Agriculture and Food

AIMS Agriculture and Food, 5(4): 868–881.
DOI: 10.3934/agrfood.2020.4.868
Received: 07 September 2020
Accepted: 28 October 2020
Published: 09 November 2020

http://www.aimspress.com/journal/agriculture

*Research article*

# Physical-sensory characteristics and nutritional contents of black oncom and peanut ingredients-based biscuits as an elderly supplementary food

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**Abstract:** Elderly people are a vulnerable group that is in a risk of getting undernutrition. This problem could be addressed by fermented peanut meal (black oncom) which has many nutritional contents and potential health benefits. This study aimed to determine physical, sensory characteristics, and nutritional contents of biscuits with the addition of black oncom or peanuts which were made from a substitution from wheat flour to sorghum flour. A factorial design was used to formulate and test the biscuits. The factors were type of flour and additions of peanuts or black oncom flour. The hardness of biscuits was analyzed using Stevens LFRA texture analyzer instrument, while water absorption analysis was determined as bound water per gram of samples. Sensory analysis was performed using the hedonic test by semi-trained panelists and was evaluated on nine point scale. Nutritional contents of protein, lipid, water, ash, carbohydrate, crude fiber, and dietary fiber were analyzed using modified AOAC methods, while protein digestability was determined based on the enzymatic principle using modified Saunder method. Physical characteristics of biscuits were not significant different in the hardness and water absorption ($P > 0.05$), indicating that additions of peanut flour or black oncom flour did not affect physical characteristics. SOB (sorghum-based black oncom biscuit) had the same acceptance with WOB (wheat-based black oncom biscuit), but it had lower acceptance than SPB (sorghum-based peanut biscuits) and WPB (wheat-based peanut biscuits). The addition of black oncom flour increased nutritional contents in SOB and WOB as follows 15.12 and 14.45 g/100 g of protein, 1.98 and 1.87 g/100 g of ash, 1.06 and 0.08 g/100 g of crude fiber, 76.28 and 76.38% of protein digestibility and fat content of 28.18 and 29.83 g/100 g, respectively.

Meanwhile, the nutritional contents of WPB and SPB were 12.18 and 12.53 g.100 g of protein, 31.78 and 29.41 g/100 g of fat, 1.93 and 1.75 g/100 g of ash, 0.69 and 1.09 g/100 g of crude fiber and 70.98 and 73.75% of protein digestibility, respectively. SOB showed significant differences in nutritional contents, especially in the protein and fat contents compared to WOB, SPB and WPB, whereas the protein digestability showed no significant differences. This study concluded that sorghum-based black oncom biscuits could be applied as a supplementary food for elderly people especially in the undernutrition problem.

**Keywords:** black oncom; black oncom biscuit; elderly people; supplementary food

## 1. Introduction

The shape of the Indonesian population pyramid in 2015 widened in the middle and there was an increase in the percentage of the elderly group [1]. The increasing number of elderly people will cause various problems that affect nutritional status because the elderly people are at risk of experiencing undernutrition. The prevalence of undernutrition in the elderly people who live at home is 13–30% [2], 26.5% in the community and 49% in the rehabilitation [3]. This undernutrition problem can disrupt the cognitive function of the elderly or dementia which affects the process of thinking, remembering, and processing various information obtained. There are around 46.8 million people living with dementia and this number will increase to 131.5 million by 2050 [4].

One of the foods that can be utilized to overcome these problems is the black oncom which is a traditional food of the people of West Java. Black oncom (fermented peanut meal) contains protein (54.42 g/100 g), fat (1.6 g/100 g), carbohydrate (27 g/100 g) [5,6], unsaturated fatty acids (39 mg/100 g) [7], amino acids (42.40–52.48 g/100 g db with the essential amino acid of 12.06 g/100 g db) [6,8]; functional components such as total phenolic content (41.73 μM/g), total flavonoid content (87.35 μM/g), % inhibition of DPPH (84.08%) [9], and has higher protein digestibility (89.9%) than peanuts due to the fermentation process [6]. Black oncom has antihypertensive benefit because it has 47.83% Angiotensin I converting enzyme (ACE) inhibitory activity as the antihypertensive characteristic [10]. In addition, another research in weanling mice showed that black oncom could increase weight, support growth performance of organs such as liver, kidney and spleen, support learning ability and memory, improve the function of intestinal microbiota imbalances by decreasing the number of *Proteobacteria* and *Firmicutes* and promoting the growth of beneficial bacteria that are reflected in alpha diversity, i.e. 323 OTU [11]. Utilization of black oncom food needs to be modified into a product in the form of snacks, because snacks are effective in increasing the energy and protein intake of the elderly people in the community, health services or hospitals [12,13]. Biscuits are a choice of snack products that have a good acceptance (palatable), and can be used as a vehicle for sources of nutrients that are likely to improve human health when added with black oncom [14]. The use of black oncom in biscuits can be complementary when combined with cereals.

