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FULL PAPER

Cookies made from mangrove (*Bruquiera gymnorrhiza*) fruit and soybean (*Glycine max*) flour

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Abstract

Demak is an area in Indonesia with a high stunting rate of 50.28%. Mangrove fruit, a major regional commodity, should be used as a basis for Supplementary Feeding Program (SFP) cookies to overcome stunting in Demak. This study was aimed to analyse the nutritional content, nutrition absorption inhibiting agents, and acceptance of mangrove fruit cookies. This research used a completely randomized sample with a one-factor design to formulate mangrove and soybean flour. The formulations used were F1 (60%: 40%), F2 (70%: 30%), F3 (80%: 20%), and F0 (100% wheat flour) as the control group. The best formula of mangrove and soybean cookies was F2 with average energy 479.44 kcal/100 g, protein 11.70 g/100 g, fat 23.93 g/100 g, carbohydrate 54.31 g/100 g, zinc 2.68 mg/100 g, iron 6.72 mg/100 g, calcium 659.03 mg/100 g, HCN 1.77 ppm, and tannin 101.9 mg/100 g. The best cookie formulation that met the SFP quality requirements was F2, with a composition of 70% mangrove fruit flour and 30% soy flour.

1. Introduction

Nutritional needs are essential for growth and development in infants and toddlers. Growth and development which are not optimal can cause children to experience stunting. Stunting is defined as, standard deviations (SDs) and the median height-for-age (HAZ), a measure based on a comparison of a child's height (cm) and age (months) to the WHO standard (Ministry of Health of the Republic of Indonesia, 2016). Stunting in toddlers is a manifestation of chronic nutritional deficiencies that occur in the first thousand days of life from the fetus until two years of age, which results in children's linear growth failure (Leroy *et al.*, 2014).

The intake of micronutrients, such as fibre, zinc, iron, and calcium contribute to growth. Physiologically, zinc increases during rapid growth due to DNA replication, DNA transcription, and endocrine function. Inadequate iron intake disrupts children's growth and development; if it occurs chronically, it can cause stunting. Adequate iron intake is required to form red blood cells in the bone marrow. Calcium regulates the activity of hormones and growth factors. Lack of calcium during the growth period results in disruption of growth (Ministry of Health of the Republic of Indonesia, 2016). Dietary fibre affects mineral absorption. Various types of dietary fibre could inhibit the intake of calcium, iron, zinc, and magnesium. One of them is lignin, which has a mineral binding function.

Based on basic health research data (Riskesdas), in 2018, the stunting prevalence in Indonesia was 30.8% (Ministry of Health of the Republic of Indonesia, 2018b). One of the 100 cities that have become the priority for stunting management by the Indonesian government is Demak, with a stunting incidence rate of 50.28% (Tim Nasional Percepatan Penanggulangan Kemiskinan, 2017).

One of the efforts to help fulfilling children's nutritional adequacy under five is by using the Supplementary Feeding Programs (SFPs). SFPs quality requirements for toddlers contain at least 400 kcal, 8–12 grams of protein, and 10–18 g of fat (The Regulation from Ministry of Health of the Republic of Indonesia, 2016). The pattern of food diversification can be made by diversifying local food ingredients such as mangroves

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in Demak because they are available in large quantities.

Mangrove (*Bruquiera gymnorrhiza*) fruit can be used as a food source because it contains relatively high energy and carbohydrates (Handayani, 2018). Unfortunately, mangroves have compounds that are harmful to the body, such as HCN and tannins, which can inhibit nutrient absorption. Therefore, the level of use must be lowered before it is processed into food (Sulistyawati *et al.*, 2012). HCN and tannins are volatile substances. Treatments such as repeated boiling and soaking can reduce the HCN and tannin content to a safe limit for consumption (Setianingsih, 2016). Tannins become carcinogenic substances when consumed in an excessive amount. The safe limit for tannins' food ingredients is 560 mg/kg/body weight/day (Setianingsih, 2016). In the body, HCN can interfere with the cytochrome-oxidase enzyme, which stimulates respiratory reactions in the aerobic organism. Therefore, the body can only tolerate HCN levels of less than 50 ppm (Baskin and Brewer, 2010).

The content in 100 g of mangrove fruit flour is 371 calories, 81.9% carbohydrates, 5.5% protein, and 0.23% fat (Mulyatun, 2018). The mineral content of mangrove fruit flour is 2948 ppm calcium, 12 ppm zinc, and 53 ppm iron. The high carbohydrate and energy content are suitable to use as food for the manufacture of SFPs products. Energy fulfilment in stunting children serves to improve their growth process (Adani and Nindya, 2017). However, the protein content in mangroves is relatively low, so it is necessary to combine them with other food ingredients containing protein sources to complement each other's nutritional content, one of which comes from soybeans.

