Characterization of Snack Food Bars Made of Nixtamalized Corn Flour and Flour Of Nike Fish for Emergency Food

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Abstract: Utilization of local food source such as nixtamalized corn flour and nike flour as base ingredients in producing snack bars may add the product value and also reduce production costs. The purpose of this study was to produce a prototype snack food bars weighing 50 grams for each bar, containing calories that meet the standards of Emergency Food Product (EFP) by 233 kcal/bar, and being favored by consumers. Snack food bars produced in this study used the formulation in the previous study, consisted of 26.77% nixtamalized corn flours, 6.69% nike flours, 9.37% corn starch, 20.08% chocolate, 13.01% margarine, 13.38% egg whites, and 13.38% sugar. Snack food bars were produced through six steps: weighing ingredients, mixing, molding, baking in the oven, cooling, and packaging. The baking process used three combinations of temperature and time, each with 3 replicates. Bars were baked at 100^0C for 20 minutes, and then followed by temperature of 140^0C (treatment A), 150^0 C (treatment B), or 160^0C (treatment C) for 40 minutes. Snack food bars produced by baking temperature combination were less preferred by the panelists based on the taste attributes due to the distinctive flavor of nike flours persisted in the bars. Baking temperature C (at 100^0 C for 20 minutes, followed by 160^0C for 40 minutes) got the highest score based on the texture attributes. The nutrient and calorie content of snack food bars produced did not show much difference with the formulation result. Snack food bars produced in this study contained 10.1751 g fat, 3.5694 g protein and 32.2681 g carbohydrate in every 50 g of snack bars. Based on the formulation result, snack food bars contained 9.8 g fat, 5.84 g protein, and 30.37 g carbohydrate per 50 g of snack bars. Snack food bars produced in this study

contained 234.926 kcal per 50 g of snack bar while based on the formulation result, snack food bars contained 233 kcal per 50 g of snack bar. This implies that Snack food bars based local product has the potential to developed in the regional in security food in the face of emergency condition.

Keywords: nixtamalized corn flour; nike flour; snack food bars; emergency food

1. Introduction

Emergency Food Product (EFP) is a processed food product specifically designed to meet the daily energy requirements of a person (2,100 kcal) and consumed in emergency situation and condition like floods, landslides, earthquakes, famine, fire, war and other events that result in humans cannot live a normal life (IOM 1995 in Zoumas *et al.,* 2002). EFP has a purpose to reduce the incidence of disease and number of deaths among the refugees by providing nutritious food to be used as a source of energy (2,100 kcal) for 15 days (Zoumas *et al.,* 2002; Sitanggang & Syamsir, 2010, Hoisington *et al.,*2011).

A variety of EFP that have the potential to be developed is a snack food bars. Snack food bar is an emergency food in the form of solid food made of flour, through a baking process (Darniadi, 2012). Snack food bars have a bar form, which is an advantage, making them easier to distribute around the refugee camps. They also have a long shelf life because of the low water activity (a_w) values compared to the semi-wet products which have a higher a_w values. Another advantage of the snack bars is the resistance of shocks due to the solid, not easily broken, and not fragile structure (Melia, 2011).

Development of snack food bars made of local food source has not been done extensively. In this study, local food source like nike flours and nixtamalized corn flours were used. Nike pflours was obtained by grinding nike (*Awaous melanocephalus*), a species of fish living in Gorontalo. Nike contains high protein, approximately 16.89%. However, nike has not been optimally used as a food source, thus, it was used in this study as the protein source of the EFP. Nixtamalized corn flours was used as the carbohydrate source in this study. Nixtamalization is an ancient process, where corn grain is cooked in ash-lime to produce softening (Ruiz-Gutiérrez, 2010).

The nixtamal (alkaline cooked corn, steeped and washed) is stone ground into-dough, which is used to produce tortillas, tamales, atole, snacks (nachos), instant corn flours, etc (Valderrama-Bravo, 2010). Corn nixtamalization may improve biovailibility of niacin, increase the quality of protein, increase calcium, The reducing of dietary fiber, the loss of vitamins and carotenoids and reduce aflatoxin content (Bressani *et al.,* 1990, Serna-Saldivar et al., 1987, Wall and Carpenter in 1988 in Sefa-Dedeh *et al.*, 2003, ; Guzman, 2009, Braham & Bressani, 1966; Bressani, Paz y Paz, & Scrimshaw, 1958; Edwin *et al.,* 2003; Serna- Saldivar, Rooney, & Greene, 1991, 1992 in Salazar *et al.,* 2013; Contreras-Jiménez, 2014).

