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Development of gluten-free biscuits made from composite flour of cassava (*Manihot esculenta* Crantz) and cowpea (*Vigna unguiculata* (L.) Walp)

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Abstract

Biscuit is a ready-to-eat, convenient, and inexpensive food product. It is one of many baked products often make with wheat flour. Nonetheless, people with gluten intolerance cannot consume wheat flour. In this research, gluten-free biscuits made with a composite flour of cassava and cowpea with different ratio (90:10, 80:20, and 70:30). The result has shown that gluten-free biscuits with 70:30 gave the highest dietary fibre content (20.54±0.32%). The combination of 70:30 cassava flour (CF) and cowpea flour (CPF) gave lightness (L*) value 60.58±1.22 means darker colour to biscuits with 4.13±0.07% of moisture content. From the scoring test, the panellists were perceived F3 as having less crunchy texture (3.51±1.20), less intensity of foreign aroma (2.60±0.87), brown colour (4.37±1.10), and slight foreign taste detected (3.01±1.10). From the hedonic test result, the panellists were neutral in the acceptances of texture (4.44±1.37), foreign aroma (4.94±1.20), and colour (4.96±1.2). The panellists have slightly liked the overall acceptance and foreign taste of gluten-free biscuits within the value of 5.01±0.97 and 5.04±1.20. Thus, the study suggests that F3 consist of 70:30 CF and CPF is selected as the best formulation to make gluten-free biscuits.

1. Introduction

Cassava is one of the most cultivated plants in Indonesia. It has been categorized as a good source of carbohydrates due to its higher starch content (65-70%). However, the freshly harvested cassava has a limited shelf life due to higher moisture content (40-70%). Thus, it will limit the utilization of the cassava itself. The processing of cassava into flour could enhance stability and long-term storage (Uchechukwu-Agua *et al*., 2015). Soedirga *et al*. (2018) reported that the drying method could increase several nutritional components in cassava, such as dietary fibre. Cassava flour (CF) obtained from an oven drying method at 60°C for 24 hrs have 13.72±0.53 % of dietary fibre content, which is significantly higher, compared to CF obtained from cabinet drying method (9.05±0.49%) and microwave-oven drying method (7.00±0.11%). Aside from cassava, cowpea is one of the legumes which have higher fibre content. According to the USDA (2016), fresh cowpeas contain 10.6 g of food fibre in 100 g of material. Although it is rich in nutrients, the utilization of cowpea itself is still limited.

Biscuit is one of the wheat flour-based products and is widely consumed due to low manufacturing cost and convenience (Nilugin *et al*., 2015). However, the gluten in wheat flour limits its consumption, especially for people who suffer from gluten intolerance. Furthermore, wheat flour also has low fibre content. The recent trend has shown an increase in dietary fibre consumption and gluten-free products (Gibson *et al*., 2019). This research began with the composite flour making of cassava and cowpea into three different ratios and subjected to the biscuit's formulations. This research aimed to determine the preferred formulation toward physicochemical characteristics and sensory properties of gluten-free biscuits.

2. Materials and methods

2.1 Materials

The primary materials used were cowpea obtained from Tangerang, Indonesia, and cassava flour obtained from previous research conducted by Soedirga *et al*. (2018). The cassava was dried by using an oven method for 24 hrs at 60°C. The dried cassava was grounded using a dry blender and sifted (80-mesh) to obtain cassava flour. While the supporting materials were granulated sugar, salt, egg, margarine, skim milk

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powder, distilled water, vanilla essence, and baking powder.

The materials used for the analyses were phosphate buffer pH 7 (Sigma Aldrich), alpha-amylase enzyme (CAS No.9000-90-2, Sigma Aldrich), Hydrochloric acid (1M, 37%, p.a, Merck), pepsin enzyme (CAS No.9001-75-6, Sigma Aldrich), sodium hydroxide (0.1 N, 3.5%, p.a, Merck), beta-amylase enzyme (CAS No.9000-91-3, Sigma Aldrich), ethanol (99.7%, p.a, Smart Lab), acetone (99.5%, p.a, Smart Lab). While the equipment used were cabinet dryer (Wangdi W), oven (Memmert UNB 500), dry blender (Phillips), sieve shaker (Retsch), mixer (Phillips), rolling pin, round ring cutter, analytical balances (Ohaus U-1800 AR 2140), furnace (Thermolyne 62700), glassware (Iwaki Pyrex), desiccator (Duran), chromameter (Konica Minolta CR-400), and granular-materials attachment (Konica Minolta CR-A50).

