The effect of addition pumpkin and carrot puree on the physicochemical and textural properties of mocaf biscuit as complementary food

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Abstract. Mocaf biscuits were developed with the addition of pumpkin and carrot puree used as complementary foods. The purpose of this study was to determine the effect of the addition of pumpkin and carrot puree on the chemical, color and textural properties of a mocaf biscuit. This study conducted using a completely randomized design with 2 factors namely type of puree (pumpkin and carrot) and concentration of puree (15, 20 and 25%). The obtained results indicated that the addition of pumpkin and carrot puree on the making of mocaf biscuit significantly affected the moisture content, protein, fat, carbohydrate, total carotenoid, a*, b* and hardness. The best treatment in this study was carried out using the de Garmo method based on the effectiveness index. The best treatment was mocaf biscuit with addition 15% carrot puree which had moisture content, ash, fat, protein, carbohydrate, energy, total carotene, total dietary fiber, L*, a*, b*, hardness and fracturability as follows 6.31%, 2.27%, 6.88%, 12.84%, 71.71%, 429.88 kcal/100g, 85.16 µg / g, 4.59%, 78.47, 5.54, 28.80, 778.85 gf, and 6.36 mm, respectively.

1. Introduction
Complementary foods are foods that are introduced to children at six months of age in the form of liquid, semisolid and solid [1]. Instant porridge and biscuits are the most popular complementary foods which are easy to prepare in a short time [2]. Biscuits are the small baked product where it is produced using flour, sugar and fat as its main ingredients and they have a long shelf life due to their low moisture contents [3]. Biscuits are ready to eat, cheap and convenient food product that is consumed as complementary foods [4]. Unfortunately, biscuits are generally made from imported wheat flour. Alternative ingredients such as cassava flour can be used to make biscuits as a complementary food.

Cassava (Manihot utilisima) is one of the most important staple food crops in Indonesia. In 2017, Indonesia ranked fourth among the world's cassava producing countries with 19 million tons of cassava production, above Brazil, Ghana, and Angola [5]. Cassava contained carbohydrates and high calories (161 Kcal), moisture content (60%), starch content (25-35%), protein, minerals, fiber, calcium, and phosphate [6]. Modified cassava flour (mocaf) is a fermentation product of cassava. This product can be used to replace wheat flour in the manufacture of various food products [7]. Afifah and Ratnawati [8] stated that mocaf flour had moisture content (10.62%), ash (1.29%), protein (1.77%), amylose and
The quality of mocaf biscuit can be improved by adding vegetables. Carrot (*Daucus carota* L.) is one of the most important root crops. Because the carrot has high vitamin (A, B1, B2, B6, B12), β-carotene and fiber content, it is used commonly for human nutrition [10]. Pumpkin (*Cucurbita moschata*) is one of the most desirable vegetables and abundantly available in Indonesia [11]. Foods prepared from pumpkin could have a nutritional advantage in terms of vitamins, minerals, and dietary fiber content [12]. Pumpkin provides a valuable source of carotenoids, pro vitamin A and ascorbic acid, which play major roles in human nutrition and have importance as antioxidants [13]. A previous study has reported the incorporation of pumpkin with wheat flour in biscuit formulation increased protein, crude fibre, calcium, carotene and vitamin C of biscuit [14]. In this study, mocaf biscuits were developed with the addition of pumpkin and carrots puree used as complementary foods. The purpose of this study was to determine the effect of additional pumpkin and carrot puree on the physicochemical and textural properties of mocaf biscuit.

2. Materials and Methods

2.1. Material

The raw materials that were used for this study include mocaf, mung bean flour, corn starch, egg, carrot, pumpkin, sugar, baking powder, unsalted butter, soy lecithin and guar gum. Mocaf was obtained from UKM Harapan Jaya, Subang, West Java, Indonesia. Mung bean flour was purchased from Fits Mandiri, Bogor, West Java, Indonesia. Carrot, pumpkin, egg, sugar (Gulaku), corn starch (Maizenaku), baking powder (Koepoe-Koepoe) were purchased from a local market at Subang, West Java, Indonesia. Unsalted butter (Anchor), soy lecithin, and guar gum were obtained from Kijang Mas, Bandung, West Java, Indonesia.