EFP in bar form has not had specific standards in Indonesia. The standard of EFP complies to Zoumas *et al.* (2002), i.e the product should be able to meet the daily en-

ergy requirements of a person (2,100 kcal), which consists of 40-50% carbohydrate, 10-15% protein, and 35-45% fat. Therefore, a formulation of snack food bar needs to be designed based on the requirements of EFP.

The results of energy calculations on previous study showed that the ingredients comprising of 26.77% nixtamalized cornmeal, 6.69% nike powder, 9.37% cornstarch, 20.08% chocolate, 13.01% margarine, 13.38% egg whites, and 13.38% sugar can generate snack food bars with the energy of 233 kcal/50g complied to the energy required for emergency food. Snack food bars produced in this study were made in the form of bars, each weighed 50 g and contained 233 kcal. Eating snack bars 9 servings/day would meet the daily energy requirements (2,100 kcal). The aim of this study was to produce a snack food bar using the formulation result on the previous study.

2. Materials and method

2.1. Materials

The ingredients used to make snack food bars in this study were nixtamalized cornmeal, nike powder, margarine, cornstarch, sugar, egg whites, chocolate.

2.2. Apparatus

Equipment used to make snack food bars were oven, mixers, sieve and containers for mixing. Chemical reagents and tools were used for proximate analysis.

2.3. Experimental Procedure and Analysis

Production of snack food bars

Snack food bars were made through six steps: weighing ingredients, mixing, molding, baking in the oven, cooling, and packaging. All ingredients were weighed according to the formulation result. Dry ingredients (nixtamalized cornmeal, nike powder, cornstarch, and salt) were combined first. Margarine and sugar were mixed with a mixer for 15 minutes. The dry ingredients were then added to the mixture of margarine and sugar and thoroughly mixed until well combined and not sticky. After that, the dough was molded into bars with size of 10 cm x 3 cm and thickness of 1.3 cm. Bars were baked in the oven with three combinations of baking temperature and baking time, each with 3 replicates:

A: baking temperature of 100^0 C for 20 minutes, followed by temperature of 140^0C for 40 minutes

B: baking temperature 100^0C for 20 minutes, followed by temperature of 150^0C for 40 minutes

C: baking temperature 100^0C for 20 minutes, followed by temperature of 160^0C for 40 minutes

The bars were then cooled for 30 minutes and packed with aluminum plastic packaging (Chandra, 2010; USAID, 2007).

Organoleptic tests

Organoleptic tests were carried out using hedonic tests to assess the level of preference for the taste, smell, and color. Coded food samples were randomly served to 25 panelists. Panelists were asked to give a score in a scale according to their level of preference. The scale used was 7-point hedonic scale (1= extremely dislike, 2= dislike, 3= moderately dislike, 4= neutral, 5= moderately like, 6= like, and 7= extremely like).

Caloric Value

The caloric value was calculated on the basis of the composition of the food bars, the Atawater conversion factors of 4 kcal/g (protein), 4kcal/g (carbohydrates) and 9 kcal/g (lipids), according to Osborne and Voogt (1978) in Paiva *et al.* (2012)

3. Results and Discussion

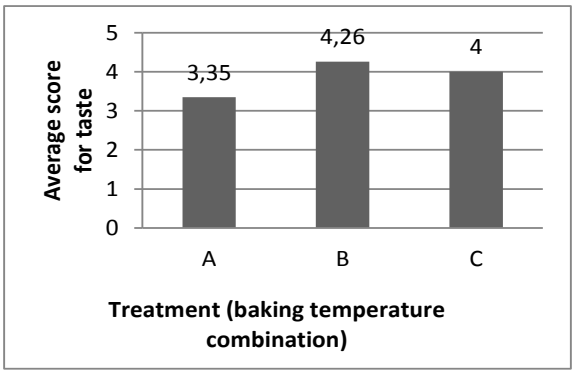
The formulation result in the previous study was used in producing snack food bars, consisted of 26.77% nixtamalized cornmeal, 6.69% nike powder, 9.37% cornstarch, 20.08% chocolate, 13.01% margarine, 13.38% egg whites, and 10.71% sugar.

