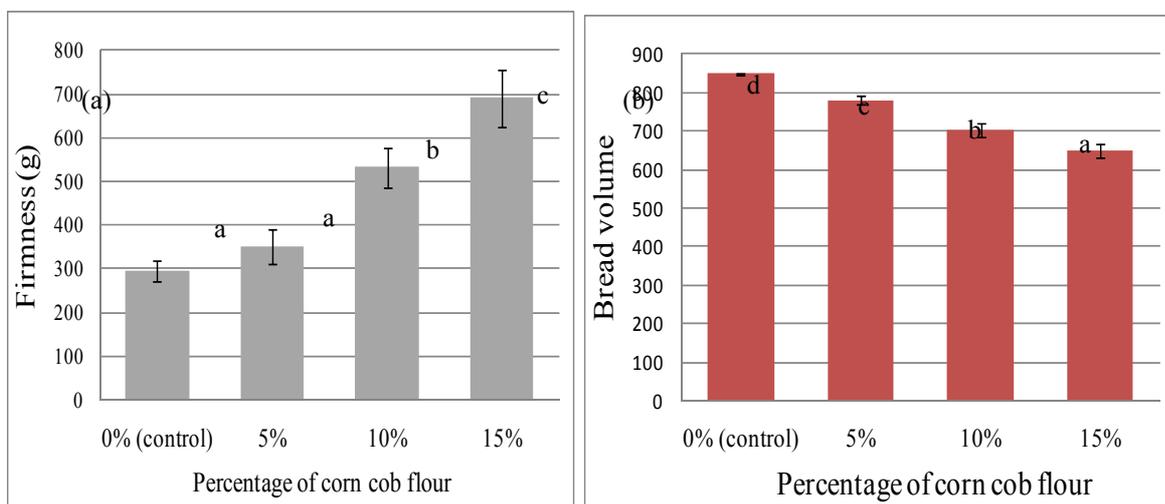
The values for chemical analysis including the determination of moisture, ash, protein, fat, fibre and carbohydrate content are shown in Table 1. Different percentages of corn cob flour incorporation have no impact ( $p \geq 0.05$ ) on most of the chemical compositions of high fibre bread as compared to whole meal bread (control), except for protein and crude fibre composition (Table 1). Results showed that protein content decreased with the increase of corn cob flour incorporation. However, the significance value was only shown between the control (0%) and high fibre bread with 10 and 15% corn cob flour incorporation ( $p \leq 0.05$ ). Corn cob flour is known to have low protein content (2.5%) [8] as compared to whole meal flour (12.7%) [9]. Hence, incorporation of corn cob flour in high fibre bread resulted in the reduction of protein content due to the declining amount of whole meal flour in the formulation. Table 1 also shows that the incorporation of corn cob flour in all formulations significantly increased the crude fibre content of the final product. It was reported that corn cob flour contained higher fibre composition (32%) [8] as compared to whole meal flour (1.8%) [9]. In addition, corn cob contained high insoluble dietary fibre which includes cellulose (40%), hemicelluloses (41.4%) and lignin (5.8%) [10].

**Table 1. Chemical composition of high fibre bread with different percentages of corn cob flour incorporation.**

Composition (%) % corn cob flour	Moisture	Carbohydrate	Fat	Protein	Crude fibre	Ash
0	42.19±1.6 <sup>a</sup>	40.21±1.8 <sup>a</sup>	2.63±0.3 <sup>a</sup>	11.43±0.8 <sup>b</sup>	1.66±0.3 <sup>a</sup>	1.87±0.5 <sup>a</sup>
5	43.68±1.4 <sup>a</sup>	38.56±1.7 <sup>a</sup>	2.51±0.4 <sup>a</sup>	10.48±0.9 <sup>ab</sup>	2.96±0.3 <sup>b</sup>	1.80±0.4 <sup>a</sup>
10	44.11±0.4 <sup>a</sup>	38.12±1.1 <sup>a</sup>	2.39±0.3 <sup>a</sup>	10.07±0.8 <sup>a</sup>	3.54±0.2 <sup>c</sup>	1.76±0.2 <sup>a</sup>
15	44.19±1.3 <sup>a</sup>	38.20±1.4 <sup>a</sup>	2.17±0.3 <sup>a</sup>	9.58±0.6 <sup>a</sup>	3.96±0.2 <sup>d</sup>	1.90±0.5 <sup>a</sup>

