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PHYSICOCHEMICAL AND FUNCTIONAL PROPERTIES OF COMPOSITE FLOURS BASED ON MOCAF AND TEMPEH FLOUR FOR MAKING COOKIES

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ABSTRACT: Gluten and casein free cookie products are increasingly in demand by consumers. Gluten and casein free cookies were made using mocaf as a substitute for gluten-free flour and tempeh flour as a casein-free protein source. The characteristics of a good cookie composite flour made from mocaf and tempeh flour need to be known. The purpose of this study was to determine the physicochemical and functional properties of a cookie composite flour based on mocaf and tempeh flour. The composite flour was mixed by dry mixing. The composite flour formulations were: C0 (100% wheat flour); C1 (100% mocaf); C2 (75% mocaf and 25% tempeh flour); C3 (50% mocaf and 50% tempeh flour); C4 (25% mocaf and 75% tempeh flour) and C5 (100% tempeh flour). The results showed that addition of tempeh flour increased the ash, protein, fat, minerals, a* value, b* value, and water absorption capacity. The addition of tempeh flour was proven to reduce moisture content, carbohydrates, lightness, and whiteness index value. The cookie composite flour made from 75% mocaf and 25% tempeh flour had a gelatinization profile similar to 100% wheat flour, so this formula was recommended as a cookie composite flour.

ABSTRAK: Produk kuki bebas gluten dan kasein semakin meningkat dalam permintaan pengguna. Kuki bebas gluten dan kasein dibuat menggunakan mocaf sebagai pengganti tepung bebas gluten dan tepung tempe sebagai sumber protein bebas kasein. Ciri-ciri tepung komposit biskut yang baik diperbuat daripada tepung mocaf dan tempeh perlu diketahui. Tujuan kajian ini adalah untuk menentukan sifat fizikokimia dan fungsian bagi tepung komposit biskut berasaskan tepung mocaf dan tempeh. Tepung komposit telah dicampur dengan adunan kering. Formulasi tepung komposit ialah C0 (100% tepung gandum); C1 (100% mocaf); C2 (75% mocaf dan 25% tepung tempeh); C3 (50% mocaf dan 50% tepung tempeh); C4 (25% mocaf dan 75% tepung tempeh) dan C5 (100% tepung tempeh). Hasil kajian menunjukkan penambahan tepung tempeh meningkatkan kadar abu, protein, lemak, mineral, nilai a*, nilai b*, dan kapasiti penyerapan air. Penambahan tepung tempeh terbukti dapat mengurangkan kandungan lembapan, karbohidrat, ringan, dan nilai indeks keputihan. Tepung komposit biskut yang diperbuat daripada 75% mocaf dan 25% tepung tempe mempunyai profil gelatinisasi yang serupa dengan 100% tepung gandum, jadi formula ini disyorkan sebagai tepung komposit biskut.

KEYWORDS: *casein free; composite flour; cookies; gluten free; mocaf; tempeh flour*

1. INTRODUCTION

Cookies are a type of biscuit that are relatively crunchy and have a dense texture. The ingredients that are often used to make cookies are wheat flour and soft sugar, starch, skim milk, egg yolks, shortening, and emulsifier. Most cookies produced and consumed in Indonesia use wheat flour as a main ingredient. The demand for wheat flour in Indonesia is relatively high for the food industry. This is a serious problem since wheat flour cannot be produced in Indonesia, so it needs to be imported.

In general, low protein wheat flour (8-9%) is a raw material for cookies that has advantages of gluten and gliadin protein contents compared to other flours. The gluten protein plays a role in providing rigidity while gliadin protein provides sticky properties. The expansion of dough volume is not required in the process of making cookies so it is possible to use gluten-free flours and thus make cookies from local commodity flours. Local commodity flour can be used as an alternative source to replace wheat flour as an effort to strengthen food security in Indonesia.

Modified cassava flour (mocaf) is a fermented flour from cassava. The use of mocaf flour as a partial or whole substitute in baked products has been widely carried out. The sensory evaluation of baked products made from mocaf was more acceptable than baked products made from wheat flour [1]. However, the low protein content of mocaf caused the protein of baked products from mocaf to be lower than baked products made from wheat flour [1]. Kristanti et al. [2] reported that mocaf contained 11.54% moisture content, 1.12% ash, 0.55% protein, 4.81% fat, and 81.96% carbohydrate.