2.2. Preparation of mocaf biscuit

Mocaf biscuits were prepared according to the method by Ratnawati et al [9]. The formulation of mocaf biscuit are shown in Table 1. This study using a completely randomized design with 2 factors namely the type of puree (pumpkin and carrot) and concentration of puree (15, 20 and 25%). Selection of the best treatment of mocaf biscuit using de Garmo method.

| Ingredients (%) | Treatments   | P15 | P20 | P25 | C15 | C20 | C25 |
|-----------------|--------------|-----|-----|-----|-----|-----|-----|
| Mocaf : pure    |              | 25:15| 20:2| 15:2| 25:1| 20:2| 15:25|
| Mung bean flour |              | 12  | 12  | 12  | 12  | 12  | 12  |
| Corn starch     |              | 12  | 12  | 12  | 12  | 12  | 12  |
| Egg             |              | 10  | 10  | 10  | 10  | 10  | 10  |
| Sugar           |              | 12  | 12  | 12  | 12  | 12  | 12  |
| Unsalted butter |              | 10  | 10  | 10  | 10  | 10  | 10  |
| Baking powder   |              | 2   | 2   | 2   | 2   | 2   | 2   |
| Soy lecithin    |              | 1   | 1   | 1   | 1   | 1   | 1   |
| Guar gum        |              | 1   | 1   | 1   | 1   | 1   | 1   |

Biscuit dough was prepared in a mixer (Philips HR 1530), sheeted and rolled out into thin sheet of uniform thickness (approximately the thickness 6 mm) and cut into desired shape using mould. The cut pieces were placed over a perforated tray and transferred into a baking oven (Mah Yi) at 150°C for 10
min. Then, the biscuits were then inverted and baked again at 100°C for 20-30 min. The well baked biscuits were cooled to room temperature and stored in polypropylene (PP) plastic till further use.

2.3. Product analysis

The moisture content, ash and fat were determined using the procedure described by Indonesian National Standard [15]. Protein content was analysed using a DuMaster protein analyzer (DuMaster D-480, Buchi, Switzerland). Carbohydrate content was obtained by differences, while energy value was calculated using the At water conversion factors for protein (4 kcal/g), carbohydrate (4 kcal/g), and lipid (9 kcal/g) [16]. Total dietary fiber of biscuit was performed using a combination of enzymatic and gravimetric method [17]. Total carotenoids was determined using a Ultra Violet Spectrophotometer at 450 nm. Approximately 0.1 g of the samples were weighed and extracted using 2 ml n-hexane. The solution mixed using vortex for 2 min and centrifuged for 3 min. The residue was extracted again using 1 ml n-hexane and this procedure was repeated five times. The filtrate evaporated with gases of nitrogen. Dissolve with methanol, transferred to 10 ml volumetric flask, the volume was made up by methanol and read at 451 nm. The total carotenoid content was calculated using the following equation:

\[
\text{Total carotenoid (µg/g)} = \frac{A \times V}{W} \tag{1}
\]

where A is sample absorbance, V is volume extract, and W is the sample weight.

Color instrumental parameters were determined using colorimeter (NH310, China) according to CIELab system. The results were expressed in L*, a* and b*, with L for lightness (L=0-100 (black-white)), a* for greenness (-60) to redness (+60) and b* for blueness (-60) to yellowness (+60).

Textural properties of biscuit were measured according to Ratnawati et al [9]. Textural properties were measured by the hardness and fracturability of biscuit using a TA.XTPlus texture analyzer (Stable Micro System, Surrey, UK). A three-point bending rig (type HDP/3PB) was used to cut samples after placement on base beams that were 4 cm apart. The compression strength of samples were measured using the following conditions: test mode, compression; test speed, 3 mm/s; target mode distance; distance, 4 mm. Peak forces (g) and mean distances at breakage (mm) were recorded.