Soybean (*Glycine max*), one of the local food protein sources, is readily available and relatively cheap. One hundred grams of soybeans contain 19.94% fat, 34.95% protein, and 29.94% carbohydrates (Damanik *et al.*, 2018). The mineral content in 100 g of dry soybeans is 10 g of insoluble fibre, 276 mg of calcium, 16 mg of iron, and 4.8 mg of zinc. The protein and amino acid content in soybeans are higher than other beans, for example, kidney beans (Audu and Aremu, 2011; Pangastuti *et al.*, 2013). The quality and quantity of adequate protein intake can function as Insulin Growth Factor 1 (IGF-1), a mediator of growth hormone and bone matrix formation. The fulfilment of protein intake in stunting children can help to repair linear growth disorders (Khairy *et al.*, 2013). Soybean contains 102 mg/g leucine (Damanik *et al.*, 2018). Leucine plays a role in regulating bone growth to help correct linear growth disorders in stunted children (Semba *et al.*, 2016).

The combination of mangrove fruit flour and soybean can create an additional food product for toddlers in the form of cookies. Cookies are an ideal snack full of nutrition and are widely consumed by all groups.

An analysis of nutritional content is necessary before the cookies are made on a large scale and given to children. This study aimed to determine the nutritional content, including the analysis of energy, carbohydrates, protein, fat, moisture, and ash content, and crude fibre, zinc, iron, and calcium mineral content. Apart from that, an anti-nutritional substance test was also carried out against HCN and tannin content to ensure food safety. An organoleptic quality test determines consumers' SFP preferences. Lastly, this research aimed to determine the best formulation of mangrove and soy cookies by considering all variables.

2. Materials and methods

2.1 Study design and sample

The research design used in this study was a randomized design with one factor. The percentages of mangrove and soybean flour used were 60:40%, 70:30%, and 80:20%. Table 1 shows the cookies' composition of mangrove and soybean flour. The main ingredients' nutritional value was calculated using the 2007 Nutrisurvey application and adjusted for the percentage of mangrove fruit flour and soybean flour that could meet SFPs specifications according to Minister of Health Regulation number 51 of 2016, which contains a minimum of 400 kcal, 8–12 g of protein and 10–18 grams of fat (The Regulation from Ministry of Health of the Republic of Indonesia, 2016).

2.2 Mangrove fruit flour preparation

Lindur was the mangrove fruit processed into flour in this study (*Bruquiera gymnorrhiza*). The fruit was quite ripe, characterized by dark green, purplish colour, soft texture, 15–30 cm long and 1–2 cm wide (Sudirman *et al.,* 2014). Mangrove flour was made by weighing the mangrove fruit first, then boiling it for 2 × 15 mins, adding 15% rubbing ash to the second boiling session, then peeling it. After boiling, the mangrove fruit was soaked for 48 hrs by replacing the soaking water every 6 hrs (Perdana *et al.*, 2012; Ayu *et al.*, 2019). The soaked mangrove fruit was then dried for 48 hrs in the scorching sun (Amalia *et al.*, 2016; Amin *et al.*, 2018). After drying, it was mashed with a grinding machine and sieved with an 80-mesh sieve (Sulistyawati *et al.*, 2012).

2.3 Cookies production

The process started by homogenizing butter,

Table 1. Formulation of cookies from mangrove fruit flour and soybean flour

Materials/Formulation	F0 (100%)	F1 (60:40%)	F2 (70:30%)	F3 (80:20%)
Plain Flour (%)	40	0	0	0
Mangrove Fruit Flour (%)	0	24	28	32
Soybean Flour (%)	0	16	12	8
Butter (%)	10	10	10	10
Margarine (%)	10	10	10	10
Egg (%)	12	12	12	12
Refined Sugar (%)	18	18	18	18
Milk (%)	10	10	10	10
Total (%)	100	100	100	100

margarine, milk, sugar powder, egg, and different types of flour according to the formula. After blending, the dough was shaped flat and round, then baked in an oven at 150°C for 15 mins.

2.4 Organoleptic test

Colour, taste, aroma, and texture of mangrove fruit and soy cookies as organoleptic test parameters were evaluated using 4 hedonic scale ratings from 1 (dislike), 2 (moderately like), 3 (like), and 4 (extremely like) (Ramadhan *et al.*, 2019). Panellists who evaluated the organoleptic test were 30 trained panellists from seventh-semester students of the Nutrition Science Study Program of Universitas Diponegoro (Negara *et al.*, 2016).

2.5 Determination of nutrition content and nutrition absorption inhibiting agents

The analysis of nutrition content and nutrition absorption inhibiting agents were carried out twice (r = 2) (Horwitz, 2005).

2.5.1 Determination of protein

Protein was analysed using the Kjeldahl method. The crushed cookies sample was accurately weighed and placed in a flask. Then it was added Li_2SO_4, $CuSO_4$, and H_2SO_4. The solution was heated in a flask while being shaken every 10 mins for 75 mins. After the solution had cooled, it was transferred into a round bottom flask. The solution was added to distilled water and NaOH. The solution was then distilled and collected in an Erlenmeyer that had H_3BO_3 and BCG-MR indicator. The results were titrated into HCl until the solution turned pink in colour.

2.5.2 Determination of fat

The fat was analysed by the Soxhlet method. The sample was placed in a flask and oven-dried at 105°C for 30 mins. Then, it was cooled in a desiccator for 15 mins, then weighed and placed on filter paper bundled with fat-free cotton. The sample was placed into the Soxhlet extraction device while fat was solvent in a flask. The extraction process lasted for 3–4 hrs. Then it was distilled and oven-dried at 105°C until its weight was constant. After the sample was cooled in a desiccator for 15–30 mins, the weighing was repeated.