Meanwhile, the type of cereals that can be combined with black oncom is sorghum flour because its utilization is still low when compared to wheat flour whose consumption reached 1.5 kg/capita/year in 2015 [15]. Sorghum flour contains ash (2.16–3.35 g/100 g), fat (1.45–3.8 g/100 g), protein (7.38–9.98 g/100 g), fiber (2.04–4.84 g/100 g), carbohydrate (73.92–71.92 g/100 g), amino acids (6.95–7.35 g/100 g), functional components such as phenolic content (1300–68000 mg/g) and amylose content (24.96–25.79%) which are suitable for substitution of wheat flour and have good raising ability similar to wheat [16]. Sorghum also has health potential in reducing the risk of heart disease, diabetes, improving the digestive system, cancer, detoxifying the body, improving the movement system and neurons and protecting various degenerative diseases [17–19]. Therefore, the production of sorghum-based black oncom biscuits intended for the elderly people needs to be implemented so that it has the potential to deal with the problem of undernutrition in the elderly people. This study aimed to determine the physical and sensory characteristics and nutritional contents of biscuits with the addition of black oncom or peanuts with a substitution of wheat flour to sorghum flour.

## 2. Materials and methods

### *2.1. Time and location of research*

This research was conducted from June to December 2019 at the Food Experiment Laboratory, Sensory Analysis Laboratory, Food Nutrition Analysis Laboratory, Nutrition Science Study Program, Faculty of Human Ecology, Institut Pertanian Bogor (IPB) University.

### *2.2. Materials*

The ingredients used for making biscuits were wheat flour, sorghum flour, refined sugar, eggs, baking powder, margarine, skimmed milk powder, vanilla, and cocoa powder. The main ingredients were peanuts and peanut meal obtained from distributors in Bogor West Java, Indonesia. The peanut was used for peanut flour production, while peanut meal was used for black oncom flour production. The materials for nutrition analysis were selenium mix, 4% boric acid, methyl red indicator, 0.1 N HCl, concentrated $H_2SO_4$, 40% NaOH, 0.5 N NaOH, Hexane, Whatman filter paper No. 42, aluminum foil, sodium phosphate buffer pH 4, 6, 7, 8 and 10, aquades, Na-azide, α-amylase enzyme, multienzyme solution, pepsin enzyme, pancreatin, ethanol 95%, and acetone.

### *2.3. Preparation peanut flour and black oncom flour*

The peanut flour was made referred to Singh dan Arivuchudar [20]. Peanuts were roasted for 20–30 minutes at 120 °C (Eyela, NDO-400, Japan). After peanuts were cooled, peanuts were ground until become flour and was sieved using a disc mill 60 mesh. Meanwhile, black oncom flour was produced from fermented peanut meal (black oncom). Black oncom production was began from soaking peanut meal for 16 hours, then it was drained and followed by steaming for 60 minutes. The peanut meal was cooled, then was fermented by *Rhizopus oligosporus* for 48 hours. The black oncom was sliced thinly and was steamed for 15 minutes. Afterwards, it was arranged in a tray for drying in an oven (Eyela, NDO-400, Japan) at 60–70 °C for 6 hours. The last procedure was grinding to produce flour using a disc mill 60 mesh.

*2.4. Biscuit formulations*

The design of this study was a factorial design with the factors in the form of flour (wheat and sorghum) and the addition of peanut flour or black oncom flour (six formulations are described in Table 1). The use of wheat flour was applied as a comparison because in general biscuits were made using wheat flour. The factor of peanuts addition was applied to compare between peanut flour as unfermented peanuts with black oncom flour as fermented peanuts. Formulas without the addition of peanuts flour or black oncom flour were used as control biscuits. The comparison of cereals flour and legumes flour which used in this formula based on previous research [20,21].