2.4. Statistical analysis

An Analysis of Variance (ANOVA) and Duncan test (confidence level, α:0.05) were performed on the obtained results in order to establish significant differences. SPSS version 13 was used for data treatment and statistical analysis. All measurements were carried out in triplicate and the results were expressed as the mean value ± standard deviation (SD).

3. Results and Discussion

3.1. Chemical properties of mocaf biscuit

Table 2 shows the chemical composition of mocaf biscuit with the addition of pumpkin and carrot puree in the different level concentration. The result found that the puree type and puree concentration increased (p<0.05) the moisture content of mocaf biscuits. The moisture content of the biscuits in this study were ranged from 5.81 to 8.41%. The moisture content of biscuit as complementary food met SNI 01-7111.2-2005 which requires a maximum moisture content of 5% [18]. The moisture content of the biscuit in this study not fulfilled the Indonesian national standard. The addition of carrot puree produces biscuits with a higher moisture content than the addition of pumpkin puree. It is due to the different moisture content of both ingredients and the carrot (91.6%) has a higher moisture content than pumpkin (87.30%) [19, 20].

Type and concentration of puree were not significantly affected the ash content (p>0.05). The ash content of the biscuits from this study was ranged from 2.27 to 2.70% and had met the Indonesian national standard of the biscuit as complementary food (SNI 01-7111.2-2005) that the ash content maximum of 3.5 % [18]. The ash content with the addition of pumpkin puree tends to be higher than
biscuit with the addition of carrot puree. It occurs due to the ash content of pumpkin puree (7.5%, db) was higher than carrot puree (1.40%) [14, 20].

Table 2 showed that the protein content of biscuits increased (p<0.05) with the addition of pumpkin and carrot puree. The range of protein content were from 6.60 to 7.21% and had met the Indonesian national standard of the biscuit as complementary food (SNI 01-7111.2-2005) in which the protein is not less than 6% [18]. Protein content increased as the concentration of puree increased.

The result of biscuit fat content are also shown in Table 2 and obtained that the fat content of biscuit was significantly different (p<0.05). The range of fat content of biscuit was from 12.84 to 17.16% and had met the Indonesian national standard of the biscuit as complementary food (SNI 01-7111.2-2005) among 6 to 18% [18]. The fat content of biscuits with the addition of pumpkin puree tends to be higher than carrot puree. It is caused by the fat content of pumpkin puree (1.77%) is higher than carrot puree (0.20%) [14, 20].

### Table 2. Chemical composition of mocaf biscuit.

| Parameter                  | P15       | P20       | P25       | C15       | C20       | C25       |
|----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Moisture content (% wb)    | 5.81±0.58a| 7.44±0.05bc| 7.22±0.22b| 6.31±0.52a| 7.94±0.25cd| 8.41±0.18d|
| Ash (% wb)                 | 2.54±0.05abc| 2.65±0.03bc| 2.70±0.06c| 2.27±0.08a| 2.28±0.01a| 2.37±0.39abc|
| Protein (% wb)             | 6.60±0.12a| 6.99±0.12bc| 7.05±0.10c| 6.88±0.06b| 7.21±0.23bc| 7.15±0.04c|
| Fat (% wb)                 | 15.17±1.36abc| 16.07±1.52cd| 17.16±0.22d| 12.84±0.19a| 13.35±0.60abc| 13.95±1.15abc|
| Carbohydrate (% wb)        | 69.88±0.63d| 66.85±1.62ab| 65.87±0.21a| 71.71±0.24d| 69.21±0.67c| 68.12±1.66bc|
| Energy (kcal/100 g)        | 442.43±9.30b| 440.00±7.61b| 446.15±1.97b| 429.88±2.85a| 425.85±3.79a| 426.65±3.75a|
| Total caroten (µg/g)       | 69.97±0.49a| 72.88±5.93a| 156.41±0.00c| 85.16±0.49b| 114.83±1.11d| 101.78±8.73c|

Superscripts within the same row with a different letter are significantly different at (p<0.05)

The results in Table 2 showed that the carbohydrate content of the biscuit was significantly different (p<0.05) with the addition of pumpkin and carrot puree. The carbohydrate content was ranged from 65.87 to 71.71 %. The carbohydrate content of biscuits tends to decrease with the puree concentration increases. It is due to the higher puree concentration results in an increase in other nutrients than carbohydrates, namely moisture, ash, protein and fat so that the percentage of carbohydrates in biscuits had decreased.