Tempeh is a vegetable protein source in food that is made from fermented soybeans. Enzyme hydrolysis occurs during fermentation, which causes improvements in texture, flavor, and aroma. According to Reyes-Bastidas et al. [3], fermentation affected the reduction of anti-nutrients and increase in nutritional value in tempeh through enzyme hydrolysis. The addition of tempeh flour caused an increase in protein in cookies [1] and instant baby porridge [2]. Omosebi and Otunola [4] reported that the proximate composition of the tempeh flour consists of 44.27-44.85% protein, 0.38-0.42% crude fiber, 16.45-17.12% fat, 5.60-5.72% ash, 2.50-3.00% moisture content, and 33.52-32.57% carbohydrate.

Mocaf and tempeh flour were used for cookie composite flour production in this study. Cookies made from mocaf flour and tempeh are gluten- and casein-free. Autism is a disorder in which the body cannot digest gluten and casein proteins, this occurs because the body does not produce the dipeptidylpeptidase IV enzyme. Therefore, cookies made from mocaf and tempeh flour are expected to be used as alternative foods for autism sufferers.

Composite flour is made from two or more flours to get the desired material characteristics for a product. Research on the characteristics of composite flour with a mixture of mocaf and tempeh flour or soybean flour in noodles [5] and biscuits [6] have been carried out. The combination of flour in cookie composite flour will affect the dough and final product characteristics. Chandra et al. [7] reported that the physicochemical properties of a dough were determined by an interaction between the composition, structure, and molecular changes of the combined components. The purpose of this study was to determine the physicochemical (proximate, mineral, and color) and functional properties (swelling power, solubility, water and oil absorption capacity, emulsion activity and stability, and gelatinization profile) of composite flour based on mocaf and tempeh flour for cookie products.

2. METHODOLOGY

2.1 Material

Modified cassava flour (mocaf) was obtained from "Tanjung Siang" Small and Medium Enterprises (SME) in Subang, Indonesia. Tempeh was obtained from SME of *Koperasi Tahu Tempe Indonesia (Kopti)* in Subang. The tapioca was bought from a local market in Subang.

2.2 Tempeh Flour Process

Fresh tempeh was sliced with a thickness of 10-20 mm. Tempeh slices were steamed at a temperature of 85 °C for 10 minutes to deactivate the enzymes and fungi in the tempeh. The steamed tempeh slices were drained then dried at 50 °C for ± 5 hours. The dried tempeh slices were ground and sieved using a 40 mesh sieve [1]. The nutritional content of tempeh flour that was used in this study was 10.78% moisture content, 1.10% ash, 45.25% protein, 35.18% fat, and 7.63% carbohydrate [2].

2.3 Cookie Composite Flour Process

The process of cookie composite flour was carried out by weighing mocaf, tempeh flour, and tapioca according to the compositions shown in Table 1. These composite flour formulas had been used to make cookies in previous studies [1]. The tapioca in this formula was used to produce cookies with a sturdy structure. All the ingredients were mixed by dry mixing using a mixer (Philips HR 1559, China) and then stored in plastic for analysis.

Table 1: The composition of cookie composite flour formula

Formula	Wheat Flour (g)	Mocaf (g)	Tempeh Flour (g)	Tapioca (g)
C0	100	-	-	5
C1	-	100	-	5
C2	-	75	25	5
C3	-	50	50	5
C4	-	25	75	5
C5	-	-	100	5

where C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

2.4 Physicochemical Properties Analysis

Proximate analysis, including moisture and ash contents, were analyzed by gravimetric method [8]; protein was obtained by Dumas method using DuMAster Buchi D-480, Switzerland; fat was determined using the Soxhlet method, and carbohydrate was calculated by the difference method [8]. The mineral content of calcium (Ca), iron (Fe), zinc (Zn), and magnesium (Mg) were analyzed using flame atomic absorption spectrometry (AAS) GBC type 933AA.