2.2 Research method

In this experiment, different ratios of CF and CPF were subjected to three different formulations of biscuits, namely F1 (90:10), F2 (80:20), and F3 (70:30). This experiment used 3 replications.

2.2.1 Cowpea flour (CPF) making

Cowpea flour (CPF) is made according to Phebean *et al.* (2017) and Oladunmoye *et al.* (2010) with modifications. Fresh cowpea was sorted, washed, then soaked in distilled water (1:10, w/v). After 2 hrs of soaking, the skin of the cowpea peeled. The skinless cowpea was then boiled for 15 mins, dried using a cabinet dryer at 60°C for 8 hrs. The dried cowpea was grounded using a dry blender and sifted (80-mesh) to obtain CPF. The moisture and dietary fibre content were analysed by using the oven method (AOAC, 2005) and the multienzyme method (AOAC, 1995). Yield, moisture content, and the dietary fibre content of CPF calculated using the formula as follow:

$$\text{Yield (\%)} = \frac{\text{weight of flour obtained after sieving process (g)}}{\text{initial weight of dried cowpea (g)}} \times 100\%$$

$$\text{Moisture content (\%)} = \frac{\text{initial weight of sample (g)} - \text{final weight of sample (g)}}{\text{initial weight of sample (g)}} \times 100\%$$

$$\text{Dietary fibre content (\%)} = \text{soluble dietary fibre (\%)} + \text{insoluble dietary fibre (\%)}$$

2.2.2 Gluten-free biscuits making

The making of gluten-free biscuits refers to Ashaye *et al.* (2015) and Olapade *et al.* (2011) with modifications. The biscuits' formulation is mentioned in Table 1. Sugar and margarine were mixed, then the composite flour, skim milk powder, salt, baking powder, and vanilla essence were added to prepare the dough. The egg was added, and the dough was thoroughly kneaded for 5 mins. The dough was rolled to 0.2 cm thickness using a rolling pin. Round-shape biscuits were cut using a ring cutter and baked on greased pans for 15 mins at 160°C in an oven.

Table 1. Gluten-free biscuits formulations

Ingredients	Composition (g)
Composite Flour (CF: CPF)	100*
Sugar	34
Margarine	36
Skim Milk Powder	6
Egg	32
Salt	0.3
Baking powder	0.5
Vanilla essence	0.5

*Ratio CF: CPF = 90:10; 80:20; 70:30
Source: Ashaye *et al.* (2015) and Olapade *et al.* (2011) with modifications

After baking, the biscuits were cooled at room temperature before being subjected to several analyses such as moisture content, dietary fibre content, lightness value (L*), organoleptic properties (scoring and hedonic test). The calculation of moisture and dietary fibre content uses the same method and formula for moisture and dietary fibre content for CPF. The biscuits analysed for their L* by using chromameter. The value of L* shown the degree of lightness which ranging from 0-100 (0 = black, 100 = white).

The sensory properties of the gluten-free biscuits determine by performing an organoleptic test which included scoring and a hedonic test to a total of 70 untrained panellists from Universitas Pelita Harapan with the age range of 17-20. The scoring test intended to determine the intensity level of colour, aroma, taste, and texture toward the different formulations of gluten-free biscuits. The scoring test scale ranges from 1 (the least intense level) to 6 (the most intense level). Meanwhile, the hedonic test aimed to determine the degree of acceptance from panellists towards colour, aroma, texture, taste, and overall acceptance of gluten-free biscuits. The hedonic test scales range from 1 (extremely -dislike) to 7 (extremely-like) (Meilgaard *et al*., 2015).

2.2.3 Data analysis

The data were analysed by SPSS version 16 which include analysis of variance (ANOVA) and Duncan post hoc test.