(<sup>a-d</sup> different letters within column show significant differences at  $p \leq 0.05$ )

For the textural study, an opposite relationship is shown between firmness value (Figure 1a) and volume (Figure 1b) of high fibre bread with different levels of corn cob flour incorporation. Incorporation of more than 5% corn cob flour significantly increased the firmness of high fibre bread ( $p \leq 0.05$ ). On the other hand, the bread volume was significantly reduced with further increase of corn cob flour incorporation. According to Wang and others [1], corn cob flour, as a weak flour with low protein content [8] is lacking in gluten, which limits its application in yeast-leavened products, such as bread. Gluten plays an important role in inhibiting the carbon dioxide produced by the yeast during fermentation process from escaping from the bread dough [5]. Besides that, weak flour reduced the bread making potential of the mixture, which resulted in difficulties in dough handling, lower loaf volume and a decrease in bread softness [8]. In this study, the presence of corn cob flour might have distorted the gas cell structure, resulting in a short and rigid network. As a result, the bread became compact and heavy. Therefore, increased use of corn cob flour directly increased the firmness of bread, thus decreasing the bread volume.

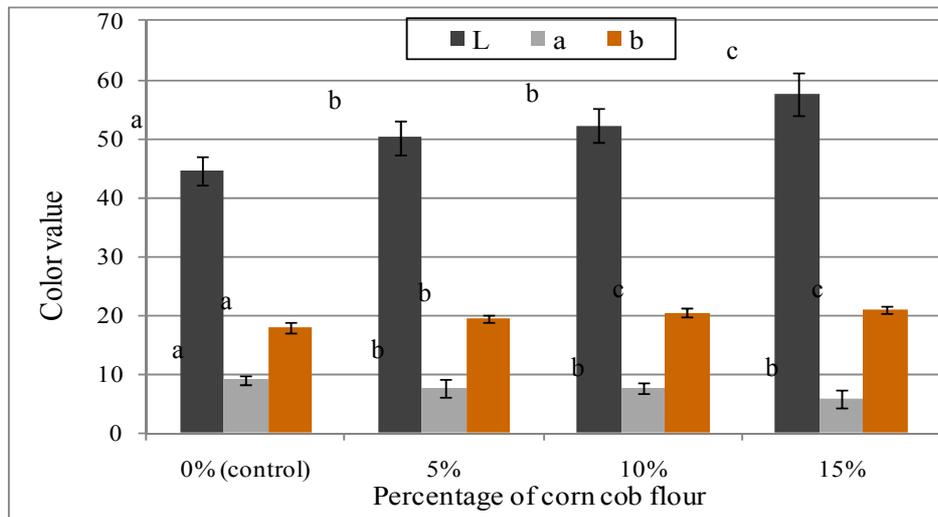


(<sup>a-d</sup> different letters in histogram show significant differences at  $p \leq 0.05$ )

**Figure 1 Firmness (a) and volume (b) of high fibre bread with different percentages of corn cob flour incorporation.**

Incorporation of corn cob flour in the development of high fibre bread also has an impact on the appearance of final product. Figure 2 shows the colour values (L, a, b) for the top crust colour of high fibre bread with different percentages of corn cob flour incorporation. From the figure, it is shown that the lightness and yellowness (L and b values) of the crust colour increased with the increase of corn cob flour in the formulations (Figure 2). As discussed previously, the increase of corn cob flour decreased the protein content in the mixes and in the final product. The existence of protein and reducing sugar components in the ingredients are important for the brown colour

development of bread during baking through Maillard reaction [11]. The lack of protein in the formulation reduced the potential for browning reaction to take place in the product. Hence, the product became lighter in colour and showed higher values for lightness (L) and yellowness (b) parameters.