The color properties (L*, a*, b* values) of cookie composite flour were measured using the NH310 Chromameter using the CIE method. The degree of whiteness (whiteness index) was calculated using equation (1).

$$\text{whiteness index} = 100 - \sqrt{\left((100 - L)\ x\ 2\right) + (b\ x2) + (c\ x\ 2)} \quad (1)$$

2.5 Functional Properties Analysis

The functional properties include swelling power, solubility, water absorption capacity (WAC), oil absorption capacity (OAC), emulsion activity, emulsion stability, and gelatinization profile. Each sample (200 mg) was added to 10 ml of distilled water then homogenized using a vortex mixer VM-300 (Gemmy Industrial Corp., Taiwan). The homogenous sample was heated at a temperature of 95 °C for 30 minutes in a water bath (GSL, D-30938 Burgwedel, type 1086, Germany). The samples were centrifuged (Thermo Scientific type SL 40R centrifuge) at 3000 rpm for 15 minutes to separate the gel and supernatant. The gel was weighed to determine the swelling power, while the supernatant was placed in a constant beaker glass then dried using an oven at a temperature of 105 °C until constant weight to determine the solubility. Swelling power and solubility were calculated using Eqs (2) and (3).

$$\text{swelling power}\left(\frac{g}{g}\right) = \frac{(\text{W2} - \text{W3})}{\text{W1}} \tag{2}$$

$$\text{solubility}\ (\%) = \frac{\text{W4}}{\text{W1}} x\ 100\% \tag{3}$$

where W1 = sample weight (g), W2 = gel + centrifuged tube weight (g), W3 = sample + centrifuged tube weight (g), W4 = dry supernatant weight (g).

Water and oil absorption capacity analysis were referred to in Chandra et al. [7] with a modification. Each sample (1 g) was added to 10 ml of distilled water or soybean oil then homogenized using a VM-300 vortex mixer. The homogenous sample was allowed to stand at room temperature (30±2 °C) for 30 minutes. The samples were centrifuged (SL 40R centrifuge) at 3000 rpm for 15 minutes to separate the precipitate and supernatant. The supernatant was decanted, while the precipitate and the centrifuge tube were weighed. The water and oil absorption capacity were calculated using Eq. (4).

$$\text{water or oil absorption capacity}\ (\%) = \frac{\text{W2}}{\text{W1}} x\ 100\% \tag{4}$$

where W1 = sample weight (g), W2 = natant weight

Emulsion capacity and stability analysis were referred to in Chandra et al. [7] with a modification. Each sample (500 mg) was added with 5 ml of distilled water and 5 ml of soybean oil then homogenized with a vortex mixer. The samples were centrifuged at 3000 rpm for 15 minutes. Emulsion capacity was expressed as a percent ratio between the height of emulsion layer and mixture solution. After measurement, the emulsion was heated at 80 °C for 30 minutes in a water bath. The samples were then cooled at room temperature for 15 minutes and centrifuged at 3000 rpm for 15 minutes. Emulsion stability was expressed as a percent ratio between the height of the emulsion layer mixture solution after the heating process.

Gelatinization profile was analyzed using a Perten Instruments Rapid Visco Analyser (RVA), Tec Master (Sweden) with the STD1 method. The operating conditions of the RVA were a standard sample weight (3.5 g); standard water weight (25 g), and base water content (14%). The weighed sample and distilled water were heated and maintained at 50 °C for 1 minute, the temperature then increased to 95 °C in 4 minutes and maintained at 95 °C for 3 minutes. Furthermore, the temperature cooled again to 50 °C in 4 minutes and maintained at 50 °C for 2 minutes. The rotational speed in the initial time (10 seconds) was 960 rpm, then reduced and maintained at 160 rpm throughout the test. The temperature at peak viscosity was expressed as gelatinization temperature (P temp), the highest viscosity was expressed as peak viscosity (PV), the final viscosity after being maintained at 95 °C was expressed as hot paste viscosity (HPV), breakdown viscosity (BD) was expressed as the result reduction of PV with HPV, the final viscosity after being maintained at 50 °C was expressed as cold paste viscosity (CPV), the setback viscosity (SB) was expressed as the result of the reduction of CPV with HPV, the stability ratio (SR) was expressed as HPV divided by PV, and the ratio setback (SBR) was expressed as CPV divided by HPV [9].

2.6 Statistic Analysis

The data were analyzed using the IBM SPSS Statistics 20 program. The data was analyzed with one-way analysis of variance (ANOVA) followed by Duncan's test at a significance level of $p<0.05$. All data were shown as mean with standard deviation.