The energy of food products is influenced by protein, fat and carbohydrate content. Biscuit in this study had the energy were ranged from 425.85 to 446.15 kcal/100 g. This is in accordance with the requirement of energy in the biscuit as complementary food (SNI 01-7111.2-2005) in which the energy content is not less than 400 kcal/100g [18]. Mocaf biscuit with addition of pumpkin puree had higher energy than carrot puree. It is caused by the biscuit with addition pumpkin puree has a higher fat content than a biscuit with the addition of carrot puree.

Pumpkin and carrot puree were significantly (p<0.05) increased the total carotenoid of biscuit. Total carotenoid of biscuit was ranged from 69.97 to 156.41 µg/g. The addition of pumpkin puree in a mocaf biscuit had higher total carotenoid than carrot puree biscuit. This result can be due to the total carotenoid in pumpkin puree (48.57 mg/100g) had higher than carrot puree (8.31 mg/100g) [14, 21]. Total carotenoid increased as the concentration of pumpkin and carrot puree increased. Similar results also reported by Gurung et al [14] that the addition of pumpkin puree increased total carotene in biscuit.

The total dietary fiber of the biscuit is presented in Figure 1. The addition of pumpkin and carrot puree tends to increase the total dietary fiber of biscuit. In this study, total dietary fiber was ranged from 3.89 to 5.37%. The samples of P15, C15 and C20 had met the Indonesian national standard of the biscuit as complementary food (SNI 01-7111.2-2005), while the other samples namely P20, P25 and C25 not fullfilled the Indonesian national standard. The requirement of total dietary fiber in the biscuit as
complementary food (SNI 01-7111.2-2005) in which the total dietary fiber content is not more than 5% [18]

![Figure 1. Total dietary fiber of mocaf biscuit.](image)

3.2 Color and textural properties of mocaf biscuit

Color is one of the most important attributes that affect directly the consumer preference of any product. The color for $L^*$, $a^*$ and $b^*$ values of mocaf biscuit as complementary food showed in Table 3. $L^*$ values represent lightness/darkness, $a^*$ values represent red/green color, and $b^*$ values represent yellow/blue color [22]. Type and concentration of puree resulted in the not significantly different for $L^*$ values ($p>0.05$) of biscuit. On the contrary, the type and concentration of puree were significantly affected $a^*$ and $b^*$ values ($p<0.05$). The higher puree concentration of pumpkin and carrots, the lower $L^*$ values, while the higher of $a^*$ and $b^*$ values. The highest of $L^*$ values obtained in the lowest concentration of pumpkin and carrots puree were 77.36 and 76.47. Meanwhile, the highest $a^*$ and $b^*$ values were obtained in biscuit sample with an addition 25% of puree were 8.78 and 33.70. The trend similar to the biscuit with the addition of carrots powder [23] and biscuit with the addition of pumpkin powder [24]. According to Arifin et al [25] the lower $L^*$ indicates a darker color caused by non-enzymatic browning between the beta carotene in pumpkin puree and flour that occurs during the baking process. In addition, the decrease in $L^*$ value occurs due to browning reaction as a result of Maillard reaction and degradation of carotenoid pigments [10]. The increase in $a^*$ and $b^*$ value along with the increase in the concentration of puree added is caused by the higher beta carotene content which carries a yellow/orange color [23, 25].