3. Results and discussion

3.1 Characteristics of CF and CPF

The result displayed in Table 2 has shown that CPF has a higher dietary fibre content (21.87±0.31%) than CF

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(13.72±0.53%). The dietary fibre content of fresh raw material could affect the obtained product. Fresh cassava and fresh cowpea have 1.8% and 18.2% dietary fibre content, respectively (Khan *et al*., 2007; Montagnac *et al*., 2009). Thus, it has supported the higher dietary fibre content of the CPF obtained in this research. Moreover, the CPF has higher fat content (2.15±0.10%) than CF (0.86±0.04%). Fresh cowpea has a 2.3% fat content while fresh cassava consists of 1% fat which explained the higher fat content in the CPF obtained (Montagnac *et al*., 2009; Sreerama *et al*., 2012)

Table 2. Characteristics of CF and CPF

Components	CF[#]	CPF
Moisture content (%)	4.72±0.22	7.15±0.02
Fat content (%)	0.86±0.04	2.15±0.10
Dietary fibre content (%)	13.72±0.53	21.87±0.31
Yield (%)	44.96 ±1.73	62.19±0.63
Lightness value (L*)	90.03±0.12	79.27±0.62

[#]Soedirga *et al*. (2018)

3.2 The effect of different formulations on the dietary fibre and moisture content of gluten-free biscuits.

As shown in Figure 1, the F1 exhibit significantly lower ($p<0.05$) dietary fibre content which reached 18.69±0.44%, while F2 and F3 were not significantly different within the value of 20.10±0.43% and 20.54±0.32%, respectively. The CPF itself has a higher dietary fibre content compared to CF (Table 2). Thus, a higher substitution of CPF will lead to an increasing value of dietary fibre content. It is supported by Olapade and Adeyemo (2014), who reported that the cookies made with a higher substitution of CPF exhibit a higher dietary fibre content.

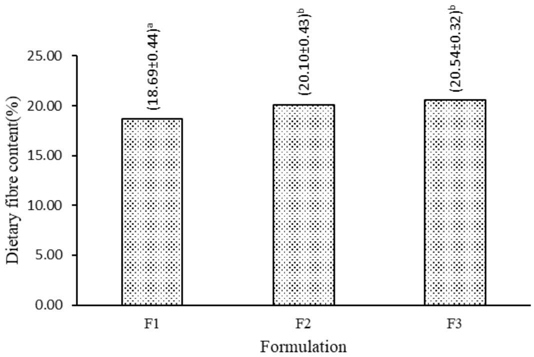

Figure 1. Dietary fibre content of gluten-free biscuits from different formulations (F1 = 90 CF: 10 CPF; F2 = 80 CF: 20 CPF; F3 = 70 CF-30 CPF). Values are presented as mean±SD. Bars with different superscript notations indicate significant difference ($p<0.05$).

Meanwhile, different formulations of gluten-free biscuits did not significantly affect the moisture content. The F1, F2, and F3 have moisture content within the value of 4.06±0.06%; 4.09±0.14% and 4.13±0.07%, respectively. The result is in line with what was previously reported by Han *et al.* (2017), Jongaroontaprangsee *et al*. (2007), and Benito *et al*. (2013). The dietary fibre can lower water retention capacity. It means that the moisture content is inversely correlated with the dietary fibre content. The lower the moisture content, the higher the dietary fibre content as presented in Figure 1.

3.3 The effect of different formulations toward the lightness (L) value of gluten-free biscuits*

The differences in L* value between formulations were statistically significant ($p<0.05$) as presented in Figure 2. L* value of F1 significantly higher (66.19±2.14) compared to F2 (63.97±1.22) and F3 (60.58±1.22). This result concludes that substitution of CF with CPF in a higher ratio produced gluten-free biscuits with the darkest colour. CPF itself has a lower L* value compared to CF (Table 2). Thus, the result obtained is also supported by this characteristic.