2.5.3 Determination of moisture

The porcelain dish was heated at 105°C for 30 mins and cooled in a desiccator before weighing. A 2 g sample was weighed and placed in a porcelain dish, and heated at 105°C for 6 hrs. After the sample had cooled in the porcelain dish in the desiccator, the weighing process was repeated until the sample reached a constant weight.

2.5.4 Determination of ash

The porcelain dish was heated for 30 mins at 105°C and then allowed to cool before weighing. A 2 g sample was placed in a porcelain dish and burned until there was no smoke. The ashing process was conducted in a furnace for 60 mins at 550–600°C. Then, the sample was cooled in a porcelain dish in a desiccator before weighing. The process was repeated until the sample had constant weight.

2.5.5 Determination of carbohydrate and energy

Carbohydrate analysis was conducted using a different method. The carbohydrate content was obtained by subtracting 100% with a percentage of protein, fat, moisture, and ash content. Total calories were obtained by converting protein, fat, and carbohydrate into calories and summing them up.

2.5.6 Determination of crude fibre

The sample was dried in an oven at 105°C till a constant weight was obtained. After the sample had cooled in a desiccator, 1 g of the sample was grounded and H_2SO_4 was added until it reached a volume of 150 mL and *n*-octanol was added as an antifoam agent. It was boiled for 30 mins, connected to a vacuum, rinsed with 30 mL hot deionized water three times, and then connected to compressed air, stirred each time rinsing took place. Then, 150 mL preheated KOH and an antifoam agent were added and boiled for 30 mins, filtered, and rinsed with 30 mL hot deionized water twice. Afterwards, it was rinsed with 30 mL cold deionized water. The rinsing was continued three times with 25 mL acetone and stirred by compressed air each time. The crucible was removed and weighed after oven-drying at 105°C for 60 mins until a constant weight was obtained.

2.5.7 Determination of calcium

A 10 mL sample was placed in a flask then added to 50 mL of distilled water and 10 mL of ammonium oxalate solution. The solution was made slightly alkaline by adding dilute ammonia. Then, it was made slightly acidic by adding a few drops of acetic acid until the colour of the solution was pink. It was boiled and left to rest for 4 hrs. The solution was filtered using Whatman paper No. 42 and rinsed several times with distilled water. The precipitate was transferred to another flask then rinsed and dissolved with hot sulfuric acid. The solution that was still in a hot state was titrated with a standard solution of $KMnO_4$ 0.1 N until the first pink solution was formed and did not disappear for 15 s. Calcium content was calculated based on the volume of the $KMnO_4$ standard solution used for titration.

2.5.8 Determination of iron, HCN, tannin

Five grams of the sample were dissolved with 2 M of HCl. The solution was filtered and mixed with KSCN. The absorbance of the solution was measured from the absorbance value that appears on the spectrophotometer compared to the standard.

2.6 Statistical analysis

The normality of data distribution was tested by the Shapiro-Wilk method. The total energy, protein, carbohydrates, water content, HCN, tannins, crude fibre, zinc, iron, and calcium content were analysed using One Way ANOVA followed by the Bonferroni test for normal distribution data. The fat, ash content, and organoleptic test data were analysed using the Kruskal Wallis test followed by the Mann-Whitney Test for irregular distribution data to determine the apparent difference between treatments.

2.7 Determination of the selected formula

The best formulation was determined by considering the value of nutritional content (energy, protein, fat, carbohydrate, moisture, and ash content), HCN content, tannins, and organoleptic parameters (colour, taste, aroma, and texture) using the Effectiveness Index (*De Garmo*) (De Garmo *et al.,* 1995). The variable weight was determined with a scale of 0–1 for each parameter based on priority subsequently by determining the effectiveness value (Ne) on each variable. Finally, the yield value (Nh) was calculated, and the best formulation had the highest score.

3. Results

3.1 Nutritional content

Based on the proximate analysis, the highest nutritional content in mangrove fruit flour was carbohydrate content as presented in Table 2. A total of 1 kg fresh mangrove fruit produced roughly 500 g of mangrove fruit flour. The HCN and tannin content was still within safe limits for consumption.

Table 2. Nutritional content in 100 g of mangrove fruit and 100 g of mangrove fruit flour

Component	Mangrove Fruit	Mangrove Fruit Flour
Energy (kcal)	144.93	349.28
Protein (g)	2.04	5.34
Fat (g)	0.43	0.64
Carbohydrate (g)	33.22	80.56
Water Content (%)	62.99	12.31
Ash Content (%)	1.32	1.17
HCN (ppm)	5.03	4
Tanin(mg)	100.9	101.9

The analysis of the nutritional content of cookies with mangrove fruit flour and soybeans was presented in Table 3. The energy (p = 0.020), protein (p = 0.001), carbohydrates (p < 0.000), HCN, and tannins were significantly different. However, there was no difference in moisture (p = 0.83) and HCN content (p = 1.54).

