

Development and physical analysis of high fiber bread incorporated with cocoa (*Theobroma cacao* sp.) pod husk powder

*Amir, I.Z., Hanida, H.S. and Syafiq, A.

Department of Food Science, Faculty of Agrotechnology and Food Science, Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia

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Abstract

The main approach of this study is to develop high fiber bread by utilizing the cocoa-by products, namely cocoa pod husk which is incorporated into whole meal bread. The cocoa pod husk can be classified as one of the source of high fiber. The cocoa pod husk was dried and milled in order to produce the cocoa pod husk powder (CPHP). There were five different percentages of CPHP level incorporated into the high fiber bread which were formulation A (0% CPHP), formulation B (5% CPHP), formulation C (10% CPHP), formulation D (15% CPHP) and formulation E (20% CPHP). All of the samples undergone physical analysis and sensory evaluation. The incorporation of CPHP give significant effects towards bread volume and hardness attribute where the bread became denser and harder in texture as compared to the control. The color of bread crumb and crust was also changed to darker color. For the overall acceptance, formulation B has the highest mean score among the composite breads (formulation B to E) studied.

Keywords

Cocoa pod husk powder
bread
physical properties
sensory acceptance

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Introduction

To date, high fiber bread is well-known to be beneficial for human health. Its consumption is scientifically proven to reduce the risks of certain medical conditions as well as used in diet for losing weight (Galisteo, 2008). However, the taste and the characteristics of this type of bread leads consumer in choosing white bread instead of high fiber bread.

Whole meal bread is generally high in fiber content. This kind of bread is different compared to white bread especially in terms of color, taste and texture (Ingram and Shapter, 2006). The color of whole meal bread is slightly brown and usually it is denser as compared to white bread. However, proper process and useful ingredients such as bread softener and calcium propionate may help to improve the whole meal bread texture (Stanley and Linda, 2006).

Due to its acquired taste compared to white bread, it becomes a stepping stone for food researcher to find new alternatives in fulfilling consumer demands for high fiber bread in their healthy diet. One of the new sources of fiber is cocoa pod husk. According to previous study from Alemawor (2009) suggested, CPH contains 357.4 g/kg (dry basis). Hence, in this study, cocoa pod husk which is high in crude fiber was evaluated as an ingredient (powder) in high fiber bread making.

In the past, cocoa pod was commonly discarded as a waste. In 2005, Malaysia has 33,313 ha area of cultivated cocoa which produces 27,964 tonnes of cocoa (Rosmin and Lee, 2006). This amount is equivalent to 42% from the total cocoa production which is 66,580.95 tonnes. Since cocoa pod husk composed of 56% of matured cocoa pod, about 37,285.33 tonnes of cocoa pod husk was produced on that year which is considered as cocoa by-products. Currently, the Commodities and Plantation Industries Ministry is targeting to increase the cacao beans production to 60,000 tonnes in 2020 (Suzana, 2011). Thus, there will be more cocoa by-products produced.

However, in recent time, cocoa pod (husks) is used as animal feed and also as fertilizer. Thus, this agro-industrial by-product should not become a waste by expanding its usage in food product. The cocoa pod husk powder (CPHP) which is high in fiber content can be supplemented into high fiber bread thus, create a variety of high fiber bread.

The main aim of this study is to incorporate the cocoa pod husk powder and whole meal flour in the bread formulation in order to develop high fiber bread. Apart from that, this research was purposely carried out to investigate and evaluate the physical properties of high fiber bread made from whole meal flour and cocoa pod husk powder (CPHP) and its acceptability

*Corresponding author.
Email: amir@umt.edu.my

among consumers.

Materials and Methods

Materials

The cocoa pod (*Theobroma cacao* sp.) was obtained from Kapar, Selangor. Ingredients such as baker's strong flour (high protein flour), Allinson Premium White Very Strong Bread Flour (protein, 13.9%) and Allinson Whole meal Plain Flour (protein 11.9%, fiber 9%) were obtained from local supplier in Selangor and Terengganu.

