https://doi.org/10.204736/mgi.v18i3.212–225

PHYSICOCHEMICAL CHARACTERISTICS, ANTIOXIDANT ACTIVITY AND SENSORY OF COOKIES BASED ON MOCAF, PURPLE YAM, AND CINNAMON FLOUR

Ibdal Satar[1*], Defita Fajar Emilia[1]
[1]Program Studi Teknologi Pangan, Fakultas Teknologi Industri, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
*E-mail: ibdal@tp.uad.ac.id

ABSTRACT

In general, cookies are made by using wheat flour with high gluten content, consequently it may cause negative impact on health. So far, cookies also have not the characteristics as functional food that is beneficial for health. Based on these issues, wheat flour is needed to substitute with alternative materials in order to reduce the gluten and increase the functional characteristic of cookies. Mocaf, purple yam flour and cinnamon powder can be used to provide cookies with low gluten and have the characteristic of functional food. The aims of this research are to characterize the physicochemical and organoleptic properties of cookies based Mocaf flour, purple yam flour and cinnamon powder. This work was used he completely randomized design (CRD) with the formulations applied F_0(100:0:0), F_1(75:24.5:0.5), F_2(75:24:1), F_3(75:23.5:1.5). F_4(50:49.5:0.5), F_5(50:49:1), F_6(50:48.5:1.5), F_7(25:74.5:0.5), F_8(25:74:1), and F_9(25:73.5:1.5) with 3 replications. Analysis of physicochemical properties of cookies consists of moisture, fat, total protein, ash, carbohydrates contents, texture, and antioxidant activity. The organoleptic properties were tested by 30 semi-trained panelists. The collected data were analyzed by one way ANOVA at significance level of 5% and followed by Duncan's test. These results show the contents of fat, protein, ash, carbohydrate, water, antioxidant activities and hardness were obtained in the range of 28.1-29.4%, 3.3-3.6%, 1.5-2.2%, 59.8-62.1%, 44.5-88.8 ppm and 13.8 - 38.3 N, respectively. Based on the organoleptic tests, F2 cookies was most preference than other formulations. The cookies produced believes have low gluten and food functi onal properties

Keywords: cinnamon, cookies, mocaf, purple yam flour

INTRODUCTION

Public health is the most important factor in supporting the progress of a nation. Good public health conditions play an important role in increasing productivity, education, development, social stability, and security as well as the development of human resources. In Indonesia, the management of health problems is regulated in the Regulation of the Minister of Health of the Republic of Indonesia Number 21 of 2020 concerning health management strategy plans (Putranto, 2020). Health management is comprehensive and reaches all levels of society so that health conditions are more under control.

Currently, several health issues such as celiac and degenerative diseases. Celiac disease is an autoimmune process in the body that is triggered by the habit of consuming foods high in gluten. The body gives an autoimmune reaction to gluten so that it interferes with the intestines and absorption of nutrients, causes gastrointestinal symptoms, and others. If this disease is not treated properly it can result in complications of various other types of diseases (Oktadiana, Abdullah, & Renaldi, 2017). Meanwhile, degenerative diseases such as heart disease, diabetes mellitus are also very important to overcome.

A good method for overcoming and preventing these diseases is to adopt a healthy diet and get used to consuming functional foods. Functional food is food that has basic nutrition and has a positive effect on health. The ingredients used in the manufacture of functional food must contain basic nutrients and bioactive components that are beneficial to health. Functional food can be prepared using a variety of basic ingredients such as vegetables, fruits, grains, tubers, herbs, and others (Suter, 2013).

 Received 13-05-2023, Accepted 25-07-2023, Published online 30-09-2023.

One of the food products that can be innovated into functional food products is cookies. Cookies are crispy dry bread with a sweet taste and are usually made from main ingredients such as wheat flour or wheat flour (Herawati, Suhartatik, & Widanti, 2018). Currently, cookies are growing and are available in various variants such as chocolate, peanut, coconut, vanilla, red velvet, blueberry, and others. However, the main ingredients used for making cookies are the same, namely wheat flour or wheat. As it is known that wheat flour (especially high in gluten) is not good for health. Gluten is a protein component composed of gliadin (20-25%) and glutenin (35-40%) (Fitasari, 2009) which are mostly found in cereal foods such as wheat flour (F Kusnandar, Harya, & Agus, 2022)

Apart from the negative impact on health, another disadvantage of high-gluten wheat flour is that it produces dough for cookies that is tough and tough (Masrikhiyah, 2021). Also, the resulting cookie products are not suitable for consumption by people with celiac disease. Patients with celiac disease such as anemia, osteoporosis, dermatitis herpetiformis, neurological symptoms, and diabetes mellitus (Gujral, Freeman, & Thomson, 2012) will detect gluten as a dangerous component, due to changes in the small intestine that result in impaired absorption of nutrients into the body (Permatasari, Ina, & Yusa, 2018). Therefore, people with celiac disease are advised to reduce the consumption of foods that contain gluten (Gujral et al., 2012).

The concept of gluten-free cookies with the theme of functional food as a new food product innovation is very interesting to develop. Indeed, the nature of functional food is not solely determined by high, low, or no gluten content, however, foods that are high in gluten content generally tend to cause adverse effects on health, so they are not suitable to be called functional foods. The concept of gluten-free cookies can be realized by substituting wheat flour with alternative flour (which does not contain gluten) such as modified cassava flour (Mocaf) (Tanjung & Kusnadi, 2015). In addition, the concept of cookies as functional food can also be realized through the use of raw materials that contain other compounds that can provide benefits to the body, such as antioxidant compounds.

It is well known that apart from being high in gluten, cookies usually do not contain (low) antioxidants. Therefore, innovation is needed to overcome this problem. Foodstuffs that can be used as sources of antioxidants include purple yam and cinnamon because these two types of ingredients are rich in antioxidants. According to research results Prasetyo and Winardi (2020) that the antioxidant activity (based on radical scavenging activity, RSA) in fresh purple yam was around 62.14%, and purple yam flour was around 20.19%. Whereas in cinnamon bark the antioxidant activity (based on the inhibition concentration, IC_{50}) is around 1.94 ppm (Antasionasti & Jayanto, 2021).

Gluten-free and high-antioxidant cookies have several advantages, including being suitable for consumption by people with celiac disease and being beneficial for the body as an antidote to free radicals. Many studies have been reported on the use of Mocaf flour, purple yam flour, and cinnamon powder for making cookies, such as research on making cookies. For example, (Herawati et al., 2018; Rasyid, Maryati, Triandita, Yuliani, & Angraeni, 2020) were used Mocaf flour, Fitriani, Yurnalis, and Hermalena (2019) used purple yam flour and white yam(40:60) and Fairus, Hamidah, and Setyaningrum (2021) were used Mocaf flour, purple yam and peanuts (20:35:45). The physicochemical characteristics of the cookies produced such as moisture, fat, protein, ash, and carbohydrate contents were obtained in the range of 1.1 - 3.1%, 12.7 - 25.2%, 2.9 - 12.6%, 0.9 - 1.1%, and 29.6%, respectively. Meanwhile, the results of research on antioxidant activity in cookies made from purple yam flour and peanuts are reported by Martins, Susilowati, and Jinarti (2014) where the percentage of radical scavenging activity (%RSA) is around 39.7%.