The energy content of the cookies F0, F1, F2, and F3 met the SFPs quality requirements, which contained at least 400 kcal. Protein content in F0, F2, and F3 met the quality requirements, but F1 exceeded the specified quality requirements. The fat content and moisture content in all cookies exceeded the SFPs quality requirements. The fibre content in the F1-F3 formulation cookies exceeded the SFPs quality requirements. Zinc content in F0, F1, and F2 met the SFPs quality requirements while F3 exceeded the requirement.

3.2 Organoleptic test

An organoleptic test to determine consumers' acceptance of cookies made from mangrove fruit flour and soybeans acceptance involved assessing the flavour, aroma, appearance, and texture. Based on Table 4, the statistical test results showed significant differences in the colour, taste, aroma, and texture of the product. On the colour indicator, a darker brown intensity of the cookies was more preferred by panellists (Dhinendra *et*

Table 3. Results of nutritional content analysis of cookies made from mangrove fruit flour, and soybeans in 100 g

Formula	F0	F1	F2	F3	*P*	Cut off[d]
Energy (kcal)	462.66±4.71[a]	483.39±5.35[b]	479.44±1.37[a]	482.28±3.68[a]	0.020*	Min.400
Protein (g)	8.99±0.24[a]	13.22±0.62	11.70±0.10[c]	10.57±0.14[d]	0.001*	8–12
Fat (g)	20.30±0.30	24.92±0.59	23.93±0.28	24.75±0.30	0.112**	10–18
Carbohydrate (g)	60.98±0.27[a]	51.55±0.62[b]	54.31±0.40[c]	54.32±0.09[d]	0.00*	-
Water content (%)	8.36±0.83	8.04±0.60	7.88±0.14	8.29±0.56	0.83*	Max.5
Ash content (%)	1.36±0.02	2.26±0.00	2.18±0.00	2.08±0.02	0.080**	-
HCN (ppm)	-***	2.87±0.75	1.77±0.28	1.75±0.06	0.154*	502
Tanin (mg)	-***	101.0±0.00[a]	101.9±0.00[b]	99.2±0.00[c]	0.006*	5603
Rough Fibre (g)	3.29±0.47[a]	5.90±0.39[b]	6.74±0.08[c]	7.88±0.29[d]	0.00*	Max.5
Zinc (mg)	4.92±0.54[a]	3.07±0.33[b]	2.68±0.03[b]	3.03±0.99[b]	0.001*	2.0–3.75
Iron (mg)	3.93±0.92[a]	6.02±0.46[b]	6.72±0.43[b]	8.32±0.79[c]	0.00*	4.0–7.5
Calcium (mg)	407.97±19.24[a]	534.27±14.87[b]	659.03±26.92[c]	735.97±25.51[d]	0.00*	225–450

Values are presented as mean±SD. Values with different superscript letters within the same row are significantly different ($p<0.05$).

*test with One Way ANOVA, **test with the Kruskal Wallis test, *** test for HCN and tannins against F0

[1]Peraturan Menteri Kesehatan Republik Indonesia (2016)

[2]Baskin and Brewer (2010)

[3]Setianingsih (2016)

Table 4. Organoleptic test results for cookies of mangrove fruit flour and soybeans

Formula	Receiving Power (Mean ± SD)			
	Colours	Taste	Aroma	Texture
F0	2.87±0.73[a] (Like)	3.60±0.56[a] (Really Like)	3.57±0.56[a] (Really Like)	3.63±0.55[a] (Really Like)
F1	3.10±0.48[b] (Like)	2.60±0.62[b] (Like)	2.73±0.74[b] (Like)	2.67±0.60[b] (Like)
F2	2.97±0.66[c] (Like)	2.40±0.49[c] (Rather Like)	2.50±0.63[c] (Rather Like)	2.23±0.60[c] (Rather Like)
F3	3.63±0.62[d] (Really Like)	2.00±0.74[d] (Rather Like)	2.40±0.67[d] (Rather Like)	1.60±0.67[d] (Dislike)
P	0.002*	0.00*	0.00*	0.00*

Values are presented as mean±SD. Values with different superscript letters within the same row are significantly different ($p<0.05$). * test with the Krusal Wallis Test

Table 5. Calculation results for determining the best formulation

Formula/ Yield Value (Nh)*	F0	F1	F2	F3
Energy	0	0.1852	0.1499	0.1753
Protein	0	0.2602	0.1667	0.0972
Fat	0.1481	0	0.0317	0.0054
Carbohydrate	0.1296	0	0.0379	0.0381
Water Content	0	0.0741	0.1111	0.0162
Ash Content	0	0.037	0.0337	0.0296
HCN	0	0	0.0909	0.0926
Tanin	0	0.0247	0	0.0741
Organoleptic Quality	0.0556	0.0206	0.0067	0
Total of Yield Value (Nh)	0.3333	0.6017	0.6287	0.5285

*result value (Nh) is obtained from the deGarmo Effectiveness Index calculation

al., 2015). The taste of cookies favoured by the panellists was sweet, and the favoured level decreased with the bitter after-taste in cookies (Rosyadi *et al.,* 2014). Cookies have a distinctive aroma, which was very fragrant. The panellists preferred less of the peculiar aroma of mangrove fruit and the unpleasant aroma of soybeans in cookies. (Fajri *et al.,* 2013). The panellists preferred the cookies' crunchy texture over a hard texture (Sarofa and Yulistiani, 2013).