**Table 1**. Raw materials for biscuit production formulas.

| Material | Formula | | | | | |
|---|---|---|---|---|---|---|
| | SB | WB | SPB | WPB | SOB | WOB |
| Wheat Flour (g) | - | 300 | - | 150 | - | 150 |
| Sorghum flour (g) | 300 | - | 150 | | 150 | - |
| Peanut flour (g) | - | - | 150 | 150 | - | - |
| Black oncom flour (g) | - | - | - | - | 150 | 150 |
| Hen Egg (g) | 50 | 50 | 50 | 50 | 50 | 50 |
| Refined Sugar (g) | 130 | 130 | 130 | 130 | 130 | 130 |
| Margarine (g) | 130 | 130 | 130 | 130 | 130 | 130 |
| Baking powder (g) | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| SP emulsifier (g) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Milk powder (g) | 50 | 50 | 50 | 50 | 50 | 50 |
| Vanilla (g) | 1 | 1 | 1 | 1 | 1 | 1 |
| Chocolate powder (g) | 15 | 15 | 15 | 15 | 15 | 15 |

Note: SB: sorghum-based biscuits; WB: wheat-based biscuits; SPB: sorghum-based peanut biscuits; WPB: wheat-based peanut biscuits; SOB: sorghum-based black oncom biscuits; WOB: wheat-based black oncom biscuits.

*2.5. Biscuits production*

Biscuits production process in this study was reffered to short dough biscuit. The initial stage of biscuits production was preparation of ingredients, making dough in the form of mixing eggs, margarine, and refined sugar using a vertical mixer (Philips, HR 1559, Netherland) that was rotated at 22–25 ℃ with a high speed for 5 minutes. Mixing process was performed to form a homogeneous cream which the color was pale yellow. The cream was added by powdered ingredients while continued to stir until it formed a smooth mixture for 15 minutes at low speed of 25 rpm. The dough was formed into sheets of uniform thickness, and it was molded into the desired shape. The pieces of biscuits were placed in an alumunium and were baked in an oven (Kirin, KBO 350, Indonesia) at a temperature of 150 ℃ for 25 minutes [21]. Finally, the biscuits were cooled and packed in alumunium foil pouches for further studies.

*2.6. Sensory and physical analysis*

Sensory analysis was performed in the form of a hedonic test that described the level of product preference and was carried out for 40 semi-trained panelists (32 females and 8 males of age 20–30 years). The panelists were instructed to rinse their mouth with water before tasting each sample. The panelists was asked to evaluate randomly coded biscuit in terms of 6 variables, i.e., color, aroma, texture, taste, aftertaste and overall acceptability using a hedonic scale of 1 to 9, where 1-dislike extremely, 2-dislike very much, 3-dislike moderately, 4-dislike slighthly, 5-neither like nor dislike, 6-like slightly, 7-like moderately, 8-like very much, and 9-like extremely. The product preference was carried out in individual testing booths under lamp daylight. Physical analysis was a texture analysis in the form of hardness using the Stevens LFRA texture analyzer instrument [22]. The instrument was managed to evaluate a normal measurement for the texture determination in the first force. Each sample was analyzed in a rounded edges platform, using a TA 18 probe with a speed of 2.0 mm/s and a distance of 10 mm. The maximum force was recorded as the hardness in N unit. The measurement was performed three times for each formulation.

Water absorption of biscuits was measured as bound water per gram of samples [23]. One gram of sample was added 10 ml of aquades and place to stand at temperature room for 30 minutes. Then, the sample was centrifuged (Gemmy PLC-03 8 HOLE, Taiwan) at 3000 rpm for 25 minutes. Water absorption capacity was performed as water absorbed per gram of sample.

*2.7. Nutritional content analysis*

Nutritional analysis consisted of water, ash, protein, lipid, carbohydrate, crude fiber, and dietary fiber contents that was performed using modified procedures from AOAC methods [24]. Water content analysis was began by drying alumunium crucibles in an oven (Eyela, NDO-400, Japan) for one hour and it was weighed after cooled in a desiccator ($W_0$). Then 2 grams of the sample was added in the alumunium crucible ($W_s$). The sample was dried in an oven at 105 °C for 5 hours. The sample was then cooled in a desiccator and was weighed ($W_o$). The water content was calculated by the following formula.

$$\text{Water content (\%)} = [(W_o - W_0)/W_s] \times 100 \quad (1)$$

Ash content was analyzed by drying porcelein crucibles in a furnace at 550 °C for 1 hour. The crucible was weighed after was cooled in a desiccator ($W_0$). 3 g of sample was weighed ($W_s$) in digital scale (Adam nimbus, Nbl 254, England) and added in crucibles. The sample was heated in a hot plate until fume disappeared, then the sample was charred in a furnace (Thermolyn, US) at 550 °C for 5 hours. The crucible that contained sample was weighed after was cooled in a desiccator ($W_t$). Ash content was calculated by the following formula