The use of local food commodities can reduce the need for wheat flour (Tamaroh & Sudrajat, 2021). Many local food commodities have not been used optimally, such as cassava (*Manihot esculenta*) and purple yam (*Ipomoea batatas*). Cassava can be processed through fermentation to produce gluten-free flour known as Mocaf. Meanwhile, purple yam (*Ipomoea batatas L.*) can be processed into antioxidant-rich flour (Nabilah, 2019). The use of cinnamon (*Cinnamomum* *burmannii*) as an additional ingredient in making cookies is also an interesting innovation because cinnamon is rich in antioxidant compounds such as eugenol, safrole, cinnamaldehyde, tannins (Hariana, 2007), and polyphenol (Priani, Darusman, & Humanisya, 2014).

Parameters of cookie quality involving physicochemical and sensory properties are very important to evaluate before the cookies are commercialized. Quality cookies are cookies that meet physicochemical and sensory quality criteria. In general, the physicochemical properties that are often evaluated include moisture content, protein, fat, ash, carbohydrates and texture. Based on SNI-2973-2018 that the maximum water content is 5%, the minimum protein is 9%, the minimum fat is 9.5%, the maximum ash is 1.5% and carbohydrates is maximum 70% (BSN, 2018). In addition, according to Rahardjo, Nugroho, and Saibele (2021) the sensory also determines the quality of cookies. Sensory parameters evaluated include aroma, taste, color, and texture.

Based on the illustration above, the scenarios are needed to produce gluten-free cookie products that have functional food characteristics. This research tries to the use of Mocaf and purple yam flour as basic ingredients for making cookies, and cinnamon powder as an additional ingredient. The purpose of this study is to determine the physicochemical characteristics, antioxidant activity, and sensory activity of cookies made from Mocaf flour and purple yam flour with added cinnamon powder. In addition, this study also aims to provide information related to the formulation of good cookies based on the nutritional, antioxidant, and sensory aspects. Several physicochemical properties of cookies were analyzed such as moisture content, fat, total protein, ash, carbohydrates, hardness, and antioxidant activity. Meanwhile, the sensory properties of the cookies that were evaluated included color, taste, aroma, texture, and overall preferences.

MATERIALS AND METHODS

Materials and Instruments

The materials were cassava. purple yam and cinnamon. Other materials needed were margarine, sugar, eggs, skimmed milk, and baking powder. All materials were purchased from the Yogyakarta Traditional Market. The instruments used were a sieve, blender, rolling pin, Soxhlet, UV-Vis Spectrophotometer (Thermoscientific), Oven (Memmert), and UTM (Zwick/z0.5).

Mocaf flour Preparation

The preparation of Mocaf flour was performed by using a method as described by Yani and Akbar (2018). A total of 1 kg of cassava peeled was washed with water and sliced using grated chips. After that, the cassava slices were soaked in water, added a total of 5 g of yeast (*Saccharomyces cerevisiae*), and left for 12 hours. Then, the cassava slices were drained and dried in an oven at 60°C for 24 hours. Dried cassava slices were fined by using a blender for 15 minutes and then sieved through an 80 mesh. The Mocaf flour product was shown in **Figure 1**.

Figure 1. Mocaf flour.

Purple Yam Flour Preparation

The preparation of purple yam flour was performed using a method as described by Anggarawati, Ekawati, and Wiadnyani (2019). A total of 1 kg of sorted purple yam was peeled, washed with clean water, sliced with grated chips, placed on a baking sheet, and dried in an oven at 60°C for 4 hours. Then, the dried slices were fined with a blender and sieved through a 60 mesh. The product of purple yam flour was shown in **Figure 2**.

Figure 2. Purple yam flour

https://doi.org/10.204736/mgi.v18i3.212–225

Cinnamon Powder Preparation

The preparation of cinnamon powder was performed as described by Shahid et al. (2018). A total of 75 g of cinnamon bark was washed with clean water, cut into small pieces, and dried in an oven at 60°C for 6 hours. After that, the dried cinnamon pieces were mashed using a blender and sieved through a 60 mesh. The product of cinnamon powder was shown in **Figure 3.**

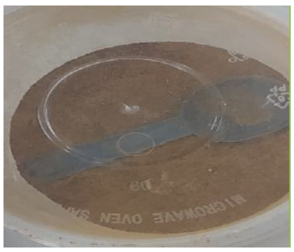

Figure 3. Cinnamon powder

Experimental Design

This work was designed by a completely randomized design (CRD) with a comparison composition of Mocaf flour (M), purple yam (PY), and cinnamon powder (C). In detail, **Table 1** was presented the research experimental design in this work.

Table 1. Experimental design in this work

Formulation (%)			Symbols	Repetitions		
M	PY	C		1	2	3
100	0	0	F_0	F_{01}	F_{02}	F_{03}
75	24,5	0,5	F_1	F_{11}	F_{12}	F_{13}
75	24	1	F_2	F_{21}	F_{22}	F_{23}
75	23,5	1,5	F_3	F_{31}	F_{32}	F_{33}
50	49,5	0,5	F_4	F_{41}	F_{42}	F_{43}
50	49	1	F_5	F_{51}	F_{52}	F_{53}
50	48,5	1,5	F_6	F_{61}	F_{62}	F_{63}
25	74,5	0,5	F_7	F_{71}	F_{72}	F_{73}
25	74	1	F_8	F_{81}	F_{82}	F_{83}
25	73,5	1,5	F_9	F_{91}	F_{92}	F_{93}

Cookies Preparation

The composition of the ingredients for making cookies were presented in **Table 2**. Margarine, fine sugar, and egg yolks were mixed by using a mixer for 3 minutes. Then, the mixtures were homogenized by using a mixer for 2 minutes. After that, the mixtures were added with the baking powder, skim milk, Mocaf flour, purple, and cinnamon powder. Again, the mixture was then homogenized with a mixer for 5 minutes. The dough was printed on the brass and baked in the oven at 180°C for 13 minutes (Waisnawi, Yusasrini, & Ina, 2019).

Table 2. Cookies ingredient

Ingredients (g)	Formulations									
	F_0	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9
Margarine	85	85	85	85	85	85	85	85	85	85
Fine Sugar	60	60	60	60	60	60	60	60	60	60
Egg yolk	10	10	10	10	10	10	10	10	10	10
Baking powder	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Skimmed milk	15	15	15	15	15	15	15	15	15	15
Mocaf flour	100	75	75	75	50	50	50	25	25	25
Purple yam flour	0	24,5	24	23,5	49,5	49	48,5	74,5	74	73,5
Cinnamon powder	0	0,5	1	1,5	0,5	1	1,5	0,5	1	1,5

Hardness Test

The texture was tested based on the level of hardness. The hardness level was tested by using the Universal Testing Machine (UTM, Zwick/z0.5). The levels of hardness were measured based on the amount of force needed to break or penetrate the cookies (Bourne, 2002).