3.3 Determining the best formulation

Based on Table 5, calculation results for determining the best formulation, F2 was the best formulation with a composition of 70% mangrove fruit flour and 30% soy flour. The selected formulation was based on the nutritional content and the panellists' level of preference in the organoleptic test. Overall, the nutritional content in F2 met the Supplementary Feeding (SF) quality requirements according to Ministry of Health Regulation number 51 of 2016. However, the fat and water content in the cookie products still exceeded the predetermined quality requirements.

4. Discussion

4.1 Nutritional content of mangrove fruit and mangrove fruit flour

The study results indicated that the levels of HCN and tannins in cookies were safe for human consumption. HCN and tannins were volatile substances. Based on previous research, treatments such as repeated boiling and soaking could reduce the HCN and tannin content in mangroves (Baskin and Brewer, 2010). Reducing the levels of HCN and tannins could be carried out during the pre-treatment of the flour process. In this study, boiling for 2 × 15 mins at a temperature of 100°C and immersion for 48 hrs resulted in a tannin content of 101.9 mg/kg and 4 ppm HCN.

The boiling process could reduce HCN levels because HCN experienced evaporation. The HCN boiling point was low, at 26°C, and it evaporated easily (Sulistyawati *et al.,* 2012). The repeated soaking process led to the slow degradation of the HCN where it would be dissolved in the bathwater. After that, the drying process after soaking the rest of the HCN would evaporate (Ayu *et al.,* 2019).

The addition of ash in the boiling process served to inhibit the metabolism rate of tannin. Alkalis could hydrolyse tannins. Rubbing ash was an alkaline group because it contained KOH. Tannins would break down into glucose and gallic acid when heated (Ayu *et al.,* 2019). The effect of rubbing ash in boiling resulted in toxic substances, including tannins bound to the ash (Perdana *et al.,* 2012).

The soaking process could reduce the levels of tannins found in mangroves. Tannins had polar properties that could dissolve in water (Dhinendra *et al.,* 2015). In the soaking process, a diffusion process occurred by dissolving the fruit's remaining substances. This was indicated by the water condition that changed colour to brown or foamy (Amalia *et al.*, 2016). Without immersion treatment, the resulting mangrove fruit flour would have high tannins to be dangerous for consumption. High levels of tannins would also affect the taste, giving food a bitter taste (Hagerman, 2010).

4.2 Nutrition content of mangrove and soy cookies

The energy in all cookie formulations fluctuated from F1 to F3. The energy in cookies was influenced by other nutrients such as protein, fat, and carbohydrates. Cookies formulated with mangrove fruit flour and soy flour had higher energy than control cookies because cookies' protein and fat content increased. The increase in protein and fat in formulated cookies came from the ingredients' fat and protein content. The energy content of cookie products met the SF quality requirements, which contained a minimum of 400 kcal of energy (the Regulation from the Ministry of Health of the Republic of Indonesia, 2016).

The protein test results showed that the addition of soy flour could increase the product's protein content. The protein source in making cookies mostly came from soy flour, which had high protein content (Damanik *et al.*, 2018). The low protein content in cookies was caused by the low levels of adding soy flour to the product. The lowest protein content was in cookies with 100% wheat flour. This was because the protein content in wheat flour (9 g/100 g) was lower than soy flour (34.9 g/100 g) (Aini and Wirawani, 2013).

In previous research on the manufacture of cookies, the substitution of canna and soy flour showed that the addition of soy flour by 75% had a protein content of 28.12 g/100 g (Lestaria *et al.,* 2018). In other studies, the substitution of 25% soy flour in the manufacture of foods to replace breast milk (MP-ASI) biscuits could increase protein content by up to 10.02% (Aini and Wirawani, 2013).

Based on the SF quality requirements, the protein content in F0, F2, and F3 cookies met the requirements of 8–12 g/100 g (the Regulation from the Ministry of Health of the Republic of Indonesia, 2016). F1 protein content excessed the SFP's quality requirement standards due to adding 40% soy flour. Adequacy of protein was required for the growth process, but excess protein consumption would increase fat mass in children (Aini and Wirawani, 2013).

Inversely proportional to the protein content, the carbohydrate content in cookies increased with increasing levels of the mangrove fruit flour. The increase in carbohydrates occurred because the carbohydrate content in mangrove fruit flour was higher (80.56 g/100 g) compared to wheat flour (77.3 g/100 g) and soy flour (42.64 g/100 g) (the Ministry of Health of the Republic of Indonesia, 2018a). Cookies with the highest carbohydrate content had the highest amount of mangrove flour.

This study's results were consistent with research on the manufacture of *curisi* fish nuggets and catfish meatballs. The carbohydrate content in food products substituted by mangrove fruit flour increased with this flour (Dhinendra *et al.,* 2015; Alno *et al.*, 2018). The carbohydrate content at F0 was higher than other cookie formulations because it only used wheat flour, while others used mangrove fruit flour and soy flour. Soy flour had the lowest carbohydrate content when compared to mangrove flour and wheat flour. Thus, it could not increase the carbohydrate content in cookies (Fajri *et al.,* 2013). The fat content in cookies fluctuated in the formulation group. The highest fat content was in F1 with the addition of 40% soy flour. Also, the fat content in cookies exceeded the predetermined SF quality requirements, which was 10–18 g/100 g (the Regulation from the Ministry of Health of the Republic of Indonesia, 2016).