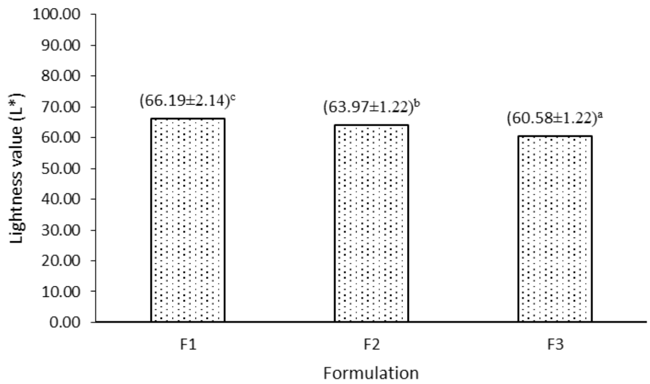

Figure 2. Lightness (L*) value of gluten-free biscuits from different formulations (F1 = 90 CF: 10 CPF; F2 = 80 CF: 20 CPF; F3 = 70 CF-30 CPF). Values are presented as mean±SD. Bars with different superscript notations indicate significant difference ($p<0.05$).

The incorporation of apple pomace that was categorized as fibre-rich material into baked products resulted in a darker colour. It has shown a combination of higher dietary content and baking process contributed to the dark colour of the products. During the baking process, the high temperature was subjected to, could destroy the integrity of cells. Therefore, several enzymes such as PPO may be released and promote the Maillard reactions which play a role in the browning process, leading to a brown and dull colour (Han *et al*., 2017; Kapreliants and Zhurlova, 2017).

3.4 The effect of different formulations toward the sensory properties of gluten-free biscuits

Different formulations did not significantly affect ($p>0.05$) the intensity of gluten-free biscuit' aroma. The

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scoring value of gluten-free biscuits' aroma was 2.46±0.97, 2.59±0.99, and 2.60±0.87, respectively, for F1, F2, and F3. This result means a higher substitution of CPF produced a less intense foreign aroma on the gluten-free biscuits. Moreover, the aroma assessment's hedonic result showed no significant difference (p>0.05) for all the sample treatments. The hedonic value ranges from 4.94±1.20 to 5.23±1.18, which falls in the range from neutral (4) to slightly like (5).

There was no significant difference (p>0.05) in terms of taste intensity and taste acceptance between gluten-free biscuits. The scoring value of the gluten-free biscuits' taste incorporated with different ratios of composite flour was in the range from 2.96±1.08 to 3.01±1.17, which indicates that the gluten-free biscuits had a slight foreign taste. The taste assessment's hedonic value was 5.13±1.10, 5.11±1.10, and 5.04±1.20, respectively, for F1, F2, and F3, which falls into the category slightly like.

Different formulations did not significantly affect (p>0.05) the scoring and hedonic value of gluten-free biscuits' texture. The higher incorporation of CPF in the formulations produced less crunchy gluten-free biscuits within the value of 3.63±0.97 (F1), 3.61±1.0 (F2), and 3.51±1.2 (F3). It was happened due to higher dietary fibre content (Figure 1). It is supported by Olapade *et al*. (2014), who reported that cookies produced from the higher substitution of CF with CPF scored least in terms of crispiness (4.78). It happened due to the ability of CPF to absorb the fat, thus leading to a less crunchy texture. Consequently, the degree of acceptance of panellists was neutral toward these biscuits (4.79±1.3, 4.79±1.2, 4,44±1.4 for F1, F2, and F3).

The statistical analysis showed a significant (p<0.05) effect of different formulations towards the gluten-free biscuits in terms of colour intensity. The result of the scoring test in terms of colour is shown in Figure 3. It implies that a higher substitution of CF with CPF in the gluten-free biscuits resulted in a browner colour (4.37±1.1). These are in line with the result presented in Figure 2. The higher the substitution of CPF resulted in a darker colour. Although there was a significant difference in terms of colour intensity due to different formulations, the hedonic test result showed the other way around. The hedonic value for the colour assessment ranges from 4 (4.96±1.2) to 5 (5.27±1.2) without any significant differences, which inferred that the panellists had a neutral (4) to slightly like (5) likeness towards the gluten-free biscuits.

Figure 4 shows that a higher substitution of CPF in F3 (5.01±0.97) could significantly decrease the overall acceptance of gluten-free biscuits compare to F1 (5.36±0.89). It might be related to the less crunchy texture of gluten-free biscuits. Despite this fact, the panellists slightly like the overall acceptance of gluten-free biscuits.