$$\text{Ash content (\%)} = [(W_t - W_0)/W_s] \times 100 \quad (2)$$

Protein content was analyzed by destruction, distillation and titration principles. 0.5–1 g of sample was placed in a digest flask, then 1 g selenium mix and 6 mL $H_2SO_4$ was added, and it was destructed by a digestor (Foss, DT 208, Denmark) at 420 °C for 1 hour a in fume hood. After the digest flask was cooled, sample was added by aquades 30 mL and was placed in a kjeldigester (Foss KT 200, Denmark) that was connected with erlenmeyer flask that contained 4% boric acid and mm:mb indicator. Furthemore, the sample was distillated by NaOH 40%. Distillation process generated a change of solution in the Erlenmeyer flask from purple to green. The sample was titrated by HCl 0.1 N until the color changed to pink. The volume of HCl was recorded in mL, and the protein content was calculated by the following formula:

$$\text{Protein content (\%)} = [(\text{titar volume} - \text{blank volume}) \times N\ HCl \times 14.007 \times 6.25/\text{mg sample})] \times 100 \quad (3)$$

Note: N HCl: normality of HCl.

Soxtec (Foss, ST 243, Denmark) instrument was used to analyze the lipid content. A flat boiling flask was dried in an oven at 105 °C for 1 hour. The flask was weighed after being cooled ($W_0$), then it was filled with 30 mL hexane solution for the sample extraction. 0.5 g of sample was weighed ($W_s$) and was placed in a sample paper, then it was inserted in the tube, after that the upper side of tube was closed by cotton. The tube and flask were placed in the soxtec for the extraction process for 72 minutes. The sample flask was taken and was dried in an oven at 105 °C for 1 hour. The sample flask was weighed ($W_t$) and the lipid content was calculated by the following formula:

$$\text{Lipid content (\%)} = [(W_t - W_o)/W_s] \times 100 \quad (4)$$

Carbohydrate was determined using the "by difference" method with the following formula :

$$\text{Carbohydrate content (\%)} = 100 - (\text{water content} + \text{ash content} + \text{protein content} + \text{fat content}) \quad (5)$$

Crude fiber was analyzed by the gravimetric method. 1–2 g of sample was sieved by 40 mesh sieve. Then, sample was extracted by 25 mL (three times) of petroleum eter. 100 mL of $H_2SO_4$ 1.25% was added to the sample residue. This mixture was refluxed for 30 minutes. The solution was filtered by a vacuum pump (EMD millipore, WP6122050, Germany) after it was cooled. The filtration process was continued by rinse using hot water of 40 mL (three times). Then, residue was rinsed by NaOH 1.25% and was placed in an Erlenmeyer. The rinsing water was refluxed for 30 minutes. The solution was filtered by a filter paper using a vacuum pump. The filter paper which contained residue was rinsed again with 25 mL of $H_2SO_4$ 1.25%, 25 mL (two times) of hot water and 25 mL of acetone. After rinsing process, the filter paper was dried in an oven at 105 °C for 2 hours, then the weight of filter paper was determined. The filter paper contained residue was then ashed. After the ashing process, weight of crucible was determined. The crude fiber content was calculated by the following formula:

$$\text{Crude fiber (\%)} = [((B - A) - (D - C))/W] \times 100 \quad (6)$$

Note : A: filter paper; B: filter paper + residue; C: porcelein crucible; D: porcelein crucible + sample; W: sample weight.

Dietary fiber was determined by the enzymatic-based method. 0.5 g of sample was added to a falcon flask. Sample was extracted by 15 mL (three times) of petroleum eter, then it was dried in an oven at 100 °C. Sample was transferred to a 500 mL Beaker glass. Then, 40 mL of buffer mes tris was added and the sample was stirred. 50 µL alpha amylase enzyme was added, and it was stirred. Beaker glass was covered with an alumunium foil, then it was incubated in a waterbath (Memmert, WNB14RACK, Germany) at 100 °C for 30 minutes. The sample was then cooled at 60 °C and it was rinsed with 10 mL of aquadest. Furthemore, 100 µL of protease enzyme was added and it was stirred. The solution was covered again with an alumunium foil, and it was incubated in a waterbath at 60 °C for 30 minutes. Afterwards, the alumunium foil was opened and 0.5 M of HCl was added. The pH of sample was maintained of 4.1–4.6 with an addition of 1 M of HCl or 1 M of NaOH (Ohaus, ST3100-F, USA). 200 µl amyloglucosidase enzyme was added to the solution and it was incubated at 60 °C for 30 minutes. 225 mL of ethanol 95% at 60 °C was added and it was stirred until homogeneous. The sample solution was placed for 1 hour in room temperature, then it was filtered using a pre-weighed filter paper and it was rinsed with 15 mL (two times) of 78% ethanol, 15 mL (two times) of 95% ethanol and 15 mL (two times) of acetone. The filter paper was dried in an oven at 103 °C for 12 hours. The filter paper that contained residue was weighed, then the ash and protein contents were determined. The total dietary fiber was calculated by the following formula [24].

$$\text{Ash weight} = [(\text{weight of crucible} + \text{ash}) - \text{weight of empty crucible}] \quad (7)$$

$$\text{Weight} = [(Vp \times Np \times Fk \times 14.007)/1000] \quad (8)$$

$$\text{Total dietary fiber} = [(R - A - P)/W] \times 100 \quad (9)$$

Notes: Vp: Titar volume (mL of HCl); Np: normality of HCl; Fk: protein conversion factor; R: mean of residue (gram); A: ash weight (gram); P: protein weight (gram); W: mean of sample weight (gram).