Water content measurement

The water content of cookies was determined by using the AOAC (2005) method. The crucible was primarily dried in the oven at 105°C for 1 hour. The cup was then cooled in a desiccator for 15 minutes and then weighed until the weight was constant. A total of 2 g of sample was placed in a cup and dried in the oven at 105°C for 24

https://doi.org/10.204736/mgi.v18i3.212–225

hours. After that, the samples were cooled in a desiccator for 15 minutes and then weighed. The water content was determined using the following Equation 1;

$$C_W = \frac{W_1 - W_2}{W_1} \times 100\% \ldots (1)$$

Where;

C_W = water content (%); W_1 = weight of the cup and sample before dried (g); W_2 = weight of the cup and sample after dried (g)

Fat content measurement

Fat content was determined by using the Soxhlet method as described in the AOAC (2005). The distillation flask (filled with boiling stones) was dried in the oven at 105°C, cooled, and weighed. Then, the distillation flask was filled with 10 mL of petroleum benzene solvent. At the same time, the cookie samples were crushed, weighed, put in an extraction sleeve, and covered with cotton. Then, the Soxhlet apparatus was installed and the casing containing the sample was placed in the sample holder. The extraction process was carried out at 60-70°C for 6 hours. After the extraction process was completed, the solvent was removed using a rotary evaporator. Lastly, fat content was determined using the following Equation 2;

$$C_F = \frac{W_o - W_d}{W_s} \times 100\% \ldots (2)$$

Where;

C_F = fat content (%); W_d = weight of flasks and boiling stone (g); W_o = weight of fat, flask, and boiling stone (g); W_s = weight of the sample (g)

Measurement of Total Protein Content

Total protein content was determined using the Kjeldahl method as described in the AOAC (2005). Three stages were carried out including the stages of destruction, distillation, and titration. A total of 0.25 g of the cookie sample was crushed, and put into a 100 mL Kjeldahl flask, added 0.7 g of catalyst N (K_2SO_4:$CuSO_4$, 2:3) and 4 mL of concentrated H_2SO_4 (98%). The sample destruction process was carried out by heating at 410°C for 1 hour in a fume hood until the color of the solution was changed to clear green. Then, the solution was cooled, added 50 distilled water and 20 mL of 40% NaOH.

The distillation process was carried out at 100°C. The distillate was collected in an Erlenmeyer containing 10 mL of boric acid solution (H_3BO_3, 2%) and 3 drops of (bromocresol green methyl red, BCG-MR) indicator. Once the color of the distillate was changed from red to blue and the volume reached 40 ml, the distillation process was stopped. Then, the distillate was titrated with 0.01 N HCl until the pink color appeared. Also, the titration process on blank was performed. Record the volume of titrant used to titrate the sample and the blank. Protein levels were determined using the following Equation 3;

$$C_P = \frac{(V_2 - V_1) \times N \times 0.014 \times F_k \times F_p}{W} \times 100\% \ldots (3)$$

Where;

C_P = protein content (%); V_1 = volume of titrant for blank (mL); V_2 = volume of titrant for sample (mL); N = normality of HCl (0.01 N); F_p = dilution factor, F_k = conversion factor (6,25)

Ash Content Measurement

The ash content was determined by using the procedure of AOAC (2005). The crucible was dried in the oven at 105°C for 1 hour., cooled in a desiccator for 15 minutes, and then weighed until the weight was constant. A total of 2 g of sample was put into a crucible and the burning process was carried out in a furnace at 600°C for 3 hours. Then, the burning process was stopped, and allowed to cool down to 120°C. The crucible was removed from the furnace and cooled in a desiccator for 15 minutes. Finally, the crucible and ashes were weighed. The ash content was calculated using the following Equation 4;

$$C_{Ash} = \frac{W_1 - W_2}{W_1} \times 100\% \ldots (4)$$

Where;

C_{Ash} = ash content (%); W_1 = weight of crucible and sample (g); W_2 = weight of crucible and ash (g).

Carbohydrate Content Calculation

Analysis of carbohydrate content can be determined based on the difference of 100% of total content minus the water, fat, protein, and ash contents. Equation 5 can be used to calculate carbohydrate content.

$$C_C = 100\% - (W + F + P + Ash)\% \ldots (5)$$

Where;
C_C = carbohydrate content (%); W = water content (%); F = fat content (%); P = protein content (%); Ash = ash content (%)

Antioxidant Activity (IC_{50}) Analysis

The procedure for analyzing the antioxidant activity was carried out by using the method as described by Indriyani, Nurhidajah, and Suyanto (2013). The solution of 0.2 M DPPH was prepared by dissolving 0.8 g of DPPH powder (BM 394.32 g/mol) in 10 mL of methanol. Then, a total of 0.1 ml of the 0.2 M DPPH solution was taken and put in a 100 ml volumetric flask, then diluted with methanol to obtain a 0.2 mM DPPH. After that, a total 1 ml of 0.2 mM DPPH solution was taken, put in a test tube, and add 4 ml of methanol, homogenized using a vortex and incubated for 30 minutes. Finally, determine the absorbance of the solution (blank) using a UV-Vis spectrophotometer (Thermo Scientific) at a wavelength of 517 nm.

The sample preparation was carried out by dissolving 10 mg of cookies in 10 mL of methanol in a test tube. Then, the sample solution was prepared in the series concentration of 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm, respectively. A total of 1 mL of each sample solution was taken, add 1 mL of 0.2 mM DPPH solution, placed in different test tubes, and diluted with methanol up to 5 mL of total volume. Then, the mixture was homogenized using a vortex and incubated for 30 minutes. Lastly, sample absorption was measured using a UV-Vis spectrophotometer (Thermo Scientific) at a wavelength of 517 nm. The percentage of inhibition was calculated by using Equation 6.

$$Inhibition\ (\%) = \frac{A_b - A_s}{A_b} \times 100\% \ldots (6)$$

Where;
A_b = absorption of the blank; A_s = absorption of the sample

Antioxidant activity (IC_{50}) was determined by using the calibration curve from the inhibition percentage. The percentage of inhibition was plotted as the y-axis and the *ln* of the concentration was plotted as the x-axis so that Equation 6 was obtained. Then, the IC_{50} was determined using Equation 7.

$$y = ax + b \ldots (6)$$

$$50 = ax + b$$

$$x = \frac{50 - b}{a}$$

$$IC_{50} = anti\ ln\ x \ldots (7)$$

Where;
a = slope; b = intercept; x = concentration of antioxidant (ppm)

Sensory Test

The sensory properties of cookies such as color, taste, aroma, texture, and overall level of preference were evaluated by involving 30 untrained panelists. The number of untrained panelists can be selected around 25 - 50 people to get good sensory test results (Meilgaard, Gail Vance Civille, & Carr, 2007). The panelists in this study were selected from healthy students consisting of 15 boys and 15 girls with an average age of 20-21 years. Scoring based on preference levels were 1 (dislike very much), 2 (dislike), 3 (neutral), 4 (like), and 5 (very like).

Data Analysis

The data obtained were analyzed by using SPSS software version 25.0. with a one-way ANOVA test at a significance level of 5% (α = 0.05). If there was a significant difference between the treatments, then a further test was carried out using Duncan's test.

RESULTS AND DISCUSSION

Cookies and Their Physicochemical Properties

Overall, the physicochemical characteristics of cookies based on Mocaf flour, purple yam flour, and cinnamon were shown in **Table 3**. As a comparison, some relevant research literature was also presented.

The types of cookie products produced were shown in **Figure 4**. Visually, the cookies showed that the color of the cookies gets darker as the purple yam flour composition increases. This can be caused by the purple pigment of the purple sweet potato.