3. RESULTS AND DISCUSSION

The chemical properties of the cookie composite flour are shown in Table 2. The increase in addition of tempeh flour significantly ($\alpha<0.05$) decreased moisture content and carbohydrate, however increased the ash, protein, and fat of the cookies composite flour. These results supported the previous research in that an addition of tempeh flour caused a decrease in moisture content and carbohydrate and an increase in protein and fat of cookies made from tempeh flour and mocaf [1]. A study by Yulianti et al. [5] showed that the percentage increase of tempeh flour had the effect of increasing protein but had no effect on moisture content, ash, or fat of pasta composite flour. The protein and fat of these cookie composite flours were contributed by the tempeh flour. Tempeh flour contained 45.25%db protein and 35.18% fat [2]. Omosebi and Otunola [4] reported that protein and fat content of the tempeh flour were 44.27-44.85% and 16.45-17.12%, respectively.

Table 2: The chemical composition of cookie composite flour

Samples	Chemical composition (%db)				
	Moisture	Ash	Protein	Fat	Carbohydrate
C0	13.87 ± 0.11^a	0.59 ± 0.02^f	12.95 ± 0.07^e	1.45 ± 0.02^e	71.15 ± 0.17^b
C1	10.11 ± 0.05^b	1.14 ± 0.04^e	1.87 ± 0.05^f	0.72 ± 0.02^f	86.14 ± 0.09^a
C2	8.94 ± 0.18^c	1.24 ± 0.06^d	13.98 ± 0.43^d	7.20 ± 0.03^d	68.75 ± 0.54^c
C3	7.63 ± 0.15^d	1.40 ± 0.01^c	25.69 ± 0.46^c	13.38 ± 0.12^c	52.08 ± 0.47^d
C4	6.56 ± 0.09^e	1.79 ± 0.08^b	37.22 ± 0.09^b	19.47 ± 0.11^b	35.01 ± 0.06^e
C5	5.45 ± 0.10^f	2.60 ± 0.11^a	48.09 ± 0.11^a	25.59 ± 0.12^a	18.29 ± 0.20^f

Values are expressed as mean ± standard deviation. The means in the same raw with different letters were significantly different at $p < 0.05$. The treatments code were C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

The zinc (Zn), calcium (Ca), and magnesium (Mg) content of cookies composite flour were significantly ($\alpha<0.05$) increased in line with the increase in percent addition of tempeh flour (Figure. 1). These results supported the research results of Kristanti et al. [1], where the mineral content (Fe, Zn, Ca and Mg) of tempeh mocaf cookies increased with the enhancement of percent tempeh flour. The mineral contents of tempeh flour were quite high, especially iron at 0.011-0.014%, calcium at 0.19-0.21%, and zinc at 0.0046-0.0050% [4].