Margarine and sugar were mixed separately from dry ingredients, according to creaming with two-stage method. In this method, fat, sugar, emulsifying agent, and other minor ingredients, except leavening agent, are combined (Matz & Matz, 1978). Two-stage method will give a compact cream. Powdered sugar was used to achieve a more homogenous mixture.

Baking temperature was started at 100^0C for 20 minutes and then raised to different temperatures for different treatments, which were 140^0C (A), 150^0C (B), and 160^0C (C) for 40 minutes. A low temperature (100^0C) at the beginning was aimed to remove most of the water content in bars, while high temperatures that followed would remove more water and cook the bars. Snack food bars were assessed in organoleptic tests based on color, texture, and taste. Proximate analysis was also done.

3.1. The Influence of baking temperature on the taste of snack food bars

Taste is an important quality attribute to determine consumer acceptance of a certain product. The taste of a food product is affected by the composition of the product. The result of organoleptic test on the taste of the snack food bars are presented in Figure 1.



A = baking temperature of 100^0 C for 20 minutes, followed by temperature of 140^0C for 40 minutes
B = baking temperature of 100^0 C for 20 minutes, followed by temperature of 150^0C for 40 minutes
C = baking temperature of 100^0 C for 20 minutes, followed by temperature of 160^0C for 40 minutes

Figure 1. Level of preference based on the taste of snack food bars with different baking temperature

Organoleptic test result in Figure 1 shows that the responses to the taste of snack food bars are between moderately dislike and neutral with the average score 3.35-4.26. Snack food bars produced by temperature combination A got a dislike response while snack food bars produced by temperature combination B and C got neutral responses in average from the panelists.

ANOVA result showed $F_{value} < F_{table}$ (α=5%). This indicates that the baking temperature treatments do not significantly

affect the score given by the panelists based on the taste of snack food bars. The taste of a food product is affected by the composition of the product (Ladamay *et al.,* 2014). Therefore, the low average score of taste given by the panelists might be due to the distinctive flavor of nike powder, which is unpleasant for the panelists.

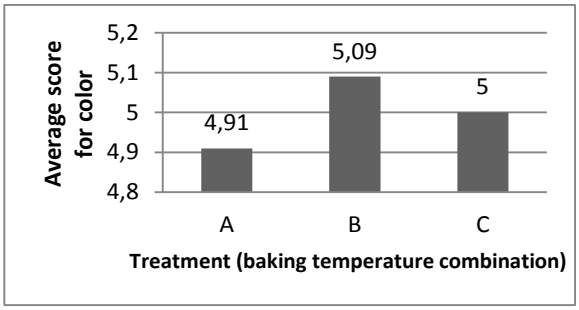
3.2. The Influence of baking temperature on the color of snack food bars

Color is one of the first factors that influence consumer acceptance of a food product other than overall appearance. Dull or unattractive colors will create a negative impression even before assessing other aspects. Colors affect the overall appearance of the food and the ability of the food to reflect, scatter, absorb, or transmit visible light. The color has been correlated with the acrylamide generation in thermally processed foods (Gökmen & S¸enyuva, 2006; Lukac *et al.,* 2007; Majcher & Jelen, 2007; Pedreschi *et al.,* 2007).

Colors depend on the physicochemical characteristics of the raw ingredients (dough) including moisture, reducing sugar, amino acids and operating conditions in all process (Ladamay *et al.,* 2014).

The average score for the color of all snack food bars in treatment A, B, and C is 5 (moderately like). Since the snack food bars in all treatments were coated with the chocolate with the same type and concentration, all snack food bars look the same.

ANOVA result showed that the baking temperature treatments do not significantly affect the score given by the panelists based on the color of snack food bars. This is indicated by the $F_{value} < F_{table}$ ($\alpha = 5\%$). The color of snack food bars were yellowish brown before coated with chocolate. This color change is mainly caused by the Maillard reaction, i.e. the interaction between reducing sugars and proteins (amino acids) in foods which undergo thermal processing (Jaeger *et al.,* 2010, Peres-Locad and Yaylayan, 2014). Maillard process occurs at 150-160^{0}C. Surface hardening and the formation of distinctive scent occur along with the water evaporation (Manley, 2001). In addition, Maillard reaction was inhibited at low pH and it had crucial influence on the antioxidant capacity in corn cookies (Zilic *et al.,* 2016)