This study showed a higher fat content than previous studies on the manufacture of fish nuggets substituted by mangrove fruit flour. The increase in fat content in the product would increase along with the additional mangrove fruit flour (Amalia *et al.*, 2016).

The high-fat content in cookies could be caused by the fat source ingredients used and the less optimal cookie processing. The cookies were baked at 150°C for 15 mins. In general, after processing, the fat contained in the cookies will break down. The degree of fat breakdown varied greatly depending on the temperature used and the length of processing time. The higher the temperature and the longer the roasting process, the fat content would decrease. This was because fat is not heat resistant, it would melt and even evaporated (*volatile*), which was caused by the breakdown of the fat components into volatile products such as aldehydes, ketones, alcohols, and hydrocarbons which greatly affected the formation of flavour (Heldman, 2012; Sundari *et al.,*2015).

This research showed that butter, margarine, egg yolk, and soy flour contribute to cookies' fat content. Soy flour was known to have a high-fat content. Fat is needed to make cookies as a dough softener, binder, and shortening to make food more savoury (Jacob and Leelavathi, 2007). Mangrove fruit flour had a low amylopectin content, making it difficult for the dough to blend and be sticky. Large amounts of butter and margarine could help bind the dough (Dhinendra *et al.,* 2015).

The water content in all formulations exceeded the predetermined SF quality requirements, a maximum of 5% (the Regulation from the Ministry of Health of the Republic of Indonesia, 2016). The process could influence the cause of the high moisture content in cookies and the materials used. In baking cookies, it only took 15 mins with a temperature of 150°C. Thus, the reduction in water content in cookies was not optimal. The higher the processing temperature and the longer the processing time, the less water content was found in the material (Nilasari *et al.*, 2017). The heat treatment process caused a gelatinization process in which the starch granule molecules absorbed water from the material. The processing process was also related to the evaporation of water on the material. The longer and higher processing temperature could cause more water to evaporate. Evaporation occurred because the water vapour pressure in the material was greater than the water vapour in the air, so the mass transfer of water from the material to the air occurred (Heldman, 2012).

The content of mangrove fruit flour had high water content. Mangrove fruit flour had a high water content because mangroves grew in aquatic habitats to have sufficient water reserved to survive (Amin *et al.*, 2018). The increase in water content was also caused by mangrove fruit flour's high fibre content, which resulted in a large amount of bound water (Rosyadi *et al.*, 2014). In the flour-making process, efforts had been made to reduce the mangroves' moisture content during drying. However, direct drying with sunlight had not resulted in a maximum reduction in moisture content.

Previous research on the substitution of mangrove fruit flour in catfish biscuits suggested that mangrove fruit flour could increase the carbohydrate, ash, and water content and reduce protein and fat content (Rahmaningsih *et al.,* 2016). In this study, the water content in biscuits was classified as low and met the Indonesian national biscuit standard of a maximum of 5%. The difference in water content in the final product was influenced by the difference in water content in the type of flour used.

The water content in the formulated cookies exceeded the specified quality requirements because making mangrove fruit flour was not optimal. During the drying process, it only used direct sunlight, which caused the evaporation process to be less optimal. As a result, it still contained water. In previous research related to mangrove fruit flour manufacturing, the drying process using an oven at a temperature of 60°C for 7 hrs, resulting in a moisture content that was 11.17% lower than this study in 12.31% (Ayu *et al.*, 2019).

The ash content in a material indicated the presence of organic mineral content in the food material. Ash could describe the content of mineral elements contained in food products or ingredients. Besides that, it could also show the purity and cleanliness of the material (Hastuti and Afifah, 2019). The lowest ash content was in F0 cookies which used 100% wheat flour. The less ash content was in the product in mangrove fruit and soy flour cookies, the less soy flour was added. This was because soy flour was a mineral source (Okoye and Nkwocha, 2008). Soy flour contained minerals such as calcium, potassium, phosphorus, and iron (Damanik *et al.*, 2018).

In the mangrove fruit flour and soybean cookies, the highest HCN content was in F1 with 60% mangrove fruit flour to the product. The HCN level decreased along with the addition of mangrove fruit flour to the cookie's product. Thus, F3 had the lowest HCN levels. This could be caused by the roasting process that alternated from F1 to F3 cookies so that the cookies baked last would receive heat accumulation from the previous roasting. The higher the temperature for roasting, the more the HCN content of the cookies would decrease. This was because HCN was a volatile compound due to heat (Sari and Astili, 2018). The HCN content in cookies was still within a safe limit for consumption of <50 ppm (Baskin and Brewer, 2010).

The highest tannin content in cookies was F2, while the lowest was F3. The percentage of mangrove fruit flour added and the cookies' baking process influenced the tannin content (Carica, 2015; Amalia *et al.*, 2016). The lowest tannin content in F3 could be because of the oven temperature. The oven alternating from F1 to F3 results in heat accumulation on F3 roasting, resulting in a higher temperature on F3 roasting than the others so that the tannin compounds were more broken down. (Hawa *et al.,* 2018). Tannins were chemical compounds belonging to the polyphenol group that could be hydrolysed into simpler compounds when they underwent a heating process (Liang and Yi, 2009).