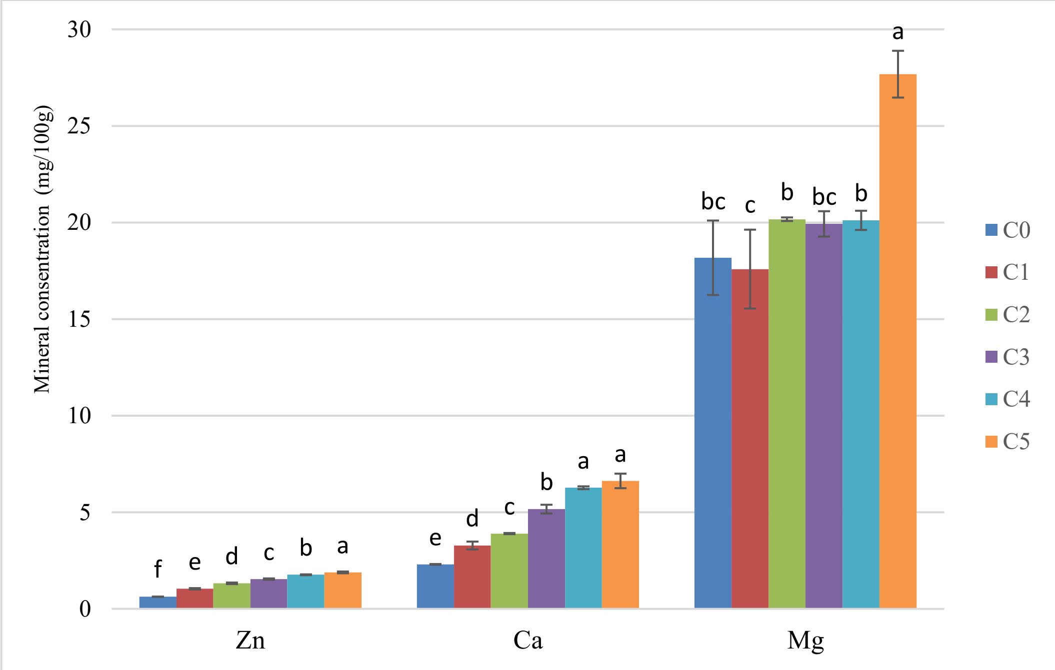

Fig. 1: The mineral concentration of cookies composite flour.
The treatments code were C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

The lightness (L* value) and whiteness index of cookies composite flour were significantly (α <0.05) decreased with the addition of tempeh flour (Table 3). The decrease in the value of L* and whiteness index showed that the color of cookie composite flour tended to be darker. However, the a* and b* values were significantly (α <0.05) increased with the addition of tempeh flour. The a* and b* values showed in a range between 0-60, this indicated that the color of cookie composite flour tended to be reddish or yellowish. The color properties of cookie composite flour were influenced by the color of the tempeh flour. The C5 cookie composite flour (100% tempeh flour) had a lowest L* value and whiteness index, and had highest a* and b* values.

Table 3: The color properties of cookie composite flour.

Samples	**Chemical composition**			
	L*	**a***	**b***	**Whiteness Index**
C0	68.18±0.86^{a}	1.22±0.03^{f}	9.04±0.11^{e}	57.92±0.77^{a}
C1	65.10±0.97^{b}	1.34±0.02^{e}	7.54±0.11^{f}	56.22±0.84^{b}
C2	63.53±0.64^{c}	2.75±0.02^{d}	10.53±0.11^{d}	50.25±0.55^{c}
C3	60.01±0.23^{d}	3.46±0.04^{c}	12.48±0.14^{c}	44.07±0.05^{d}
C4	56.51±0.42^{e}	4.40±0.12^{b}	14.48±0.27^{b}	37.64±0.04^{e}
C5	52.38±0.23^{f}	6.15±0.09^{a}	15.99±0.10^{a}	30.24±0.18^{f}

Values are expressed as mean ± standard deviation. The means in the same raw with different letters were significantly different at $p < 0.05$. The treatment codes were C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

The results of this study supported previous research, where the value of L* and whiteness index decreased, while the values of a* and b* increased along with the increase in the percentage of tempeh flour in cookies [1]. Yulianti et al. [5] reported that an increase in the percentage of tempeh flour had an effect on decreasing the whiteness value of pasta composite although it was not significantly different. The addition of soy flour was shown to reduce the L* value in the bakery composite flour [6,9].

The water and oil absorption capacity of cookie composite flour from mocaf and tempeh flour (C1, C2, C3, C4, and C5) were significantly (α <0.05) higher than wheat flour (C0). The increase in an addition of tempeh flour significantly (α <0.05) increased WAC, but had no effect on OAC (Figure. 2). The tempeh used in the tempeh flour process was made from soybeans. The results of Julianti et al. [10] studies showed that wheat flour had a lower WAC and OAC than composite flour from sweet potato, maize, soybean and xanthan gum. The increase of soybean concentration did not been affect the WAC and OAC of bakery composite flour [9,10]. The WAC and OAC of tempeh flour were 2.61-2.77 g/g and 0.96-0.98 g/g [4].