Preparation of cocoa pod husk powder (CPHP)

The cocoa pod husk powder (CPHP) was prepared by the following steps. Firstly, the cocoa pod husk (CPH) was cleaved by using a 10 inches, stainless steel kitchen knife. The wet bean (seed) including the placenta and the outer layer of the cocoa pod which is known as cocoa shell was removed from the pod.

The CPH which is white in color was cleaned and cut into smaller pieces. Then, the CPH was cooked for about half an hour in order to reduce its theobromine content, as well as practicable in removing the slime layer of CPH and soften its texture. Next, the CPH was placed on a tray and dried in a cabinet dryer at temperature of 60°C until the moisture content was 8-10%.

Finally, CPH was grinded by using warring blender (Warring Commercial, Laboratory Blender) and continue with milling by using a sample mill to obtain particle size of 0.12 mm. Then, CPHP produced was stored in a polyethylene bag at room temperature for further analysis.

CPHP was then deployed for proximate analysis and the result gained were as following; crude fiber (27.01%), protein (5.78%), crude fat (2.02%), ash (4.84%) and moisture (8.83%).

Preparation of four blends

The flour blends was comprised by whole meal flour and cocoa pod husk powder (CPHP). There are five different ratios of the flour blend formulations were made in order to determine the optimum tolerability of CPHP incorporated into the high fiber bread formulation. The ratio of the whole meal flour and cocoa pod husk powder is shown in Table 1. The formulation of high fiber bread was simplified as in the Table 2.

Preparation of high fiber bread

The high fiber bread was produced by using the straight dough method modified by Gisslen (2009). Firstly, the ingredients such as flours, water, shortening, salt, yeast and sugar were prepared and

Table 1. Ratio of five different flour blends

| Formulation | Composition (%) | |
|-------------|------------------|------|
| | Whole meal flour | CPHP |
| A | 100 | 0 |
| B | 95 | 5 |
| C | 90 | 10 |
| D | 85 | 15 |
| E | 80 | 20 |

CPHP: Cocoa Pod Husk Powder

Table 2. The formulation of bread

| Ingredients | Amount (gram) | Percentage (%) |
|----------------------|---------------|----------------|
| Whole meal flour | 180.00 | 33.18 |
| Baker's strong flour | 120.00 | 22.12 |
| Instant yeast | 3.78 | 0.69 |
| Fine salt | 7.20 | 1.33 |
| Granulated sugar | 10.80 | 1.99 |
| Shortening | 10.80 | 1.99 |
| Water | 192.00 | 35.39 |
| Non-fat milk solid | 15.00 | 2.76 |
| Bread improver | 3.00 | 0.55 |
| TOTAL | 542.58 | 100.00 |

Source: Gisslen (2009) by modification

weighed accurately according to the formulation. After that, the baker's strong flour, high protein flour and whole meal flour were sifted by using Endecotts sieve operated with Octagon Digital Sieve Shaker (United Kingdom), to the size of 0.12 mm. This is important to prevent the particle size from affecting the bread in terms of physical and sensory analysis. Next, the flour were mixed together in stand mixer (Kitchen Aid Professional 600 Series 6 Quart Bowl-Lift Stand Mixer, KP26M1XNP) at speed 2 by using spiral pedal and followed by addition of instant yeast (Mauri-pan) and sugar. For formulation B, C, D and E, the CPHP was mix together with the mixture of whole meal flour and high protein flour. Then, the process was continued by adding bread improver, non fat milk solid, salt and shortening. Lastly, water was added slowly to the mixture.

After kneading, the dough was allowed to undergone fermentation process for about 30 minutes. Then, the dough was folded to allow the gas expelled from the dough and at the same time distribute the yeast for further growth. Then, the dough was portioned into the required size. The dough was rounded to shape it into a smooth layer. This procedure also may assist in retaining the gas that was produced by yeast.

The dough was allowed to rest for about 10-20 minutes before molding and placed into a baking tin. Then, the dough was placed into the proofer for the final proofing stage for about 45 minutes at 37 °C (75% RH) (Giesslen, 2003). Next, the dough was baked in baking oven at 200°C for 30 minutes.

The bread was removed from the oven, de-panned and allows it to cool. After cooling for about 1 hour at room temperature, the bread undergone

physical analysis to observe its texture, volume, and color. The rest of bread was packed into packaging materials High-density polyethylene (HDPE) and stored properly in ambient condition.