Table 3. Physicochemical properties of cookies

Sample	Water content (%)	Fat content (%)	Total Protein (%)	Ash content Abu (%)	Carbohydrate content (%)	Hardness (N)
F0	4,8 ± 0,1[a]	28,5 ± 0,2[ab]	3,4 ± 0,1[b]	1,5 ± 0,2[a]	61,8 ± 0,2[de]	35,3 ± 3,5[de]
F1	4,9 ± 0,1[ab]	28,2 ± 0,2[a]	3,3 ± 0,0[a]	1,6 ± 0,1[a]	62,1 ± 0,1[e]	21,6 ± 4,2[bc]
F2	4,9 ± 0,1[ab]	28,5 ± 0,3[ab]	3,3 ± 0,1[a]	1,6 ± 0,1[ab]	61,8 ± 0,5[de]	18,8 ± 3,2[ab]
F3	4,9 ± 0,2[ab]	28,6 ± 0,2[ab]	3,3 ± 0,0[a]	1,6 ± 0,0[ab]	61,6 ± 0,4[cde]	13,8 ± 2,3[a]
F4	4,9 ± 0,2[ab]	28,4 ± 0,1[ab]	3,5 ± 0,0[bc]	1,6 ± 0,0[ab]	61,5 ± 0,1[cde]	30,3 ± 0,5[d]
F5	4,9 ± 0,1[ab]	28,8 ± 0,3[abc]	3,5 ± 0,0[bc]	1,8 ± 0,2[b]	61,0 ± 0,4[bc]	24,9 ± 2,0[c]
F6	4,9 ± 0,0[ab]	29,1 ± 0,9[bc]	3,5 ± 0,1[bc]	1,9 ± 0,0[c]	60,6 ± 0,9[b]	17,9 ± 2,3[ab]
F7	5,0 ± 0,1[b]	28,1 ± 0,2[a]	3,5 ± 0,1[bc]	2,1 ± 0,0[cd]	61,2 ± 0,2[bcd]	38,3 ± 0,5[e]
F8	5,0 ± 0,2[ab]	28,7 ± 0,3[ab]	3,5 ± 0,0[bc]	2,2 ± 0,0[cd]	60,6 ± 0,1[b]	35,1 ± 0,7[de]
F9	4,9 ± 0,1[ab]	29,4 ± 0,3[c]	3,6 ± 0,0[c]	2,2 ± 0,0[d]	59,8 ± 0,3[a]	35,0 ± 5,9[de]
Rata-rata	4,9 ± 0,1	28,6 ± 0,5	3,4 ± 0,1	1,8 ± 0,2	61,2 ± 0,8	27,1 ± 8,8
Referensi	Max. 5%*	Min. 9,5%*	Min. 5%*	Max. 1,6%*	Min. 70%*	22-50 N**

Note: Numbers followed by the same superscript letter indicate no significant difference;* Source (Nasional, 2011); ** Source (Nindyarani, Sutardi, & Suparmo, 2011).

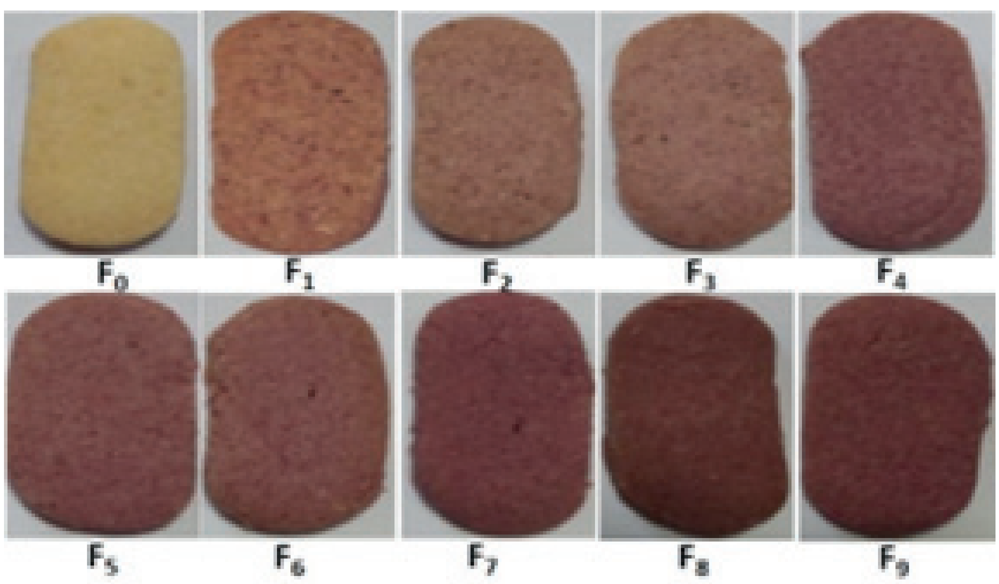

Figure 4. Cookies based on Mocaf flour, purple yam flour and cinnamon powder

Water content

Water content indicates the proportion of water composition in a food ingredient. Based on **Table 3**, the F_7 shows the highest level of water content which was obtained at around 5.0%, while the F_0 shows the lowest level of water content which was around 4.8%. The high or low water content is caused by the ability of raw materials to absorb the water. Mocaf and purple yam flour have a greater water absorption capacity than wheat flour (Etudaiye, Oti, Aniedu, & Omodamiro, 2015). The water absorption capacity of Mocaf flour and purple yam were around 250 – 300% (Olatunde, Henshaw, Idowu,

& Tomlins, 2016), while wheat flour is around 50 – 60% (Feri Kusnandar, Danniswara, & Sutriyono, 2022). One of the important factors that affect the absorption of water in food is the protein content. The side chain polar groups of protein compounds such as carbonyl, hydroxyl, amino, carboxyl, and sulfhydryl are hydrophilic components, so they can hydrogen bond with water (Rauf & Sarbini, 2015). As shown in **Figure 5**, the water content tends to increase with increasing protein content in cookies. However, in general, the water content in each formulation was not significantly different (p>0.05).

Reference to the quality requirements for cookies based on SNI 01-2973-2011 where the maximum water content is around 5% (Badan Standarisasi Nasional, 2011). The water content for all formulations meet the specified criteria where the moisture content of cookies was in the range of 4.8-5.0%.

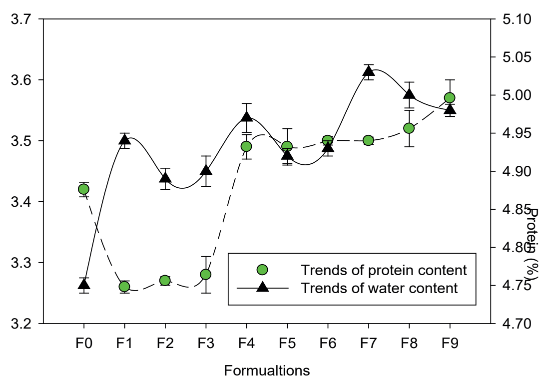

Figure 5. Correlation between protein and water contents

Fat content

Based on **Table 3**, the fat contents were obtained in the range of 28.1 - 29.4%. These fat contents were much higher than the standard set by SNI 01-2973-2011 where the minimum cookie fat content is around 9.5% % (Nasional, 2011). These facts show the resulting cookies meet the standards set.

Overall, the fat content in each formulation was not significantly different (p>0.05). This fact might be due to the fat content in Mocaf flour and purple yam flour being quite the same, which was in the range of 0.4 – 0.8 g per 100 g, consequently, the changes in composition do not have a significant effect on the fat content of cookies. In addition to the fat content in Mocaf and purple yam flour, the cinnamon composition also affects the fat content of cookies. According to Singh, Maurya, Delampasona, and Can (2007) that cinnamon contains essential oils which can be categorized as fats (Mulyani & Sujarwanta, 2018). In general, although not significant, the increase in the composition of purple yam flour and cinnamon powder tends to increase the fat content of cookies. The phenomenon of the effect of adding purple yam flour and cinnamon powder on the increase in fat content was shown in **Figure 6**. The higher composition of purple yam flour and cinnamon powder tends to increase the fat content in the cookies.