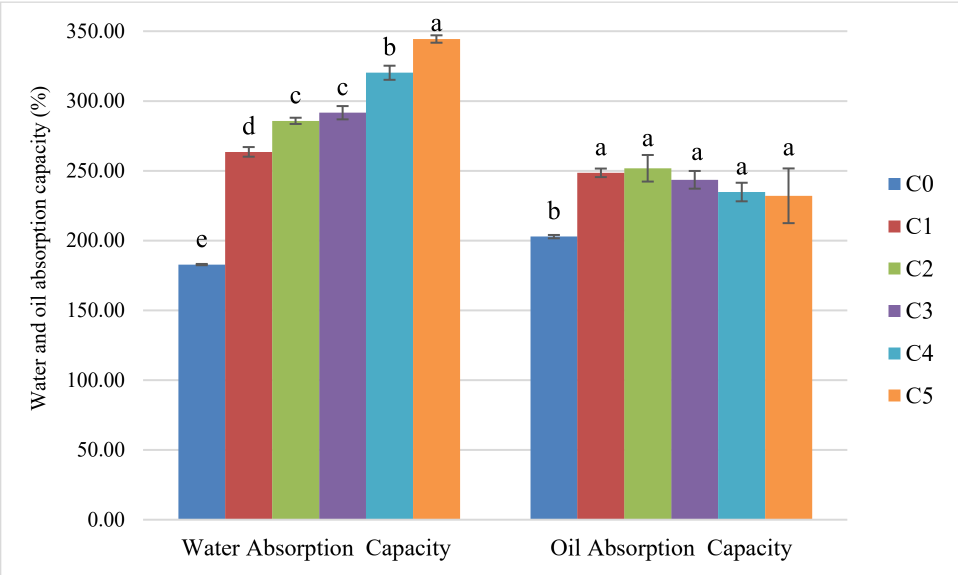

Fig. 2: The water and oil absorption capacity of cookie composite flour.
The treatment codes are C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

WAC and OAC are the important parameters for bakery products. WAC was related to the viscosity of an ingredient, important in the development process, and maintaining the consistency of bakery products [11]. Aremu et al. [12] reported that oil had a function of retaining and enhancing taste, and extending the shelf life of bakery products. Protein affects the WAC and OAC of a material, it consists of hydrophilic and hydrophobic groups. The hydrophilic groups can interact with water, while the hydrophobic groups can interact with oil.

Swelling power and solubility of the cookie composite flour can be seen in Fig. 3. Swelling power of C1, C2, and C3 cookie composite flour were significantly (α <0.05) higher than wheat flour (C0). Solubility of C1, C2, C3, C4, and C5 cookies composite flour were significantly (α <0.05) higher than wheat flour (C0). The increase in the addition of tempeh flour was generally significant (α <0.05) in reducing the swelling power of the cookie composite flour. The increase in addition of soybeans caused a decrease in swelling power of composite flour of bakery products [9,10]. High protein content in cookie composite flour may cause starch granules to adhere to the protein matrix, thereby limiting the interaction between starch and water. It is thought to cause a decrease in swelling power. The decrease in solubility of cookie composite flour was thought to be caused by a destruction of starch granules after the gelatinization process so that they were not strong enough to hold water.

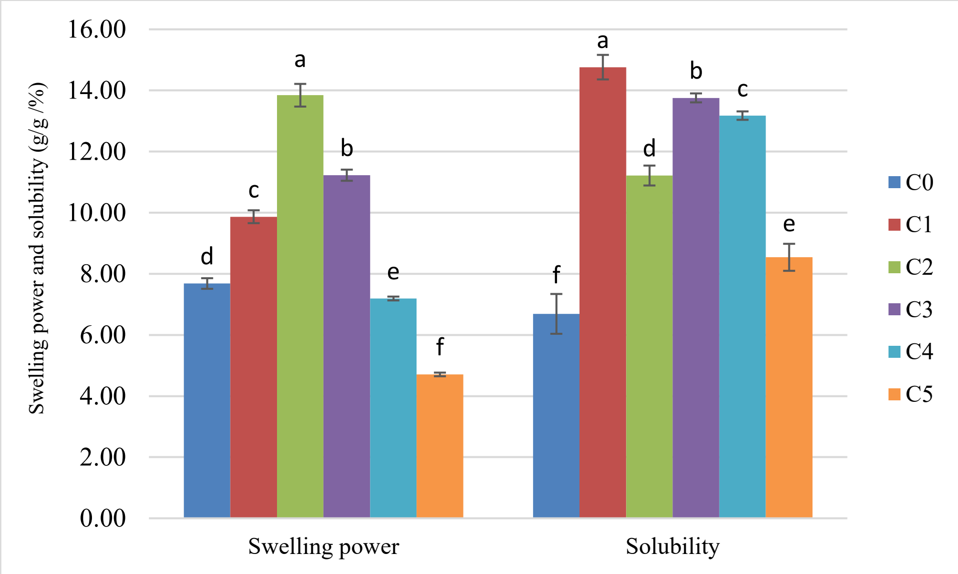

Fig. 3: The swelling power and solubility of cookie composite flour.
The treatment codes are C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