Analysis of protein digestibility was performed in vitro by modified methods [25]. Sample with 0.2 g protein content was added to a Beaker glass. 25 mL of 0.1 N HCl and 1.5 mg pf pepsin enzyme was added. The solution was incubated in a waterbath (Memmert, WNB14RACK, Germany) at 37 °C and 150 rpm for 3 hours. The pH of incubated solution was managed with 0.5N NaOH until pH reached 7 (Ohaus, ST3100-F, USA). Then, 7.5 mL of buffer posphate (pH 8), 1 mL of sodium azide and 4 mg of pancreatin enzyme were added. This mixture was incubated in a waterbath at 37 °C and 150 rpm for 24 hours. After the incubation, the solution was filtered by a pre-weighed Whatman filter paper. Dried solid sample was weighed and the protein content was analyzed by the kjeldhal method. Following these procedures, in vitro protein digestability was determined.

### *2.8. Data analysis*

Research data was processed using Microsoft Excel for Windows 2010 program and analyzed using SPSS 16.0 for Windows. ANOVA analysis and Duncan’s further test were applied to examine differences with p-value less than 0.05 ($p < 0.05$) set as the significance limit.

## 3. Results and discussion

### *3.1. Physical characteristics of biscuits*

The physical characteristics of biscuits were measured in terms of texture, i.e., hardness which is the force needed to penetrate the biscuits which is presented in Table 2. SB had the same texture characteristics as WB because the hardness were not significantly different. SPB also did not show a significant difference either with WPB or SB and WB. SOB also showed no difference with WOB, but WOB tended to be harder so the texture was significantly different from SB. The texture characteristics of peanut biscuits (SPB and WPB) were still represented in black oncom biscuits (SOB and WOB). This was reflected in the hardness that it was not significantly different from the texture of SPB and WPB. The measurement of hardness texture showed that SOB had a similar texture to WOB, so that sorghum flour can substitute wheat flour in producing black oncom biscuits.

**Table 2.** Physical characteristics of biscuits.

| Formula | Hardness (N) | Water Absorption (g/g) |
|---|---|---|
| SB | 945.29 ± 59.98[a] | 1.81 ± 0.03[a] |
| WB | 1,004.2 ± 2.68[ab] | 1.84 ± 0.05[a] |
| SPB | 997.0 ± 16.26[ab] | 2.14 ± 0.53[a] |
| WPB | 997.35 ± 2.47[ab] | 1.82 ± 0.12[a] |
| SOB | 992.55 ± 6.15[ab] | 1.92 ± 0.14[a] |
| WOB | 1014.0 ± 4.67[b] | 1.73 ± 0.01[a] |

Note: SB: sorghum-based biscuits; WB: wheat-based biscuits; SPB: sorghum-based peanut biscuits; WPB: wheat-based peanut biscuits; SOB: sorghum-based black oncom biscuits; WOB: wheat-based black oncom biscuits.

The water absorption was measured as a characteristic of biscuits if it is consumed by mashing. Table 2 shows that sorghum-based biscuits had water absorption which was not significantly different from wheat-based biscuits. If sorghum and wheat-based biscuits were added with peanuts, it also showed no difference in water absorption, similar to sorghum and wheat-based biscuits added with black oncom. The water absorption capacity of SPB and WPB showed no differences from SOB and WOB, indicating that the characteristics of peanut biscuits (SPB and WPB) were still represented in black oncom biscuits (SOB and WOB). All biscuits formulas showed that water absorption capacity was not significantly different, meaning that all biscuits can absorb water well. This charasteristic showed that water absorption capacity of all biscuits with high carbohydrate and protein contents could absorb more water and indicated the presence of hydrophilic components which in turn interacted to polar group [26]. This finding was in agreement with previous study which reported water absorption capacity from 1.45 to 2.88 [27]. Based on the functional properties, water absorption could maintain nutritional constituents in complex food systems during manufacture or storage of the product [28].