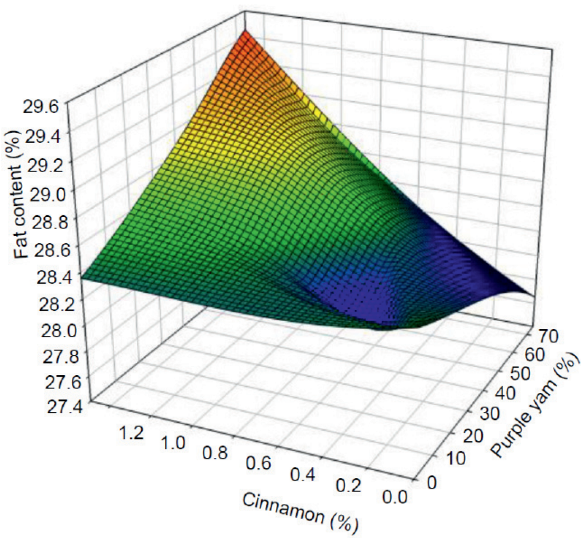

Figure 6. Correlation between purple yam flour and cinnamon powder compositions on fat content in cookies

Protein Total Content

Protein is one of macronutrients that is the most important for the body. Protein content can help repair muscles and create a feeling of fullness. However, consuming cookies that are rich in protein must be limited to prevent a negative impact on health. Based on **Table 3**, the protein contents were obtained in the range of 3.3 - 3.6%. These protein contents were lower than the standard set in SNI 01-2973-2011 which is 5%. The low protein content may be caused by the low protein content in Mocaf, purple yam flour, and cinnamon powder. The highest protein content was found in F_9 while the lowest in F_1. Based on **Figure 7**, protein content tends to increase with increasing composition of purple yam flour and cinnamon. An increase in the composition of purple yam flour and cinnamon powder had a significant effect on protein content ($p<0.05$). This means the higher the composition of purple yam flour and cinnamon powder, so the higher the protein content of cookies. This might be due to the protein content in purple yam flour (3.8%) and cinnamon (2.5%). As described above, the F_9 formulation uses the most purple yam flour and cinnamon powder, so the protein content was the highest (3.6%).

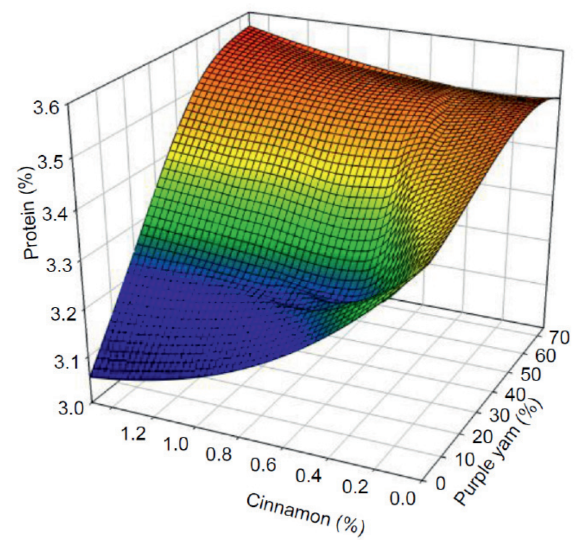

Figure 7. Effect of purple yam flour and cinnamon powder compositions on the changes in protein content

Ash content

Although the ash content does not have a direct effect on health, it needs to analyze to find out a general description of the mineral content in food products. The ash content in food refers to the minerals that remain after all the organic compounds have been burned during the ashing process. Table 3 shows the ash content of cookies, where the highest content was around 2.2% (F_9), while the lowest was around 1.5% (F_0). These results illustrated that the ash content was affected by the high composition of purple yam flour and cinnamon powder. Based on the preliminary test, it was known that the ash content in purple yam was around 1.8%. So that the highest formulation of purple yam flour will have the highest ash content. In addition, the use of cinnamon powder also had a significant effect ($p<0.05$) on the ash content. It was well known that cinnamon powder contains the highest ash compared to other ingredients, which was around 4.0%. This fact was caused by cinnamon powder containing calcium oxalate, glycyrrhizin, asparagine, essential oils, and other components (Herawati et al., 2018). As shown above, F_0 has the lowest ash content because Mocaf flour contains the lowest ash content compared to other ingredients, which was 0.4%. The correlation between the composition of purple yam potato flour and cinnamon powder on ash content were shown in **Figure 8.**

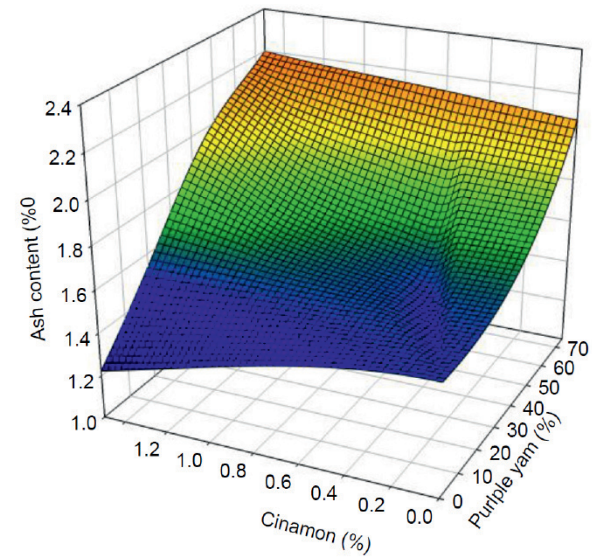

Figure 8. Effect of purple yam flour and cinnamon powder compositions on ash content

The standard of the quality requirements of cookies based on ash content has been stipulated in SNI 01-2973-2011, where the maximum ash content of cookies is 1.6% (Nasional, 2011). The results of the analysis showed that the formulations of F_0 (1.5%), F_1 (1.6%), F_2 (1.6%), and F_3 (1.6%) met the quality requirements for ash content which were obtained around 1.6%. Meanwhile, the formulations of F_4, F_5, F_6, F_7, F_8, and F_9 were not meet with the standard ash content (> 1.6%) set.

Carbohydrate content

Based on the quality requirements of cookies according to SNI 01-2973-2011 that the minimum carbohydrate content that must be fulfilled by cookies is around 70% (Nasional, 2011). As

https://doi.org/10.204736/mgi.v18i3.212–225

shown in **Table 3** that the carbohydrate contents of cookies were lower than the standard set where the carbohydrate content was in the range of 59.8 - 62.1%. The low carbohydrate content in cookies might be due to the low carbohydrate content in the raw materials of both Mocaf flour and purple yam flour.

In the context of carbohydrate content, Mocaf flour has undergone quality improvements (Kurniati, Aida, Gunawan, & Widjaja, 2012). During the fermentation process, the starch from cassava flour can be hydrolyzed into maltose and then converted into sugar, as a result, Mocaf flour contains higher carbohydrates (Yani & Akbar, 2018). Therefore, the high composition of Mocaf flour tends to increase the carbohydrate content of cookies. The correlation between the composition of Mocaf flour and purple yam on carbohydrate content was shown in **Figure 9**.

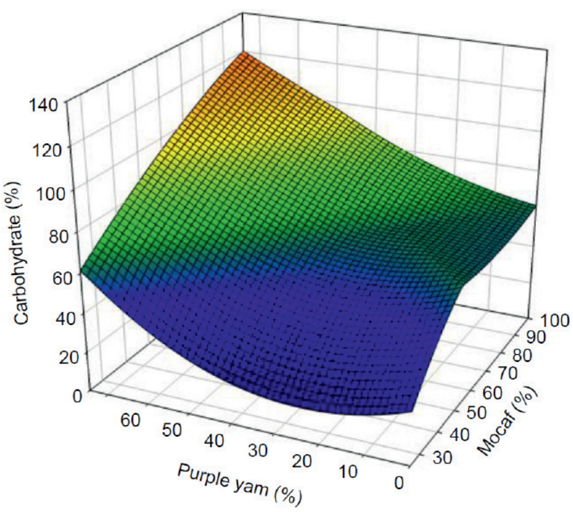

Figure 9. Effect of Mocaf flour and purple yam composition on carbohydrate content in coockies

Hardness

Texture such as hardness is one of the physical parameters that need to be evaluated because it greatly affects the quality of cookies. Cookies that are too hard will be difficult to chew and can reduce the delicious taste. In addition, textures that are too hard also tend to be more brittle and easily crushed, consequently reducing the shelf life. So far, there is no standard hardness value set for cookies, so generally, the results of texture identification are only used to provide information related to the relationship between the formulation and the hardness value. As shown in Table 3, the highest hardness value was obtained at around 38.3 N (F_7), while the lowest hardness value was obtained at around 13.8 N (F_3). The hardness of cookies was generally affected by water, fat, carbohydrate, and protein contents.