The results of this study showed that the emulsion activity and stability of cookie composite flour were significantly different ($\alpha<0.05$) between treatments (Figure. 4). The greater the proportion of tempeh flour, the lower the emulsion activity and stability. This was possible because the protein content of cookie composite flour affects the formation of hydrophilic and hydrophobic bonds in the emulsion. The quality and quantity of protein content was not proven to affect the formation of the emulsion. The emulsion formation and stability were determined by protein denaturation and unfolding to form hydrophilic and hydrophobic surfaces [13].

The gelatinization profile of the cookie composite flour is shown in Table 4. The results showed that the gelatinization temperature of C0, C1, C2, and C3 cookie composite flours were not significantly different ($\alpha<0.05$), while C4 and C5 cookie composite flours were not read (error). The increase in the proportion of tempeh flour significantly ($\alpha<0.05$) decreased the PV, HPV, BD, CPV, SB, and SR values, while it also showed a significantly ($\alpha<0.05$) increased SBR value for the cookie composite flour. The results of this study were in line with previous research. A study by Tharise et al. [9] reported that gelatinization temperature of wheat flour was not significantly different with bakery composite flour. The PV, HPV, BD, and CPV values of wheat flour were significantly lower than that of bakery composite flour with added soybean flour [9]. According to Yulianti et al. [5] results studies, the increase in the addition of tempeh flour had an effect of reducing the PV, CPV, and SB values, increasing the gelatinization temperature and BD, but had no effect on the HPV value of the composite flour. The increase in the addition of soybean flour to bakery composite flour had the effect on decreasing the PV, HPV, BD, CPV, and SB values, increasing the SR and SBR values, but had no effect on the gelatinization temperature [9,10]. Ratnawati et al. [6] reported that an addition of soybean flour increased the SB value and decreased the PV, BD, and HPV values of biscuit composite flour.

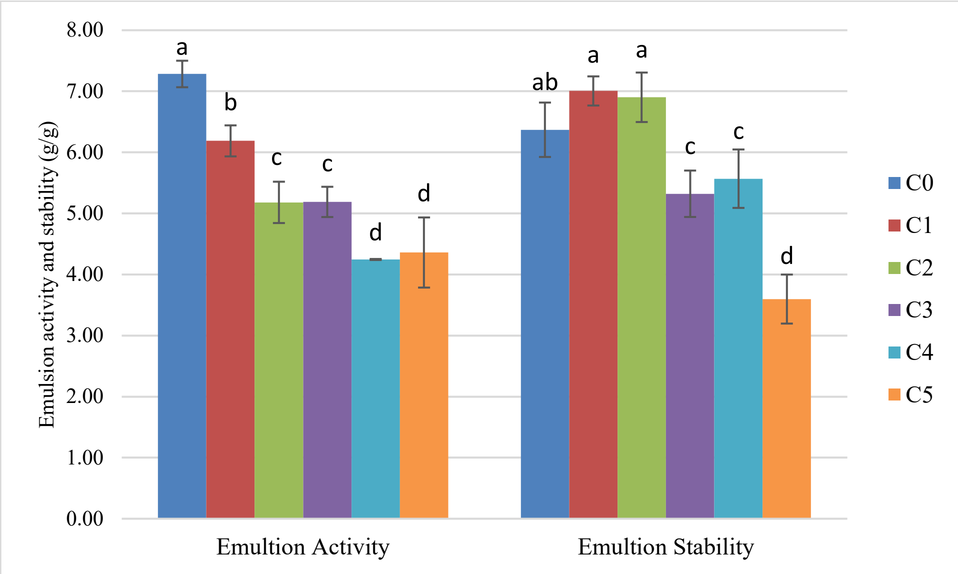

Fig. 4: The emulsion activity and stability of cookie composite flour.
The treatment codes are C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

Changes in the gelatinization profile, such as a decrease in the value of PV, HPV, BD, CPV, SB, and SR might cause by the high protein and fat content of cookie composite flour (Table 2). High protein content of flour might limit the interaction between starch and water, thereby inhibiting the starch gelatinization process. The swelling process of starch granules was inhibited which might cause a decreasing of viscosity [14]. Fat content in the ingredients had been shown to inhibit the starch gelatinization process. Fat might form a complex bond with amylose, which is hydrophobic, so that it had the effect of inhibiting the binding of water and reducing the viscosity of the material. The amylose and starch content in the composite flour also affected the gelatinization process of starch.