| Parameter | P15          | P20          | P25          | C15          | C20          | C25          |
|-----------|--------------|--------------|--------------|--------------|--------------|--------------|
| $L^*$     | 77.36±4.50$^{ab}$ | 77.12±1.12$^{ab}$ | 73.80±0.44$^a$ | 78.47±0.60$^b$ | 76.35±0.89$^{ab}$ | 74.29±0.67$^a$ |
| $a^*$     | 4.25±0.15$^a$  | 5.74±0.84$^b$  | 8.78±0.09$^{ab}$ | 5.54±0.29$^b$  | 6.84±0.68$^a$  | 8.45±0.43$^d$  |
| $b^*$     | 28.33±1.40$^a$ | 29.36±0.51$^b$ | 33.70±1.05$^{ab}$ | 28.80±1.08$^{ab}$ | 31.10±0.75$^b$ | 30.11±0.32$^{bc}$ |
| Hardness (gf) | 771.23±59.55$^a$ | 909.83±44.85$^a$ | 1348±117.77$^b$ | 778.85±168.14$^a$ | 812.23±56.91$^a$ | 1424.87±137.11$^b$ |
| Fracturability (mm) | 6.11±0.12$^a$   | 6.57±0.10$^a$   | 6.57±0.68$^a$   | 6.36±0.16$^a$   | 6.46±0.18$^a$   | 6.48±0.29$^a$   |

Superscripts within the same row with the different letter are significantly different at ($p<0.05$)

Hardness is the amount of force required to break the sample [26]. As could be seen in Table 3 that the addition of pumpkin and carrot puree was significantly affected ($p<0.05$) the hardness of the biscuit. The addition level of pumpkin and carrot puree was increased from 15 to 25% the hardness of biscuit increased considerably. The result in this study in accordance with previous studies conducted by Mridula [23] and Kulkarni et al [26]. They stated that the replacement level of wheat flour by carrot and pumpkin powder increased the hardness of the biscuit [23, 26]. This might have resulted from the higher
protein content of dough due to the need for more water to obtain good cookie dough, and the cookies prepared from high absorption dough tend to be extremely hard [24]. The higher the puree concentration, the higher the protein content of biscuit (Table 2).

Fracturability is the amount of force required to give the first crack on the sample while breaking [26]. The addition of pumpkin and carrot puree not significantly affected (p>0.05) the fracturability of the biscuit. Fracturability of the biscuit in this study were ranged from 6.11 to 6.57 mm and tends to increase with the increasing concentration of pumpkin and carrot puree. A similar trend also reported by Kulkarni et al [26], that the replacement level of wheat flour with pumpkin powder was increased the fracturability of biscuit.

3.3 Selection of the best treatment
The selection of the best treatment using the de Garmo method could be seen in Table 4. Selection of the best treatment based on the highest total yield value (ΣNh). From Table 2 it is known that the best treatment was biscuits with the addition of 15% carrot puree. The best treatment had moisture content, ash, fat, protein, carbohydrate, energy, total carotene, total dietary fiber, L*, a*, b*, hardness and fracturability as follows 6.31%, 2.27%, 6.88%, 12.84%, 71.71% , 429.88 kcal / 100g, 85.16 µg / g, 4.59%, 78.47, 5.54, 28.80, 778.85 gf, and 6.36 mm, respectively.

Table 4. Effectiveness index of mocaf biscuit.

| Treatments | ΣNh  | Ranking |
|------------|------|---------|
| C15        | 1.29 | 1       |
| P15        | 1.19 | 2       |
| C20        | 1.19 | 3       |
| P25        | 0.85 | 4       |
| P20        | 0.77 | 5       |
| C25        | 0.67 | 6       |

4. Conclusions
The addition of pumpkin and carrot puree in mocaf biscuit has a significant effect on the moisture content, protein, fat, carbohydrate, total carotenoid, a*, b* and hardness. The best treatment was mocaf biscuit with addition 15% carrot puree which had moisture content, ash, fat, protein, carbohydrate, energy, total carotene, total dietary fiber, L*, a*, b*, hardness and fracturability as follows 6.31%, 2.27%, 6.88%, 12.84%, 71.71% , 429.88 kcal / 100g, 85.16 µg / g, 4.59%, 78.47, 5.54, 28.80, 778.85 gf, and 6.36 mm, respectively.

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