According to Istinganah, Rauf, and Widyaningsih (2017) that starch content (especially amylose) was very associated with the level of hardness. Flour with a high amylose composition tends to produce cookies that were much harder than flour with a low amylose content. Purple yam flour contains about 74.6% starch with 24.8% amylose (Nindyarani et al., 2011) which is higher than the starch content in Mocaf flour which is around 63.1% with an amylose content of around 11.1% (Yani & Akbar, 2018). Therefore, the high composition of purple yam flour tends to increase the hardness level. The phenomenon of the purple yam effect on the level of hardness was shown in **Figure 10.**

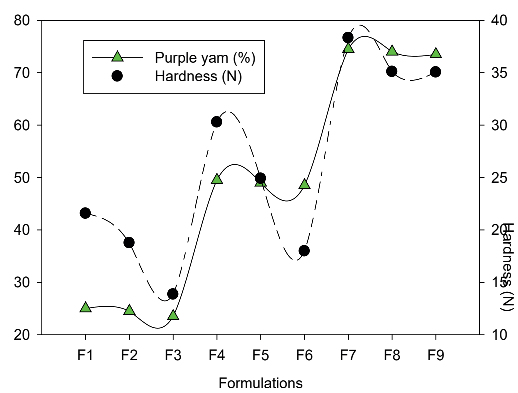

Figure 10. The pattern of increasing the hardness value of cookies was based on increasing the composition of purple yam flour

Antioxidant Activities

The high value of antioxidant activity can describe the functional characteristics of cookies. It is well known that high antioxidant activity has a high ability to counteract free radicals. Antioxidant compounds can prevent the occurrence of an oxidation reaction by preventing the formation of radicals.

Table 4 shows the IC_{50} values for each formulation. The value of antioxidant activity (IC_{50}) of cookies was obtained in the range of 44.5 - 88.8 ppm. The lowest IC_{50} value (very strong)

https://doi.org/10.204736/mgi.v18i3.212–225

was shown by F_9, while the highest (strong) was shown by F_1. This fact indicates that increasing the composition of purple yam and cinnamon can increase antioxidant activity. This might be due to the purple yam and cinnamon contain various antioxidant compounds. Purple yam contains anthocyanins, β-carotene, vitamin C, and vitamin E which act as antioxidants. Meanwhile, cinnamon contains polyphenols, flavonoids, and caffeine which also act as antioxidant compounds.

The antioxidant activity in purple yam flour was about 83.7% with anthocyanin levels were around 391.1 mg GAE/100 g (Tamaroh & Sudrajat, 2021). Meanwhile, cinnamon contains antioxidant compounds, especially cinnamtannins B1 and B2, oligomeric procyanidins, and proanthocyanidins. The antioxidant activity (%RSA) of cinnamon powder was around 90.0% with an antioxidant level of around 355.0 mg GAE/100 g (Shahid et al., 2018).

According to the research results of Fitriani *et al.* (2019) regarding the antioxidant activity in cookies using 80% purple yam flour (without cinnamon powder) showed the IC_{50} value was obtained around 75.3 ppm (strong antioxidant activity). Whereas, in this study, the F_7 cookies with a purple yam flour composition of 74.5% show a much lower IC_{50} value (stronger activity), which was around 50.6 ppm. This fact indicated that the addition of cinnamon powder contributed significantly ($p<0.05$) to the increase in antioxidant capacity.

Table 4. Antioxidant activities of cookies

Sample	IC_{50} (ppm)	Categories
F_0	$88,7 \pm 0,6^g$	Strong
F_1	$88,8 \pm 0,5^g$	Strong
F_2	$80,2 \pm 0,3^f$	Strong
F_3	$74,9 \pm 1,3^e$	Strong
F_4	$67,3 \pm 0,8^d$	Strong
F_5	$66,0 \pm 1,5^d$	Strong
F_6	$55,7 \pm 1,7^c$	Strong
F_7	$50,6 \pm 0,2^b$	Strong
F_8	$49,5 \pm 0,8^b$	Very strong
F_9	$44,5 \pm 1,6^a$	Very strong
Reference	70-8 ppm*	Strong
	62,3 ppm**	Strong

Note: Numbers followed by the same superscript letter indicate no significant difference;* Source (Fitriani et al., 2019); **Source (Hati, Setiani, & Bintoro, 2020)

Sensory Evaluation

The sensory properties of cookies including color, taste, texture, aroma, and overall preference were presented in **Table 5**. Color is a parameter attached to cookies that is first seen (Tarwendah, 2017). Based on the color analysis the color F_7 was the most preferred, where the level of preference was around 3.9 (like criteria). While the color F_0 was the least preferred with a preference level of around 3.1 (neutral category). The appearance of a strong purple color on F_7 makes cookies more attractive to attention than F_0 which was brown (See Figure 1). According to Nabilah *et al.* (2019) which stated that the most preferred color of cookies was cookies with the highest purple sweet potato flour composition, namely 75%.

Taste is one of the sensory parameters of cookies. The taste of the F_9 formulation was the most preferred where the level of preference was observed around 4.1 (like), while the F_0 formulation was least preferred with a level of preference of around 3.4 (neutral). According to Widyasitoresmi (2010) that purple yam has a distinctive taste and tends to be sweet so it was preferred over Mocaf flour which does not have a distinctive or sweet taste (Setyadjid & Setiyaningrum, 2022). In addition to purple yam flour, increasing the composition of cinnamon powder can also improve the taste and flavor of cookies because cinnamon powder contains cinnamaldehyde compounds which act as flavor and flavor formers (Shobur, Hersoelistyorini, & Syadi, 2021). Thus, the high composition of purple yam flour and cinnamon powder (formulation F_9) resulted in a balanced taste that the panelists preferred.

As with color and taste, aroma is also an important parameter in food products. Aroma is a parameter attached to food products that can be identified using the sense of smell. Based on the aroma evaluation that the F_9 formulation was the most preferred with a preference level of around 3.8 ± 0.8 (liking criteria). This might due to the aroma of purple sweet potato flour was not so strong. In addition, the use of cinnamon powder in the composition also makes the aroma more attractive. While the F_0 formulation was the least preferred with a preference level of around 3.2 ± 1.0 (neutral criteria). This might be caused by the emergence of a sour aroma caused by the high composition of Mocaf flour. Mocaf flour has a distinctive cassava flavor and a slightly sour aroma (Yani & Akbar, 2018), as a result, the higher the Mocaf flour composition causes the stronger the sour aroma in the cookies.