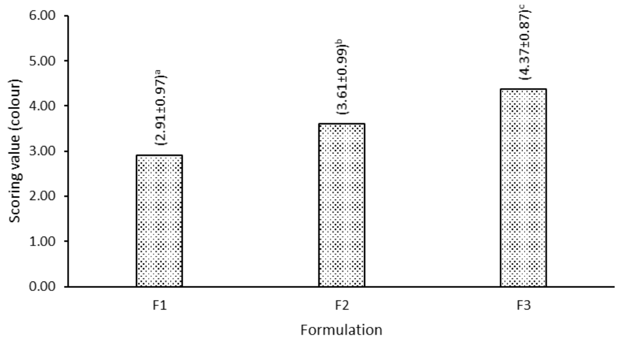

Figure 3. Scoring value for colour of gluten-free biscuits from different formulations (F1 = 90 CF: 10 CPF; F2 = 80 CF: 20 CPF; F3 = 70 CF-30 CPF). Scale 1 (very yellow)- 6 (very brown). Values are presented as mean±SD. Bars with different superscript notations indicate significant difference (p<0.05).

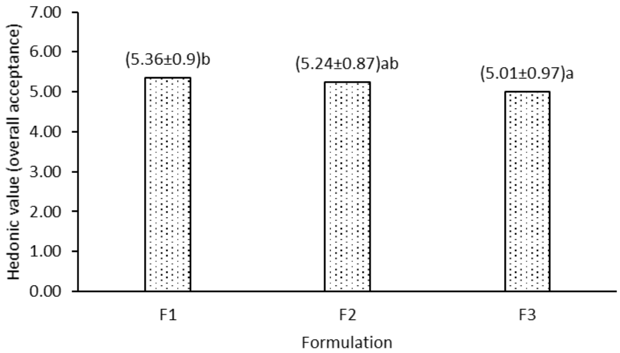

Figure 4. Hedonic value for overall acceptance of gluten-free biscuits from different formulations (F1 = 90 CF: 10 CPF; F2 = 80 CF: 20 CPF; F3 = 70 CF-30 CPF). Values are presented as mean±SD. Bars with different superscript notations indicate significant difference (p<0.05). Scale 1 (extremely dislike) – 7 (extremely like)

4. Conclusion

F3 that consists of CF and CPF with a ratio 70:30 was selected as the preferred formulation to make gluten-free biscuits. Although the different formulations did not significantly affect the scoring and hedonic scores of biscuit textures, there was a decrease in the crunchiness of the biscuits with the higher CPF ratio. CPF has a higher fat content than CF. This high-fat content is related to a reduction in the level of crunchiness; therefore, it is necessary to produce defatted CPF before being used in the biscuit formulation. Thus, it can improve the panellist's assessment crispness.

Conflict of interest

The authors declare no conflict of interest.

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References

Ashaye, O.A., Olanipekun, O.T. and Ojo, S.O. (2015). Chemical and nutritional evaluation of biscuits processed from cassava and pigeon pea flour. *Journal of Food Processing and Technology,* 6(12), 1-4. DOI: 10.4172/2157-7110.1000521.

AOAC. (1995). Official Methods of Analysis of The Association of Official Analytical Chemists. 16th ed. Washington, USA: Benjamin Franklin Station.

AOAC. (2005). Official Methods of Analysis of The Association of Official Analytical Chemists. 18th ed. Washington, USA: Benjamin Franklin Station.

Benito, I.R., Omar, G.O. and Carlos, R. (2013). Characterization of dietary fiber and pectin of cassava bread obtained from different regions of Venezuela. *Revista Chinela de Nutricion,* 40(2), 169-173. http://dx.doi.org/10.4067/S0717-75182013000200012.

Gibson, R., Eriksen, R., Chambers, E., Gao, H., Aresu, M., Heard, A., Chan, Q., Elliott, P. and Frost, G. (2019). Intakes and food sources of dietary fibre and their associations with measures of body composition and inflammation in UK Adults: cross-sectional analysis of the airwave health monitoring study. *Nutrients*, 11(8), 1839. https://doi.org/10.3390/nu11081839.