4.3 Mineral content of mangrove and soy cookies

Cookies with the substitution of mangrove and soybean flour had higher crude fibre content than control cookies (100% wheat flour). The increased crude fibre content was influenced by the composition of the flour used in making cookies. A crude fibre in the mangrove fruit flour was greater than wheat flour. The crude fibre content in wheat flour was 5.60%, while in the mangrove fruit flour was 7.46% (Bashir *et al.*, 2017). This was consistent with previous research, which suggested that the addition of mangrove fruit flour to the African catfish nuggets could increase crude fibre content (Mervina *et al.,* 2012).

The *c*rude fibre content in modified cookies had exceeded the SFP's quality requirement standard due to mangrove fruit flour which had higher crude fibre content than wheat flour in control cookies. Besides being able to have beneficial effects on health, there were detrimental effects on crude fibre if consumed in excess amounts. Crude fibre could bind to nutrients that could affect mineral balance. This could bind to cations such as calcium, zinc, and iron, causing deficiency of calcium, iron, zinc, copper, and magnesium due to the excessive amount of fibre in the diet, especially in young children (Clifford *et al.,* 2015).

Iron was an important micronutrient for the body. Iron has several functions, energy metabolism, growth and development, the immune system, and the ability to learn (Sundari and Nuryanto, 2016). The iron content of cookies increased along with the addition of mangrove fruit flour. Based on the statistical test results, the highest iron content in cookies was found in F3 cookies, which showed that F3 cookies did not meet the SF quality requirements because iron levels exceeded the requirements (>7.5 mg/100 g). The composition of the ingredients used in making cookies influenced the increased iron levels. The iron content of mangrove and soybean flour used in F1, F2, and F3 cookies was higher than the wheat flour used in F0 cookies. The iron content in mangrove fruit flour was 53 ppm (5.3 mg/100 g), and soybean flour was 8.4 mg/100 g, while wheat flour was 1.3 mg/100 g. Several studies have shown that excess iron supplementation in toddler's results in slower growth and lower body weight. Excess iron intake could also reduce zinc absorption (Lönnerdal, 2017).

Calcium was a micronutrient that played an important role in children's linear growth. Lack of calcium in infants could cause rickets, while in children, a deficiency could result in stunted growth (Stuijvenberg *et al.*, 2015). Calcium test results showed the addition of mangrove and soy flour could increase the calcium content of cookies. The lowest calcium content was found in control cookies which only used 100% wheat flour. The addition of calcium levels was influenced by the ingredients' composition, which was the calcium content of mangrove and soybean flour which were higher than wheat flour. The calcium of mangrove fruit flour was 2948 ppm (294.8 mg/100 g), and soy flour was 195 mg/100 g, while wheat flour was only 22 mg/100 g.

Based on SFP's quality requirements, the content of calcium cookies in F1, F2, and F3 did not meet the requirements because the levels exceeded the standard (>450 mg/100 g). A study showed that high calcium intake had no side effects in increasing the risk of hypercalcemia, hypercalciuria, or kidney stone symptoms in toddlers. Short-term studies showed that calcium could affect iron and zinc absorption but not in the long term (SCF (Scientific Committee on Food), 2003; European Food Safety Authority (EFSA), 2012).

As a source of functional food, soybeans contained important components useful for health, including vitamins (vitamins A, E, K, and several types of B vitamins) and minerals (K, Fe, Zn, and P). The high mineral content in cookies with the substitution of mangrove fruit flour and soybean flour was influenced by the ash content contained in the materials used. Ash content was closely related to the mineral content in a food product. The largest ash content among mung bean flour, winged bean, and jack bean came from soybean flour. This was because soybeans were a high source of vitamins and minerals. The vitamins in soybeans were thiamine, riboflavin, niacin, and carotene. Soybeans were also a good source of minerals such as Ca, Fe, Cu, Mg, and Na. Mangrove fruit flour had higher ash content than wheat flour. This also showed that the mineral content in mangrove fruit flour was higher than wheat flour. Also, in previous studies, extra soy flour could increase the ash content of food bars because soybeans were a high mineral source (Sandjaja, 2009; Jariyah *et al.,* 2017; Amin *et al.*, 2018).

4.4 Organoleptic quality test for mangrove and soy cookies

The panellists' assessment on the most preferred cookie colour parameter was F3 with 80% mangrove fruit flour. The brown colour of F3 captivated the panellists. The brown colour produced in the cookies came from the mangrove fruit flour colour (Amin *et al.*, 2018).

Mangrove fruit flour had a brown colour, so the resulting product would also be brown. (Rosyadi *et al.,* 2014). The brown colour produced by mangrove fruit flour came from the mangroves' tannin content (Amin *et al.*, 2018).

The heating process at high temperatures could also cause a Maillard reaction between reducing sugars from starch and amino acids (primary amino groups) from proteins, resulting in the formation of a brown colour. This reaction occurred due to lysine and simple sugars in soy flour and skim milk (Tien and Fitriyono, 2010). F0 cookies had the lowest colour preference value by panellists because the F0 cookies used 100% wheat flour, the final colour of the product was golden yellow. This colour lacked appeal to the panellists.