Textural measurement

The texture characteristics (hardness) of breads were analyzed by using TA.XT. Plus Texture Analyzer (Stable Micro System Ltd., U.K) at temperature 25 + 2°C. The probe (P/75) was chosen for hardness characteristics of bread by using Texture Profile Analysis (TPA). All of the breads were sliced into a standard size of 40 mm x 40 mm x 10 mm in order to fit on the platform of the analyzer with the test speed of 2.0 mm/s and distance 10 mm.

Volume determination

The volume of bread was determined by using the rapeseed displacement method. The volume of a container was measured by filling the container using the rapeseed. Then, the bread was placed into the container and followed by refilling the rapeseed into the container. The bread displaced the volume of seed which is equivalent to its own volume.

Color profile determination

The profile color of bread crust and crumb formed were determined by using colorimeter (Minolta Chroma Meter 300, Japan). The color of samples were measured in L*, a* and b* parameters which indicates the lightness, redness and yellowness were recorded.

Microscopic structure observation

The microscopic structure of bread was observed to determine the effect of incorporation of CPHP towards the pore size of bread. Before the analysis was done, the bread was sliced into 15 mm x 5 mm x 15 mm and dried at 60°C for 24 hours. It is important to ensure that the bread is totally dried in order to get the clear image of bread.

Measurement was done using (Hitachi High Technologies UK, TM1000-EDS) scanning electron microscope. The 100x magnification was used to view the pore size of bread.

Statistical analysis

The Minitab14 software was used to perform statistical analysis on all of the data obtained. The design of experiment used was done using completely randomized design (CRD).

Results and Discussion

Textural properties (hardness)

The hardness of five formulations high fiber bread increased significantly as the CPHP level augmented periodically from 10% to 20% level. This is due to the fiber contained in bread may restrict the expansion of gas cells (Collar *et al.*, 2007). It gave rise to the composite bread to have a more compact texture which imparts to the increment of the bread hardness.

According to several previous studies, the fiber presence may improve the quality parameters of bread and other baked products as long as it is less than certain content (Brockmole and Zabik, 1976; Chaplin, 2003; Lebesi and Tzia, 2009). The increasing of hardness was also due to the increase of moisture content in the composite bread. The baking condition (temperature and time variables), bread components such as fiber, starch, protein (gluten) weather damage or undamaged and the amounts of absorbed water during dough mixing will contribute to the final texture of breads (Gomez *et al.*, 2003; Bakke and Vickers, 2007; Akhtar *et al.*, 2008 and Serrem *et al.*, 2009).

Loaf volume

Increasing level of CPHP (0 - 20%) insignificantly reduced the volume and specific volume (Table 3). It was attributed to the higher fiber content which increased the water absorption capacity of CPHP. The 5% CPHP bread had the highest loaf volume and specific volume compared to other composite breads.

Moisture content plays a major factor affecting loaf volume of bread (Noor Aziah *et al.*, 2007). According to Wang *et al.* (2002), the fiber addition in bread causes a most evident appreciable which is the reduction of loaf volume. Same trend also reported by Yusnita and Wong (2011), Noor Aziah *et al.* (2007) and Wang *et al.* (2002).

Table 3. Hardness and volume of bread

| Bread | Hardness (N.sec) | Bread volume | |
|-------|----------------------|----------------------|--------------------|
| | | Volume | Specific volume |
| A | 726.60 ^d | 1350.00 ^a | 2.88 ^a |
| B | 845.40 ^{cd} | 1300.00 ^a | 2.64 ^{ab} |
| C | 945.90 ^c | 1225.00 ^a | 2.44 ^b |
| D | 1174.30 ^b | 1050.00 ^b | 2.09 ^c |
| E | 1407.00 ^a | 990.00 ^b | 1.94 ^c |

A:0% CPHP,B:5% CPHP,C:10% CPHP,D:15% CPHP,E:20% CPHP
^{abcd} different letter in table (column) show significant differences at P < 0.05

Color

By referring to Table 4, the L*, a* and b* decreased jointly with the augmentation of CPHP level in the bread formulation. The colour of crust and crumb had