Han, W., Ma, S., Li, L., Wang, X. and Zheng, X. (2017). Application and development prospects of dietary fibers in flour products. *Journal of Chemistry,* 2017, 2163218. https://doi.org/10.1155/2017/2163218.

Jongaroontaprangsee, S., Tritong, W., Chokanaporn, W., Methacanon, P., Devahastin, S. and Chiewchan, N. (2007). Effect of drying temperature and particle size on hydration properties of dietary fiber powder from lime and cabbage by-products. *International Journal of Food Properties*, 10(4), 887-897. https://doi.org/10.1080/10942910601183619.

Kapreliants, L. and Zhurlova, O. (2017). Technology of wheat and rye bran biotransformation into functional ingredients. *International Food Research Journal*, 24(5), 1975-1979.

Khan, A.R., Alam, S., Ali, S., Bibi, S. and Khalil, I.A. (2007). Dietary fiber profile of food legumes. *Sarhad Journal of Agriculture*, 23(3), 763-766.

Meilgaard, M.C., Civille, G.V. and Carr, B.T. (2015). Sensory Evaluation Techniques. 5th ed. Boca Raton, USA: CRC Press.

Montagnac, J. A., Davis, C.R. and Tanumihardjo, S.A. (2009). Nutritional value of cassava for use as a staple food and recent advances for improvement. *Comprehensive Reviews in Food Science and Food Safety*, 8(3), 181-194. https://doi.org/10.1111/j.1541-4337.2009.00077.x.

Nilugin, S.E., Mahendran, T. and Inthujaa, Y. (2015). Studies on the formulation and quality characteristic of value-added cassava-mango composite flour biscuits. *Tropical Agricultural Research and Extension*, 18(2), 47-56.

Oladunmoye, O.O., Akinoso, R. and Olapade, A.A. (2010). Evaluation of some physical-chemical properties of wheat, cassava, maize, and cowpea flours for bread making. *Journal of Food Quality*, 33 (6), 693-708. https://doi.org/10.1111/j.1745-4557.2010.00351.x

Olapade, A.A., Aworh, O.C. and Oluwole, O.B. (2011). Quality attributes of biscuit from acha (*Digitaria exilis*) flour supplemented with cowpea (*Vigna unguiculata*) flour. *African Journal of Food Science and Technology*, 29(9), 198-203.

Olapade, A.A. and Adeyemo, M.A. (2014). Evaluation of cookies produced from blends of wheat, cassava and cowpea flours. *International Journal of Food Studies*, 3(2), 175-185. https://doi.org/10.7455/ijfs/3.2.2014.a4.

Phebean, I.O., Akinyele, O., Toyin, A., Folasade, O., Olabisi, A. and Nnenna, E. (2017). Development and quality evaluation of carrot powder and cowpea flour enriched biscuits. *International Journal of Food Science and Biotechnology*, 2(2), 67-72. https://doi.org/10.11648/j.ijfsb.20170202.15.

Soedirga, L. C., Cornelia, M. and Vania, V. (2018). Analysis of water content, fibre content, and yield of cassava flour with several types of drying method. *FaST-Jurnal Sains dan Teknologi (Journal of Science and Technology)*, 2(2), 8-18.

Sreerama, Y.N., Sashikala, V.B., Pratape, V.M. and Singh, V. (2012). Nutrients and antinutrients in cowpea and horse gram flours in comparison to chickpea flour: Evaluation of their flour functionality. *Food Chemistry*, 131(2), 462-468. https://doi.org/10.1016/j.foodchem.2011.09.008.

United States Department of Agriculture. (2016). National nutrient database: cassava, raw. Retrieved from USDA website: https://ndb.nal.usda.gov/ndb/foods/show/2907?n1=%7BQv%3D1%

7D&fgcd=&man=&lfacet=&count=&max=&sort=&qlookup=&offset=&format=Full&new=&measureby=&Qv=1&ds=Standard+Reference&qt=&qp=&qa=&qn=&q=&ing=.

Uchechukwu-Agua, A.D., Caleb, O.J. and Opara, U.L. (2015). Postharvest handling and storage of fresh cassava root and products: a review. *Food and Bioprocess Technology*, 8(4), 729-748. https://doi.org/10.1007/s11947-015-1478-z.