Based on the organoleptic test on taste, F1 cookies with the addition of 60% mangrove fruit flour and 40% soybean flour were the preferred cookies' formulation by panellists. The taste preference level decreased as the amount of mangrove fruit flour increased because it caused a bitter after-taste (Sudirman *et al.,* 2014).

Mangrove fruit flour had a distinctive taste and was still less familiar to the panellists. The taste of mangrove fruit flour that was too thick could cover the flavours of the other ingredients. The bitter taste might come from the mangrove tannins. In this study, efforts have been made to reduce tannin levels by boiling and soaking in mangroves. Tannins were acidic polyphenol compounds that caused a bitter taste in mangrove fruit flour (Hagerman, 2010). Soy flour was also identical with a bitter taste (chalky flavour). Soybeans had an off-flavour in the form of a bitter taste caused by the presence of glycosides and isoflavone compounds in soybean seeds. Among these glycosides were soyasaponin and sapogenol (Purwanto and Hersoelistyorini, 2011). In making soy flour, efforts were made to reduce chalky flavours such as soaking and heating soybeans. However, soyasaponin compounds were relatively heat resistant, so that not all of them could be removed (Ginting and Antarlina, 2002). Research on making soy flour using the boiling method at 100°C for 5 mins could reduce soya saponin by 28.6% (Chaturvedi *et al.,* 2012). The addition of sugar in making cookies from mangrove fruit flour and soybeans was one effort to reduce the final product's bitterness.

The most preferred cookie was F0 with 100% wheat flour, and the least preferred was F3 with the addition of 80% mangrove fruit flour and 20% soy flour. The aroma produced by cookies comes from the ingredients used, such as butter, margarine, sugar, milk, and eggs. In addition to the aroma produced from these ingredients, mangrove fruit flour and soybeans' aroma also affected the cookies' final aroma. The addition of a higher concentration of mangrove fruit flour reduces the panellists' preference. This is due to the unfamiliar aroma of mangrove fruit flour.

Mangrove fruit flour had a distinctive aroma. Thus, it could cover up the aroma of other ingredients used (Alno *et al.*, 2018). Also, the addition of soy flour had a role in cookies' aroma. Soy flour had a distinctive aroma from soybeans (beany flavour). The lipoxygenase enzyme activity found in soybeans caused the unpleasant aroma due to the mixing of lipoxygenase in soybean fat when making soybean flour, which was when the soybean seeds broke during the peeling and refining process (Purwanto and Hersoelistyorini, 2011). The cause of the beany flavour in the flour was the less optimal process of making soybean flour and the method used (Yang *et al.*, 2016). Efforts to reduce beany flavour were soaking by adding 0.25% sodium bicarbonate and boiling it at 100°C for 20 mins (Rajapakse, 2015).

Based on the organoleptic test results, the preference for the cookies' texture was lower when there was more mangrove fruit flour (Alno *et al.*, 2018). The texture of the cookies would harden along with the increase in the amount of mangrove fruit flour. This was because the amylopectin content in mangrove fruit flour was lower than wheat flour (Amin *et al.*, 2018).

Amylopectin played an important role in the formation of product elasticity. Amylopectin played a role in the formation of the physical properties of the product. The higher the amylopectin level was, the stickier the food material was, and vice versa (Dhinendra *et al.,* 2015). In the mangrove and soybean flour cookies, the additional soy flour was inversely proportional to extra mangrove fruit flour. The concentration of adding soybean flour also affected the texture of the resulting product. The more soy flour was added, the crunchier the texture would be. Soy flour contained lecithin, which functioned as an emulsifier and bound water to improve the texture of the product to become crispier (Mervina *et al.,* 2012).

4.5 Determination of the best formulation

Determination of the best formulation was done using the product effectiveness test with the *De Garmo* method. The selected formula's nutritional content was the basis for determining SF cookies' serving size for mangrove flour and soybeans. The serving size was calculated from the number of cookies needed to meet 1/3 of a toddler's daily energy needs. The selected formula F2 contained energy as much as 479.44 kcal/100 g, carbohydrates 54.31 g/100 g, protein 11.70 g/100 g, and fat 23.93 g/100 g.

Supplementary Feeding (SF) cookies' serving size for mangrove fruit flour and soybeans was 5 pieces (50 g) for children aged 7–11 months and 9 pieces (90 g) for children aged 12–36 months. This met 33–38% RDA for energy, 31–32% RDA for carbohydrates, 32–38% RDA for protein, and 33–48% RDA for fat. Supplementary Feeding (SF) cookies could be used as a morning, afternoon, and evening snack.

5. Conclusion

The nutritional content, mineral substances, and HCN compounds and tannins in cookies have met the SFP quality requirements. However, the content of F1 protein, fat, and water exceeded the quality requirements. Crude fibre and calcium content in F1, F2, and F3 did not meet the quality requirements, but zinc content met SF quality requirements. The iron content in F1 and F2 met the SF quality requirements. The best cookie formulation that met the PMT quality requirements was F2, with a composition of 70% mangrove fruit flour and 30% soy flour.

Conflict of interest

The authors declare no conflict of interest.

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