Table 4. Color (crust and crumb) of bread

| Bread | Color (Crust) | | | Color (Crumb) | | |
|-------|--------------------|---------------------|--------------------|---------------------|-------------------|--------------------|
| | L* | a* | b* | L* | a* | b* |
| A | 58.78 ^a | 12.23 ^a | 32.75 ^a | 69.32 ^a | 2.09 ^a | 18.10 ^a |
| B | 57.58 ^a | 10.32 ^{ab} | 26.76 ^a | 61.55 ^{ab} | 2.75 ^a | 15.69 ^a |
| C | 56.86 ^a | 10.19 ^b | 24.93 ^a | 59.75 ^{ab} | 2.88 ^a | 15.41 ^a |
| D | 56.07 ^a | 7.21 ^c | 23.33 ^a | 51.81 ^b | 3.48 ^a | 14.61 ^a |
| E | 49.60 ^a | 7.11 ^c | 23.25 ^a | 47.53 ^b | 3.55 ^a | 14.25 ^a |

A:0% CPHP,B:5% CPHP,C :10% CPHP,D:15% CPHP,E:20% CPHP

^{a-d} different letter in table (column) show significant differences at P < 0.05

changed from light brown (control) to darker brown (20% CPHP) due to the additional glucose contained in loaves promote to exhibit darker crust (Noor Aziah *et al.*, 2007). This change is also logically due to the color of CPHP itself which is darker than whole meal flour.

Besides, it also attributed to Maillard browning caused by the reaction between wheat protein with the added sugar (Fayle and Gerard, 2002). The caramelization are influenced by the distribution of water and the reaction of added sugars and amino acids (Kent and Evers, 1994). According to Hodge (1967), the temperature, time and moisture (the presence of water) influence the Maillard reaction.

The surface color of bread is influenced by the physicochemical characteristics of the raw dough such as its water content, pH, reducing sugar and amino acid content. Meanwhile, the operating conditions applied during baking also will influence the surface color of bread such as temperature, air speed and relative humidity (Zanoni *et al.*, 1995).

As the CPHP level increased, a reduction of bread's pore size was clearly observed as shown in Figure 1. This is due to the fiber contained in bread may restrict the expansion of gas cells (Collar *et al.*, 2007). Thus, the bread tends to have a compact cellular structure.

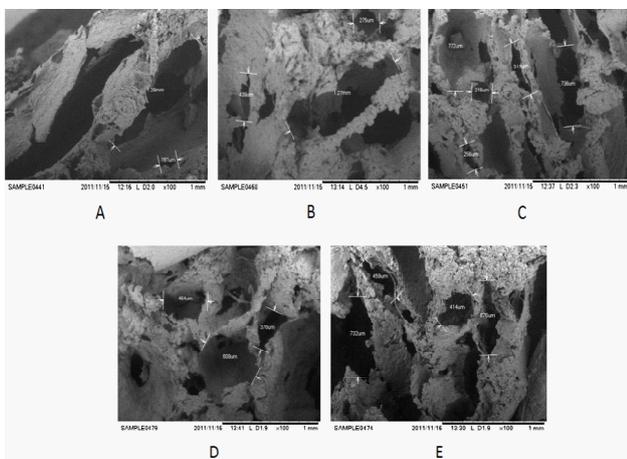


Figure 1. Microscopic structure of high fiber bread (A:0% CPHP,B:5% CPHP,C :10% CPHP,D:15% CPHP,E:20% CPHP) incorporated with cocoa pod husk (CPH).

Another factor is the increment of moisture content which possibly leads the cellular pores of bread experiencing undue expansion and bread become denser, eventually. The reduction of pore size of bread also related to its texture that became harder as CPHP increased.

Conclusion

The specific volume, microscopic structure and pore size of bread decreased as the CPHP level increased in formulation while the texture of bread became harder. This is due to the fiber content that higher in CPHP (27.01% fiber) as compared to that of whole meal flour (9% fiber). The fiber which possesses high water absorption capacity is also able to restrict the gas expansion in bread cell and retain the moisture content. The presence of CPHP in bread also gave effects on crust and crumb color in which it became darker compared to the bread that was not incorporated with CPHP (control).