A = baking temperature of 100^0 C for 20 minutes, followed by temperature of 140^{0}C for 40 minutes
B = baking temperature of 100^0 C for 20 minutes, followed by temperature of 150^{0}C for 40 minutes
C = baking temperature of 100^0 C for 20 minutes, followed by temperature of 160^{0}C for 40 minutes

Figure 2. Level of preference based on the color of snack food bars with different baking temperature

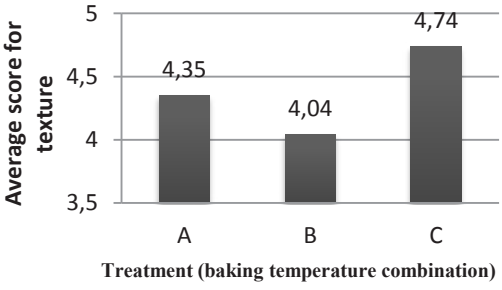
3.3. The Influence of baking temperature on the texture of snack food bars

The average score based on the texture of snack food bars in this study is ranged from 4.04- 4.74, which means the responses are between neutral to moderately like. The

level of preference for each treatment can be seen in Figure 3.

Snack food bars produced by temperature combination C got the highest average score, 4.74 (moderately like), while temperature combination A and B got neutral responses with average score 4.2. Treatment C has the highest baking temperature of all (100^0 C for 20 minutes, followed by 160^0C for 40 minutes), making the snack bars have more crispness in texture than other treatments. Rising temperature during the baking process causes the moisture flowing out from the dough through capillary action and diffusion.

Baking temperature treatments in the production of snack food bars do not significantly affect the score given by the panelists based on the texture of snack food bars. This is supported by the ANOVA result which showed that $F_{value} < F_{table}$ ($\alpha = 5\%$).



A = baking temperature of 100^0 C for 20 minutes, followed by temperature of 140^0C for 40 minutes
B = baking temperature of 100^0 C for 20 minutes, followed by temperature of 150^0C for 40 minutes
C = baking temperature of 100^0 C for 20 minutes, followed by temperature of 160^0C for 40 minutes

Figure 3. Level of preference based on the texture of snack food bars with different baking temperature

3.4. Chemical characteristic of snack food bars

Proximate analysis was performed on snack food bars in treatment C (baked at 100^0 C for 20 minutes, followed by 160^0C for 40 minutes for 40 minutes). Chemical characteristic and calculation of energy value in snack food bars can be seen in Table 3.

Table 3. Nutritional Compositions in snack food bars of nixtamalized corn flour and nike flour with treatment

Nutrient content	Amount (%)	Amount/ Unit	Amount/ 50 g bar
Water	6.2011	0.0620	3.1006
Ash	1.7735	0.0177	0.8867
Fat	20.3503	0.2035	10.1751
Protein	7.1389	0.0714	3.5694
Carbohydrate	64.5363	0.6454	32.2681

Based on Table 3 above, every 50 g of analyzed bar contain 10.1751 g fat, 3.5694 g protein, and the 32.2681 g carbohydrate. This result is not much different from the nutrient content based on the formulation result, i.e. 9.8 g fat, 5.84 g protein, and 30.37 g carbohydrates for every 50 g bar. The calorie content in analyzed bar is 234.926 kcal for every 50 g bar, which is also only slightly different with the formulation result, 233 kcal for every 50 g bar. This implies that These products, in addition to consumption practicality, meet a considerable part of the daily nutrient requirements of the individuals.

4. Conclusion

Snack food bars produced by baking temperature combination were less preferred by the panelists based on the taste attributes due to the distinctive flavor of nike powder persisted in the bars. Baking temperature C (at 100^0 C for 20 minutes, followed by 160^0C for 40 minutes) got the highest score based on the texture attributes.

The nutrient and calorie content of snack food bars produced did not show much difference with snack bars based on the formulation result. Snack food bars produced in this study contained 10.1751 g fat, 3.5694 g protein and 32.2681 g carbohydrate in every 50 g of snack bars. Based on the formulation result, snack food bars contained 9.8 g fat, 5.84 g protein, and 30.37 g carbohydrate per 50 g of snack bars. Snack food bars produced in this study contained 234.926 kcal while based on the formulation result, snack food bars contained 233 kcal per 50 g of snack bar.

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