In general, the gelatinization profile of C2 cookies composite flour was similar to that of wheat flour (C0), especially the DB, SB, SR, and SBR values. The decrease in BD and CPV in C2 cookies composite flour indicated the ability to form a gel after the cooking process was followed by cooling and gel resistance to maintain consistency during the stirring process. According to Devi et al. [15] studies, the gelatinization profile wheat flour variety H5 490, which was of a good quality for making cookies, had lower PV, HPV, CPV, and SB values than wheat flour variety HD 2967, which was of a poor quality. The gelatinization profiles of wheat flour varieties H5 490 included PV, HPV, BD, CPV, SB, and the gelatinization temperature were 3050 cP, 2343 cP, 707 cP, 3762 cP, 1419 cP, 80.70 °C, respectively [15]. Based on the Devi et al. [15] study, C2 cookie composite flour had a good gelatinization profile, so this formula was recommended as a cookie composite flour.

Table 4: The gelatinization profile of cookie composite flour

Samples	Gelatinization profile							
	P temp.	**PV**	**HPV**	**BD**	**CPV**	**SB**	**SR**	**SBR**
C0	73.13±5.47[a]	3267.67±122.07[b]	3140.00±115.54[b]	747.33±102.84[b]	2451.33±194.88[b]	816.33±98.55[a]	0.98±0.00[b]	0.77±0.04[c]
C1	71.85±0.43[a]	3798.00±26.16[a]	5609.33±26.16[a]	2492.33±44.47[a]	3117.00±27.51[a]	681.00±37.03[b]	1.48±0.01[a]	0.56±0.01[f]
C2	72.75±0.09[a]	2670.00±43.03[c]	2668.00±29.31[c]	798.00±12.00[b]	1870.00±18.19[c]	800.00±27.87[a]	1.00±0.01[b]	0.70±0.00[d]
C3	73.82±0.38[a]	1336.00±7.55[d]	980.67±30.57[d]	118.67±25.15[c]	862.00±9.85[d]	474.00±6.08[c]	0.73±0.02[c]	0.88±0.02[b]
C4	err	330.67±4.51[e]	234.67±4.51[e]	17.00±0.00[d]	217.67±4.51[e]	113.00±0.00[a]	0.71±0.00[c]	0.93±0.00[b]
C5	err	42.67±1.53[f]	26.33±1.53[f]	3.00±0.00[d]	23.33±1.53[f]	19.33±2.31[d]	0.62±0.04[d]	0.89±0.01[a]

Values are expressed as mean ± standard deviation. The means in the same raw with different letters were significantly different at $p < 0.05$. The treatment codes are C0 (100% wheat flour), C1 (100% mocaf), C2 (75% mocaf and 25% tempeh flour), C3 (50% mocaf and 50% tempeh flour), C4 (25% mocaf and 75% tempeh flour), C5 (100% tempeh flour).

4. CONCLUSION

The increase in addition of tempeh flour has been shown to increase the ash, protein, fat, minerals (Zn, Ca, Mg), and water absorption capacity as well as decrease the moisture content, carbohydrates, lightness value, and whiteness index of cookie composite flour. The gelatinization profile of cookie composite flour made from 75% mocaf and 25% tempeh flour was similar to 100% wheat flour, so this formula was recommended as a cookie composite flour. The characteristics of recommended cookie composite flour were moisture content (8.94%), ash (1.24%), protein (13.98%), fat (7.20%), carbohydrates (68.75%), zinc (1.32 mg / 100 g), calcium (3.90 mg / 100 g), magnesium (20.17 mg / 100 g), lightness value (63.53), whiteness index (50.25), swelling power (13.84 g/g), solubility (11.22%), WAC (188.77%), OAC (117.85%), breakdown viscosity (798.00 cP), and setback viscosity (800.00 cP).

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