Texture parameters also greatly affect the quality of cookies. The harder or softer the texture of the cookies describes the worse the quality. Texture can be judged by biting, chewing. and touching. Based on the texture analysis, the F_2 was the most preferred cookie with a preference level of around 3.9 ± 0.7 (like criteria), while the F_7 was the least preferred with a preference level of around 3.5 ± 0.9 (neutral criteria). Reducing the composition of purple yam flour (decreasing amylose content) resulted in a decrease in the level of hardness. Formulations F_2 and F_3 used the purple yam flour at 24% and 23.5%, respectively, so their textures were less hard. The level of preference decreased with increasing the purple yam flour composition because the cookies tended to be harder. According to the result that was reported by (Setyadjid & Setiyaningrum, 2022) that cookies with a low composition of purple yam flour (30%) were the most preferred texture. In addition, the results of Nindyarani et al. (2011) also stated that cookies with a low purple sweet potato flour composition (about 25%) were the most preferred.

Table 5. Sensory of cookies

Sample	Hedonic tests				
	Color	Taste	Texture	Aroma	Overall
F_0	3,1 ± 1,3^a	3,4 ± 1,0^a	3,6 ± 1,1^a	3,2 ± 1,0^a	3,4 ± 1,1^a
F_1	3,4 ± 0,8^{ab}	3,6 ± 0,9^{ab}	3,7 ± 0,6^a	3,5 ± 0,7^{ab}	3,8 ± 0,8^a
F_2	3,4 ± 0,9^{ab}	3,8 ± 0,9^{ab}	3,9 ± 0,7^a	3,6 ± 0,7^b	3,9 ± 0,7^a
F_3	3,2 ± 0,9^a	3,8 ± 1,0^{ab}	3,9 ± 0,7^a	3,6 ± 0,6^{ab}	3,7 ± 1,0^a
F_4	3,8 ± 0,6^b	3,9 ± 0,8^{ab}	3,7 ± 0,9^a	3,7 ± 0,7^b	3,8 ± 0,7^a
F_5	3,8 ± 0,7^b	3,8 ± 0,9^{ab}	3,7 ± 0,9^a	3,6 ± 0,7^{ab}	3,7 ± 0,8^a
F_6	3,8 ± 0,9^b	3,9 ± 0,9^{ab}	3,7 ± 0,7^a	3,7 ± 0,5^b	3,9 ± 0,8^a
F_7	3,9 ± 0,9^b	4,0 ± 0,9^b	3,5 ± 0,9^a	3,6 ± 0,9^{ab}	3,6 ± 1,0^a
F_8	3,8 ± 0,9^b	3,9 ± 0,9^{ab}	3,6 ± 0,9^a	3,5 ± 0,9^{ab}	3,5 ± 0,9^a
F_9	3,8 ± 1,0^b	4,1 ± 0,7^b	3,7 ± 0,8^a	3,8 ± 0,8^b	3,8 ± 0,9^a
Average	3,6 ± 0,9	3,8 ± 0,9	3,7 ± 0,8	3,6 ± 0,8	3,7 ± 0,9^a
Reference	2,1 - 3,1*	1,8 - 3,6*	4,3 - 5,7**	2,3 - 3,0*	3,3 - 4,0***

Note: Numbers followed by the same superscript letter indicate no significant difference;*Source (Nabilah, 2019); **Source (Nindyarani et al., 2011); ***Source (Setyadjid & Setiyaningrum, 2022)

CONCLUSION

The physicochemical properties, antioxidant activities, and sensory of cookies made from Mocaf flour and purple yam have been evaluated. The results of the physicochemical properties test showed that the cookies produced could not meet all the established quality standard criteria. However, in terms of antioxidant activity showed that the use of Mocaf flour, purple yam flour, and cinnamon powder can produce cookies with strong and very strong criteria of antioxidant activity. Formulations of F_8 and F_9 show the highest antioxidant activity (IC_{50}), which were around 49.5 ppm and 44.5 ppm, respectively (very strong category). The high composition of purple yam flour and cinnamon powder tends to provide better physicochemical characteristics and antioxidant activity (IC_{50}) compared to the use of Mocaf flour only. The sensory results showed that F_2 was the most preferred cookie compared to other formulations. Further research is needed to get the right formulation to produce cookies with balanced physicochemical properties, antioxidant activity, and sensory.

ACKNOWLEDGMENTS

The author would like to thank all lecturers and food technology laboratory assistants at Ahmad Dahlan University for the support and

https://doi.org/10.204736/mgi.v18i3.212–225

assistance provided during the research so that this scientific article could be produced.

REFERENCES

Anggarawati, N. K. A., Ekawati, I. G. A., & Wiadnyani, A. A. I. S. (2019). Pengaruh substitusi tepung ubi jalar ungu termodifikasi (*Ipomoea batatas var ayamurasaki*) terhadap karakteristik waffle. *Jurnal Ilmu dan Teknologi Pangan (ITEPA), 8*(2), 160–170.

Antasionasti, I., & Jayanto, I. (2021). Aktivitas antioksidan ekstrak etanol kayu manis (*Cinnamomum Burmani*) secara in vitro. *Jurnal Farmasi Udayana,, 10*(1), 38-47.

AOAC. (2005). Official Method of Analysis of The Association of Official Analytical of Chemist. In. Arlington: The Association of Official Analytical Chemist Inc.

Bourne, M. C. (2002). *Food texture and viscosity: Concept and measurement* (S. L. Taylor Ed. 2nd ed.). New York, USA: Academic Press.

BSN. (2018). SNI-2973-2018

Etudaiye, H. A., Oti, E., Aniedu, C., & Omodamiro, M. R. (2015). Utilization of sweet potato starches and flours as composites with wheat flours in the preparation of confectioneries. *African Journal of Biotechnology, 14*(1), 17-22.

Fairus, A., Hamidah, N., & Setyaningrum, Y. I. (2021). Substitusi tepung terigu dengan tepung ubi ungu (*Ipomoea batatas l. Poir*) dan tepung kacang tanah (*Arachis hypogaea*) pada pembuatan cookies : kajian kadar protein dan mutu organoleptik. *Health Care Media, 5*(1), 16-22.

Fitasari, E. (2009). Pengaruh tingkat penambahan tepung terigu terhadap kadar air, kadar lemak, kadar protein, mikrostruktur, dan mutu organoleptik keju gouda olahan. *Jurnal Ilmu Dan Teknologi Hasil Ternak, 4*(2), 17-29.

Fitriani, L., Yurnalis, & Hermalena, L. (2019). Pembuatan cookies menggunakan tepung ubi jalar ungu dan tepung ubi jalar putih. *Unes Journal mahasiswa Pertanian, 3*(1), 49–57.

Gujral, N., Freeman, H. J., & Thomson, A. B. R. (2012). Celiac disease : Prevalence, diagnosis, pathogenesis and treatment. *World J Gastroenterol, 18*(42), 6036–6059.

Hariana, A. H. (2007). *Tumbuhan Obat dan Khasiatnya*. Jakarta: Penebar Swadaya.

Hati, I. P., Setiani, B. E., & Bintoro, V. P. (2020). Optimasi penambahan tepung komposit terigu, bekatul, dan kacang merah terhadap kualitas kimia cookies. *Journal of Nutrition College, 9*(2), 100–105.

Herawati, B. R. A., Suhartatik, N., & Widanti, Y. A. (2018). Cookies tepung beras merah (*Oryza nivara*) – Mocaf (*modified cassava flour*) dengan penambahan bubuk kayu manis (*Cinnamomun burmanni*). *Jurnal teknologi dan industri pangan, 3*(1), 33-40.

Indriyani, F., Nurhidajah, & Suyanto, A. (2013). Karakteristik fisik, kimia dan sifat organoleptik tepung beras merah berdasarkan variasi lama pengeringan. *Jurnal Pangan dan Gizi, 4*(8), 27-34.

Istinganah, M., Rauf, R., & Widyaningsih, E. N. (2017). Tingkat kekerasan dan daya terima biskuit dari campuran tepung jagung dan tepung terigu dengan volume air yang proporsional. *Jurnal Kesehatan, 10*(2), 83-93.