### *3.2. Sensory characteristics of biscuits*

The results of sensory analysis in the form of panelist preference (hedonic) are presented in Table 3. The panelists' preferences of SB on the taste, aftertaste and overall attributes was 4 (slighthly dislike), which is rather dislike because biscuits may have flavors and aftertaste which tended to be gritty and rough in the mouth. Preferences of SB on color, aroma and texture attributes was still acceptable. WB achieved a preference of 6 (slightly like) on all attributes, except the texture that had a value of 5 (neither like nor dislike). SB and WB showed significantly differences in aroma, taste, aftertaste and overall attributes. These findings revealed that the preference for SB tended to be lower compared to WB.

Meanwhile, the preference for SPB was not significantly different from WPB on all attributes, except the aroma because of the distinctive aroma of delicious peanut. The preference for SPB was the same as Alhassan's research [29] reporting the average preference of 5 (like). The addition of peanut-based flour ranging from 20% to 60% in wheat-based biscuits was well accepted (slightly like to moderately like) [22,30,31]. This occurred because peanut-based biscuits had a more palatable texture, aroma and taste [30]. High palatability of peanuts does not become a barrier for a regular consumption [32].

**Table 3.** Hedonic rating test results of biscuits.

| Formula | Color | Aroma | Texture | Taste | Aftertaste | Overall |
|---|---|---|---|---|---|---|
| SB | $5.90 \pm 1.59^{a}$ | $5.58 \pm 1.34^{a}$ | $6.00 \pm 1.57^{a}$ | $4.48 \pm 1.74^{a}$ | $4.12 \pm 1.58^{a}$ | $4.72 \pm 1.52^{a}$ |
| WB | $6.55 \pm 1.22^{ab}$ | $6.42 \pm 1.35^{b}$ | $5.65 \pm 1.66^{a}$ | $6.62 \pm 1.48^{b}$ | $6.50 \pm 1.36^{b}$ | $6.51 \pm 1.28^{b}$ |
| SPB | $6.62 \pm 1.41^{b}$ | $7.15 \pm 1.09^{c}$ | $6.95 \pm 1.52^{b}$ | $6.48 \pm 1.69^{b}$ | $6.05 \pm 1.77^{b}$ | $6.62 \pm 1.39^{b}$ |
| WPB | $6.72 \pm 1.28^{b}$ | $6.98 \pm 1.33^{b}$ | $6.88 \pm 1.54^{b}$ | $6.90 \pm 1.48^{b}$ | $6.45 \pm 1.55^{b}$ | $6.88 \pm 1.31^{b}$ |
| SOB | $6.20 \pm 1.42^{ab}$ | $5.72 \pm 1.55^{a}$ | $6.10 \pm 1.34^{a}$ | $5.15 \pm 1.68^{a}$ | $4.60 \pm 1.59^{a}$ | $5.15 \pm 1.53^{a}$ |
| WOB | $6.55 \pm 1.41^{ab}$ | $5.50 \pm 1.71^{a}$ | $5.55 \pm 1.65^{a}$ | $5.08 \pm 1.88^{a}$ | $4.60 \pm 1.71^{a}$ | $5.35 \pm 1.35^{a}$ |

Note: SB: sorghum-based biscuits; WB: wheat-based biscuits; SPB: sorghum-based peanut biscuits; WPB: wheat-based peanut biscuits; SOB: sorghum-based black oncom biscuits; WOB: wheat-based black oncom biscuits.

Meanwhile, the preference for SOB was not different from WOB on all attributes. The lowest preference was on the aftertaste attribute because it was rather acidic and rather bitter, but according to the panelists the aftertaste caused was still acceptable (neither like nor dislike to like slightly). Based on the sensory analysis, SOB were still acceptable even though it showed a significant difference in preference to SPB or WPB on the attributes of aroma, texture, taste, aftertaste and overall. The hedonic test results also showed that there were differences in the sensory characteristics of black oncom biscuits (SOB , WOB) with peanut biscuits (SPB, WPB) that influenced the preferences. In addition, sorghum flour can still substitute wheat flour if added with peanuts or black oncom flour. This is in agreement with Singh's research [33] that the production of sorghum biscuits with an addition of peanut flour can improve the acceptance.

### *3.3. Nutritional contents of biscuits*

The nutritional contents of the biscuits is presented in Table 4 which shows that SB and WB showed no significant differences in the energy, fat, carbohydrate, crude fiber and water contents per 100 g of biscuits. Significant differences were found in protein, protein digestibility, dietary fiber, and ash content, in which WB had higher protein and protein digestibility than SB. SB had higher dietary fiber and ash content than WB. High levels of dietary fiber affected the digestibility of SB.