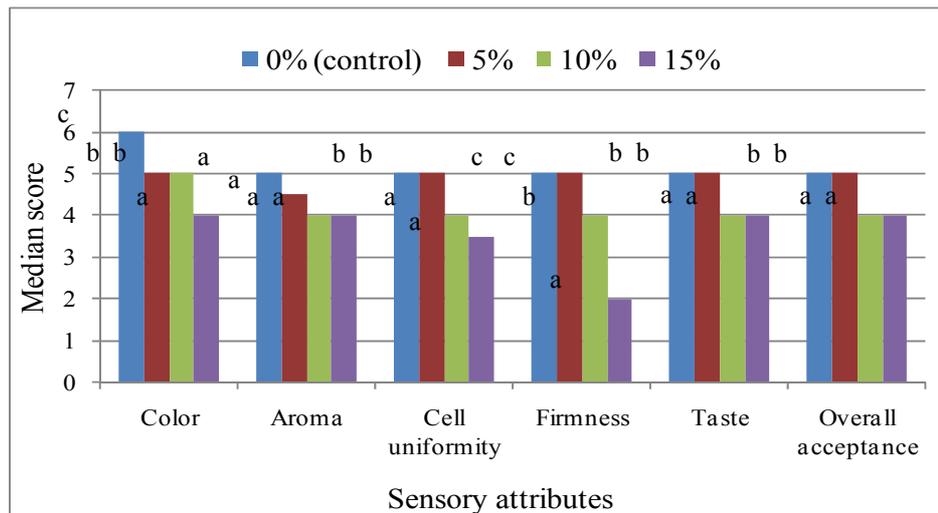


(<sup>a-c</sup> different letters for each color parameters in histogram show significant differences at  $P \leq 0.05$ )

**Figure 2. Top crust colour of high fibre bread with different percentages of corn cob flour incorporation.**

(L=lightness, a= redness, b= yellowness)

Figure 3 shows the median score for several sensory attributes of high fibre bread with different percentages of corn cob flour incorporation including colour, aroma, cell uniformity, firmness, taste and overall acceptance. For bread colour evaluation, control sample (0% corn cob flour) scored the highest median score (6.0) and differed significantly with others. This finding indicated that panellists prefer bread with darker colour, which was high fibre bread with less corn cob flour incorporation. In addition, Figure 3 also shows that panellists gave similar likeness scores (4.0 – 5.0) to aroma attributes for all bread formulations. The incorporation of corn cob flour in high fibre bread development did not reduce or increase the aroma acceptability of final product. In terms of texture evaluation, panellists were also being asked to give ‘likeness’ score for cell uniformity and firmness of high fibre bread. Results showed that the incorporation of 15% corn cob flour in the formulation contributed to low median score values for these attributes with scores below 4.0. This might be because of the compact structure of bread which is due to the lower protein and higher fibre content in the samples with corn cob flour addition. Taste and overall acceptance of high fibre bread showed similar insignificant scores between 0 and 5% and between 10 and 15% of corn cob flour incorporation. However, significant score values were shown between 0 and 5% with 10 and 15% of corn cob flour incorporation. Overall sensory evaluation showed similar ‘likeness’ scores were obtained for bread with 0 (control) and 5% of corn cob flour incorporation for all attributes except for colour (Figure 3). This finding showed the acceptability of high fibre bread up to 5% of corn cob flour incorporation as it was comparable with control which contained 100% of whole meal flour.



(<sup>a-c</sup> different letters within each attribute in histogram show significant differences at  $P \leq 0.05$ )

**Figure 3. Median score for sensory attributes of high fibre bread with different percentages of corn cob flour incorporation.**

## Conclusion

In conclusion, corn cob flour has potential to be a source of fibre when incorporated in high fibre bread formulations. Its incorporation in the development of high fibre bread did not contribute to major changes in most of the chemical properties of the final product. However, further studies have to be carried out in order to improve its physical properties when higher substitution of corn cob flour is applied. Modification of ingredients in high fibre bread making is also required so that the product can be improved and accepted by consumers. Thus, the main aim of this study which was to optimize the usage of the edible wastage from corn could be achieved.

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