Kurniati, I. L., Aida, N., Gunawan, S., & Widjaja, T. (2012). Pembuatan Mocaf (*modified cassava flour*) dengan proses fermentasi menggunakan *Lactobacillus plantarum*, *Saccharomyces cereviseae,* dan *Rhizopus oryzae*. *Jurnal Teknik Pomits, 1*(1), 1-6.

Kusnandar, F., Danniswara, H., & Sutriyono, A. (2022). Pengaruh penambahan jahe (*Zingiber officinalle roscoe*) dengan level yang berbeda terhadap kualitas organoleptik dan aktivitas antioksidan susu pasteurisasi. *Jurnal Mutu Pangan, 9*(2), 67-75.

Kusnandar, F., Harya, D., & Agus, S. (2022). Pengaruh komposisi dan sifat rheologi tepung terigu terhadap mutu roti manis *Jurnal Mutu Pangan, 9*(2), 67-75.

Martins, O. D. J., Susilowati, S., & Jinarti. (2014). Pengaruh substitusi ubi jalar ungu terhadap sifat organoleptik cookies ubi jalar ungu (*Ipomoea batatas var ayamurasaki)*. *Jurnal Bistek, 1*(1), 69-86.

Masrikhiyah, R. (2021). Retensi kadar gluten cookies subtitusi tepung Mocaf (*modified cassava flour*). *Jurnal Ilmu Pangan dan Hasil Pertanian, 5*, 20-25.

Meilgaard, M., Gail Vance Civille, & Carr, B. T. (2007). *Sensory evaluation techniques*. New York: CRC Press.

Mulyani, H. R. A., & Sujarwanta, A. (2018). *Lemak dan Minyak*. Metro: Lembaga Penelitian UM Metro.

Nabilah, M. (2019). *Substitusi biskuit dengan tepung ubi jalar ungu dan tepung kedelai sebagai sumber protein dan antioksidan*. (Undergraduate). Universitas Mercu Buana

Yogyakarta, Yogyakarta.

Nasional, B. S. (2011). *S.N.I. 01-2973-2011. Syarat mutu dan cara uji biskuit*. Jakarta: Badan Standar Nasional

Nindyarani, A. K., Sutardi, & Suparmo. (2011). Karakteristik kimia, fisik dan inderawi tepung ubi jalar ungu (Ipomoea batatas poiret) dan produk olahannya. *Agritech, 31*(4), 273–280.

Oktadiana, H., Abdullah, M., & Renaldi, K. (2017). Diagnosis and treatment of celiac disease. *Jurnal Penyakit Dalam Indonesia, 4*(3), 157-165.

Olatunde, G. O., Henshaw, F. O., Idowu, M. A., & Tomlins, K. (2016). Quality attributes of sweet potato flour as influenced by variety, pretreatment and drying method. *Food Sci. Nutr, 4*(4), 623–635.

Permatasari, K. B. D., Ina, P. T., & Yusa, N. M. (2018). Pengaruh penggunaan tepung labu kuning (*cucurbita moschata durch*) terhadap karakteristik *chiffon cake* berbahan dasar *modified cassava flour* (Mocaf). *Jurnal ITEPA, 7*(2), 53-64.

Prasetyo, H. A., & Winardi, R. R. (2020). Perubahan komposisi kimia dan aktivitas antioksidan pada pembuatan tepung dan cake ubi jalar ungu (*Ipomoea batatas L.*). *Jurnal Agrica Ekstensia, 14*(1), 25-32.

Priani, S. E., Darusman, F., & Humanisya, H. (2014). *Formulasi sediaan emulgel antioksidan mengandung ekstrak etanol kulit batang kayu manis (Cinnamomum burmannii Ness ex BI).* Paper presented at the SNaPP2014 Sains, Teknologi, dan Kesehatan, Bandung.

Putranto, T. A. (2020). *Rencana strategis kementerian kesehatan tahun 2020-2024*. Jakarta: MENTERI KESEHATAN REPUBLIK INDONESIA

Rahardjo, M., Nugroho, K. P. A., & Saibele, G. (2021). Analisis fisik serta sensori kue kering dengan campuran tepung mocaf, oats, dan bekatul. *Teknologi Pangan, 12*(2), 166-173.

Rasyid, M. I., Maryati, S., Triandita, N., Yuliani, H., & Angraeni, L. (2020). Karakteristik sensori cookies mocaf dengan substitusi tepung labu kuning. *Jurnal Teknologi Pengolahan Pertanian, 2*(1), 1-7.

Rauf, R., & Sarbini, D. (2015). Daya serap air sebagai acuan untuk menentukan volume air dalam pembuatan adonan roti dari campuran tepung terigu dan tepung singkong. *Agritech, 35*(3), 324-330.

Setyadjid, O., & Setiyaningrum, Z. (2022). Uji organoleptik dan uji kadar air formulasi brownies kukus tepung ubi jalar ungu dan tepung Mocaf. *Jurnal Ilmiah Gizi dan Kesehatan, 3*(2), 45-52.

Shahid, M. Z., Saima, H., Yasmin, A., Nadeem, M. T., Imran, M., & Afzaa, M. (2018). Antioxidant capacity of cinnamon extract for palm oil stability. *Lipids Health Dis, 17*(116), 1-8.

Shobur, F., Hersoelistyorini, W., & Syadi, Y. K. (2021). Sifat fisik, kimia, dan sensoris es krim susu kedelai dengan penambahan ekstrak kayu manis. *Jurnal Pangan dan Gizi, 11*, 73-87.

Singh, G. S., Maurya, M. P., Delampasona, & Can, C. (2007). A comparison of chemical, antioxidant and antimicrobial studies of cinnamon leaf and bark volatile oils, oleoresins and their constituents. *Journal of Food and Chemical Toxicology, 4*(5), 1650–1661.

Suter, I. K. (2013). *Pangan fungsional dan prospek pengembangannya*. Paper presented at the Pentingnya Makanan Alamiah (Natural Food) Untuk Kesehatan Jangka Panjang, Denpasar, Bali.

Tamaroh, S., & Sudrajat, A. (2021). Antioxidative characteristics and sensory acceptability of bread substituted with purple yam *(Dioscorea alata L.*). *Int. J. Food Sci.,* -(-), 1-9.

Tanjung, Y. L. R., & Kusnadi, J. (2015). Biskuit bebas gluten dan bebas kasein bagi penderita autis. *Jurnal Pangan dan Agroindustri, 1*(3), 11-22.

Tarwendah, I. P. (2017). Studi komparasi atribut sensoris dan kesadaran merek produk pangan. *Jurnal Pangan dan Agroindustri, 5*(2), 66-73.

Waisnawi, P. A. G., Yusasrini, N. L. A., & Ina, P. T. (2019). Pengaruh perbandingan tepung suweg (*Amorphophallus campanulatus*) dan tepung kacang hijau (*Vigna radiate*) terhadap karakteristik cookies. *Jurnal Ilmu dan Teknologi Pangan (ITEPA), 8*(1), 48-56.

Widyasitoresmi, H. S. (2010). *Formulasi dan karakterisasi stake berbasis sorgum (Sorghum bicolor L.) dan ubi jalar ungu (Ipomoea batatas L.).* (Undergraduate). Institut Pertanian Bogor, Bogor.

Yani, A. V., & Akbar, M. (2018). Pembuatan tepung Mocaf (*modified cassava flour*) dengan berbagai varietas ubi kayu dan lama fermentasi. *Jurnal Edible, 7*(1), 40–48.