Meanwhile, the addition of peanuts increased energy and protein contents, protein digestibility, fat, crude fiber, ash content and reduced carbohydrate in SB, as well as WB. SPB had significantly different fat, dietary fiber and ash content from wheat-based peanut biscuits, in which SPB had higher fat, dietary fiber and ash content. Therefore, sorghum tended to contribute dietary fiber in the biscuits because sorghum flour had dietary fiber content (2.04–4.84 g/100 g) [16]. The nutritional content of SPB in this study was not significantly different from the Alhassan study [29], and the content of WPB was consistent with the study [34]. The content of WPB in this study was different from Singh's [20] study that wheat-based peanut biscuits had crude fiber 12.24%, protein 38.50%, fat 13.25%, and carbohydrate 27.01%.

**Table 4.** Nutritional contents of biscuits in dry basis.

| Parameter | SB | WB | SPB | WPB | SOB | WOB |
|---|---|---|---|---|---|---|
| Water content (g/100 g) | 3.63 ± 0.37$^{a}$ | 5.03 ± 0.074$^{ab}$ | 3.65 ± 0.34$^{a}$ | 4.72 ± 0.66$^{ab}$ | 4.73 ± 0.91$^{ab}$ | 5.14 ± 0.64$^{b}$ |
| Ash content (g/100 g) | 1.47 ± 0.01$^{b}$ | 1.34 ± 0.02$^{a}$ | 1.93 ± 0.0$^{d}$ | 1.75 ± 0.08$^{c}$ | 1.98 ± 0.03$^{d}$ | 1.87 ± 0.09$^{cd}$ |
| Protein (g/100 g) | 5.61 ± 0.15$^{a}$ | 6.32 ± 0.13$^{b}$ | 12.18 ± 0.27$^{c}$ | 12.53 ± 0.14$^{c}$ | 15.12 ± 0.21$^{e}$ | 14.45 ± 0.29$^{d}$ |
| Fat (g/100 g) | 19.96 ± 0.08$^{a}$ | 20.33 ± 0.37$^{a}$ | 31.78 ± 0.77$^{c}$ | 29.41 ± 0.38$^{b}$ | 28.18 ± 0.10$^{b}$ | 29.83 ± 1.99$^{bc}$ |
| Carbohydrate (g/100 g) | 72.96 ± 0.25$^{b}$ | 72.02 ± 0.26$^{b}$ | 54.10 ± 0.49$^{a}$ | 56.31 ± 0.61$^{a}$ | 54.71 ± 0.08$^{a}$ | 53.83 ± 2.37$^{a}$ |
| Saturated fat (g/100 g) | na | na | 12.10 ± 0.12$^{a}$ | na | 14.39 ± 3.04$^{a}$ | na |
| Fat energy (kkal/100g) | 173.16 ± 0.063$^{a}$ | 173.76± 3.08$^{a}$ | 275.62 ± 7.70$^{c}$ | 252.18 ± 5.09$^{b}$ | 241.67 ± 3.21$^{b}$ | 254.65 ± 15.34$^{b}$ |
| Total energy (kkal/100 g) | 476.04 ± 1.49$^{a}$ | 471.34 ± 1.33$^{a}$ | 531.06 ± 5.61$^{c}$ | 514.53 ± 5.13$^{b}$ | 507.79 ± 5.25$^{b}$ | 513.79 ± 5.69$^{b}$ |
| Crude fiber (g/100 g) | 0.15 ± 0.18$^{a}$ | 0.02 ± 0.00$^{a}$ | 0.69 ± 0.37$^{b}$ | 1.09 ± 0.11$^{b}$ | 1.06 ± 0.09$^{b}$ | 0.08 ± 0.09$^{a}$ |
| Dietary Fiber (g/100 g) | 9.18 ± 0.122$^{b}$ | 5.86 ± 0.16$^{a}$ | 9.69 ± 0.05$^{b}$ | 6.23 ± 1.05$^{a}$ | 8.17 ± 1.67$^{ab}$ | 5.85 ± 0.94$^{a}$ |
| Protein digestibility (%) | 53.20 ± 4.47$^{b}$ | 73.28 ± 15.04$^{a}$ | 70.98 ± 1.45$^{a}$ | 73.75 ± 0.53$^{a}$ | 76.28 ± 0.77$^{a}$ | 76.38 ± 1.26$^{a}$ |

Note: SB: sorghum-based biscuits; WB: wheat-based biscuits; SPB: sorghum-based peanut biscuits; WPB: wheat-based peanut biscuits; SOB: sorghum-based black oncom biscuits; WOB: wheat-based black oncom biscuits; na: not analyzed.