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References

- Akhtar S., Anjum F., Rehman, S., Sheikh, M. and Farzana, K. 2008. Effect of fortification on the physico-chemical and microbiological stability of whole wheat flour. *Food Chemistry* 112; 156-163.
- Alemawor, F., Dzagbafia, V. P. and Oddoye, E. O. K. 2009. Enzyme cocktail for enhancing poultry utilization of cocoa pod husk. *Academic Journals* 4 (6): 556-557.
- Bakke, A. and Vickers, Z. 2007. Consumer liking of refined and whole wheat breads. *Journal of Food Science* 72: 473-480.
- Brockmole, C. L. and Zabik, M. E. 1976. Wheat bran and middlings in white layer cakes. *Journal of Food Science* 41(2): 357-360.
- Collar, C., Santos, E. and Rosell, C.M. 2007. Assessment of the rheological profile of fiber-enriched bread dough by response surface methodology. *Journal of Food Engineering* 78: 820-826.
- Fayle, S. E. and Gerrard, J. A. 2002. Consequences of Maillard reaction in food, Cambridge, UK: Royal Society of Chemistry.9-19.
- Galisteo, M., Duarte, J. and Zarzuelo, A. 2008. Effects of dietary fibers on disturbances clustered in the metabolic syndrome. *Journal of Nutritional Biochemistry* 19: 71-75.
- Gisslen, W. 2003. *Yeast Products. Essentials of Professional Cooking*. New Jersey; John Wiley & Sons, Inc. 518-519.
- Gisslen, W. 2009. Understanding yeast dough. In

- Professional baking. Fifth edition. New Jersey; John Willey & Sons, Inc. 112-121.
- Gomez, M., Ronda, F., Blanco, Caballero, P. and Apesteguia, A. 2003. Effect of dietary fiber on dough rheology and bread quality. *European Food Research Technology* 216: 51-56.
- Hodge, J. E. 1967. Origin of flavors in foods, nonenzymatic browning reaction. In *Symposium on Food Chemistry and Physiology of Flavors*. Schults, H. W., Day, E. A. and Libbey, L.M. (Eds). 465-491.
- Kent, N. L. and Evers, A. D. 1994. *Technology of cereals*. 4th. An introduction for students of Food Science and Agriculture 215-220.
- Lebesi, D.M. and Tzia, C. 2009. Staling of cereal bran enriched cakes and the effect of an endoxylanase enzyme on the physicochemical and sensorial characteristics. *Journal of Food Science* 76(6): 380-38.
- Noor Aziah, A.A, See, E.F. and Wan Nadiah, W.A. 2007. Physico-chemical and sensory evaluation of breads supplemented with pumpkin flour. *Asean Food Journal* 14 (2): 123-130.
- Rosmin, K. and Lee, C. H. 2006. Malaysian cocoa, Malaysian Cocoa Board ISSN 1675-5669 (3) 2: 1-3.
- Serrem, C., Kock, H. and Taylor J. 2011. Nutritional quality, sensory quality and consumer acceptability of sorghum and bread wheat biscuits fortified with defatted soy flour. *International Journal of Food Science and Technology* 46: 74-83.
- Stanley, P. C. and Linda, S. Y. 2006. *Baked products: Science, technology and practice*. Blackwell Publishing Ltd. 36-37
- Suzana, J. 2011. 60,000 tonnes cocoa by 2020. *Daily Express*. 22 August: 4.
- Wang, J, Rosell, C.M. and Benedito de Barber, C. 2002. Effect of the addition of different fibers on wheat dough performance and bread quality. *Food Chemistry* 79: 221-226.
- Yusnita, H. and Wong, F.L. 2011. Physicochemical properties and acceptance of high fiber bread incorporated with corn cob flour. Pp. 647-651. In: *The 12th ASEAN Food Conference 2011*, BITEC Bangna, Bangkok, Thailand, 16-18 June.
- Zanoni, B. Peri, C. and Bruno, D. 1995. Modeling of browning kinetics of bread crust during baking. *Lebensm. Wiss. U. Technology* 28: 604-609.