The addition of black oncom flour increased the energy and protein content, protein digestibility, fat, crude fiber and reduced carbohydrate in SB, as well as in WB. SOB tended to have higher protein than WOB, but its protein digestibility was not significantly different. WOB tended to have higher protein content than WPB, but its protein digestibility was not significantly different despite the higher digestibility of black oncom protein. SOB tended to have higher protein content and lower fat than SPB, but its protein digestibility was not significantly different even though the digestibility of black oncom protein was higher. The high digestibility of protein in black oncom biscuits (SOB and WOB) occurred because black oncom was a fermented peanut meal, in which protein had been fragmented so that the digestibility of the protein was increased.

Therefore, SOB have good potential to be developed because it achieved a nutritional content that tended to be higher than peanut biscuits (SPB, WPB) and it was not much different from WOB. The nutritional contents of SOB has the potential to overcome nutritional problems in the elderly people. This was supported by other studies reported that black oncom extract supports weight management, growth performance, learning ability and memory of mice [11]. Furthermore, the protein contained in peanuts can improve the memory ability of normal mice. Therefore, it can be used as food that has the potential to improve neurodegenerative diseases [35]. In addition, the high fat content of black oncom, one of which is oleic fatty acid, can improve cerebrovascular and the cognitive function [36].

SPB and SOB have higher fat content than the other formula, so it was analyzed saturated fat content (Table 4). The saturated fat of SPB and SOB showed that have no significant difference, indicating that fermentation process of peanut meal as substrat to produce black oncom flour have fat content as same as with peanut flour. According to this, the saturated fat of the biscuits have higher than american biscuit which contain 4.31–13.33% of saturated fat [37]. Even though, saturated fat content of the biscuits accordance to Malaysian and british biscuit [38,39] and it have lower than egyptian biscuit and Sri Lanka' biscuit which contain 64.35–85.43% and 18.957–43.592% of saturated fat, respectively [40,41]. Based on this formula of biscuits, addition of peanut flour and black oncom flour contribute to increase fat content, indicating the formula have to be improved especially in reduction of fat composition to decrease saturated fat content through fat replacement with other fat source or technical.

### *3.4. Contribution of biscuit nutrition to the elderly nutrition adequacy ratio*

Based on nutritional contents obtained, SOB had a nutritional content that tended to be higher than WB, WOB, SPB, and WPB, especially in the protein content. Sorghum-based black oncom biscuits (SOB) can be used as a supplementary food for elderly people with a contribution of 15% to the nutrition adequacy of the elderly based on the Nutrition Adequacy Ratio as presented in Table 5. The required number of biscuits serving to achieve this contribution was 55 gram.

**Table 5.** Contribution of biscuit nutrition to the elderly nutrition adequacy ratio.

| Biscuit | Gender | Energy (%) | Protein (%) | Fat (%) | Carbohydrate (%) | Fiber (%) |
|---|---|---|---|---|---|---|
| SOB | Male | 15.42 | 13.42 | 29.25 | 9.74 | 26.45 |
| | Female | 18.91 | 14.85 | 36.05 | 11.94 | 20.44 |

The contribution of biscuits to the nutrition adequacy, especially energy, protein and fat to the Nutrition Adequacy Ratio of elderly men tended to be lower than elderly women because men have higher nutritional needs than women. The highest contribution of nutritions was in fat nutrition of 29.25% for the nutrition adequacy of elderly men and 36.05% for elderly women, while the contribution of fiber reached 26.45% for the nutrition adequacy of elderly men and 20.44% for elderly women. stated that the contribution of fat nutrition and fiber of biscuits from peanuts contributed protein and dietary fiber by 16.8% and 10.2%, respectively [42], to the nutrition adequacy of elderly women, while the contribution to the nutrition adequacy of elderly men was 12.1% and 8.5%, respectively.

## 4. Conclusion

SOB had physical characteristics of hardness and water absorption which were not significantly different from WB and SB either with the addition of peanuts flour, black oncom flour or without addition. The results of sensory analysis showed that SOB had an acceptable preference as WOB, but it had a significantly lower preference than SPB or WPB due to different sensory characteristics between peanuts and black oncom. SOB had significant differences with SB and WB in nutritional contents, but did not have a significant difference with SPB, WPB, and WOB, except for the protein content and ash content. Even though, the biscuit have to analyze sugar content because it is the key for health of elderly. SOB can be used as a supplementary food for the elderly people with a contribution of 15–18% to the total energy adequacy of elderly people and a number of biscuits serving of 55 gram, but it have to reformulate espescially in fat composititon to produce low saturated fat content through other technical and fat source.

**Acknowledgments**

The author thank the Ministry of Research and Technology for providing PMDSU (Scholarship Programs Leading to Doctoral for Distinguished Bachelors) and research scholarships 2018–2019.

**Conflict of interest**

All authors declare no conflict of interest in this paper.

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