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FULL PAPER

Optimization of premix flour made of modified cassava flour and rice flour for biscuit manufacture and the best effect of storage

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Abstract

This research aimed to study the relationship of modified cassava flour (MOCAF) and rice flour formulations and storage time to the value of moisture content, aw (premix flour), physical chemical and organoleptic properties (biscuit) based on the best formula. A two-factor Completely Randomized Design (CRD) was used in this study. MOCAF and Rice Flour formulations (100:0%, 95:5%, 90:10%, 85:15%, 80:20%, 75:25%, and 70:30%) serves as the first factor and storage time as the second factor (0, 1, and 2 weeks). The best formula results were carried out by proximate analysis and organoleptic tests. The proportion of MOCAF and rice flour in biscuit premix flour had a significant effect and caused an increase in the moisture content, water activity (premix flour), fracture strength, chroma, and lightness (cookies) with the best treatment being 75% MOCAF formulation and 25% rice flour) with the longest duration of 2 weeks storage.

1. Introduction

Premix flour is a mixture of several cake ingredients in powder form, and there are some brands that even include margarine and complementary ingredients to decorate a mature cake, in general, premix flour is the main basic raw material of wheat flour or wheat (Amin, 2019).

Indonesia is among the largest importers of wheat for its industrial activities, in the form of grain or flour (called meslin). The data from Central Statistics Agency (BPS) shows that Indonesia's wheat flour imports reached 31.34 thousand tons valuing US $11.81 million throughout 2021. About 19.9 thousand tons of them were imported from India valuing US $6.76 million. To reduce wheat import and wheat use, alternatively, Mocaf or cassava flour is used.

Mocaf is a flour product made of modified *cassava*. Modification of cassava in mocaf is done through fermentation using lactic acid bacteria (Subagio *et al*., 2008). The fermentation carried out changes the characteristics of flour so that it can be used as raw material for various food products (Sarprastp, 2021). MOCAF swellability is equivalent to wheat type II (medium protein content) (Rachman, 2012). MOCAF has been widely applied to Ambon Bika cake (Diniyah *et al.*, 2013), analog rice (Diniyah, Puspitasari, Nafi *et al*., 2016), analog rice glycemic index (Diniyah, Firdaus, Windrati *et al*., 2016), peanut brittle (Nadhifah *et al*., 2016), Mojang noodles (Diniyah, Setiawati, Windrati *et al*., 2017), mojang noodle extrusion technique (Diniyah, Agustin, Setiawan *et al*., 2017), seasoned flour (Anwar *et al*., 2016) and others. Therefore, MOCAF is very suitable to be used in making biscuits.

Rice flour is the one produced by milling or pounding rice (*Oryza sativa* L.) that has been or has not been milled (BPOM, 2019). This research aimed to study the effect of MOCAF and rice flour formulations on moisture content, and Aw of premix flour with flour storage time, and to characterize the physical biscuits, as well as the chemical and organoleptic properties of biscuits based on the best formula.

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2. Materials and methods

2.1 Materials

The main ingredients used were Mocaf, obtained from the Home Industry of Puji 21 Women Farmers Group, Playen Gunung Kidul District, Yogyakarta, refined sugar with rose stamp, vanilla powder stamped, grade A full cream milk, salt, vegetable oil, butter, and eggs obtained from Rappang's traditional market. Meanwhile, the rice flour comes from grinding the tungro-resistant variety (Inpari 36) in 2019 in Experimental Garden of the Tungro Disease Research Station. The tools used include kirin oven and mixer, baking sheet, ohaus analytical balance, brush, knife, cookie mold, texture analyzer (Brookfield CT3), desiccator, memmert oven, color reader (Minolta CR-10), soxhlet, furnace, porcelain crucible, and weighing bottle.

2.2 Research methods

The study was conducted using a factorial Completely Randomized Design (CRD), consisting of two factors: the ratio of MOCAF and rice flour (100%: 0%; 95%:5%; 90%:10%; 85%:15%; 80%:20%; 75%:2%; 70%:30%) and storage time (0, 1 and 2 weeks) with three replications. The research was carried out in two stages: the manufacture of biscuit premix flour and followed with biscuit making. The data obtained were tested by analysis of variance and followed with the Duncan New Multiple Range Test (DMRT) at a test level of 5% using Minitab 17 if there were differences.

2.3 Research stage

The first stage is the manufacture of premix flour which includes weighing the flour mix ingredients (MOCAF, rice) according to the formula, and the concentrations of sugar, milk, vanilla, salt are the same. Mixing all the ingredients and sifting using an 80-sized mesh for a more uniform or finer size obtained. The premix flour is stored according to the treatment. The second stage is the process of making biscuits which includes mixing the auxiliary ingredients and the main ingredient flour mix (according to the treatment), printing, and then baking (oven) at a temperature of 160° C for 16 mins.

Analysis Procedure Parameters observed for premix flour include moisture content and water activity (Association of Official Analytical Chemists (AOAC), 2000). Meanwhile, the analysis of biscuits includes hardness (Uthumporn *et al*., 2015 with modifications), fracture strength (Okaka and Isieh, 1990), chroma, and lightness (Hutching, 1999). The best treatment (De Garmo *et al*., 1984) was taken from the two samples with the highest values and analyzed for organoleptic and proximate properties (moisture, protein, fat, ash content (AOAC, 2000) and carbohydrates).

3. Results and discussion

3.1 Results of the analysis of the chemical composition of premix flour

3.1.1 Water content

The results of moisture content analysis on biscuit premix flour ranged from 9.53% to 10.12%. Based on the results of ANOVA at the 5% test level, there were significantly different numbers in the MOCAF formula and the addition of rice flour and the storage time of premix flour. The moisture content of biscuit premix flour is presented in Table 1.

Table 1. Moisture value of biscuit premix flour.

Storage Time (Week)	MOCAF: Rice Ratio	Moisture Content (%)	Water activity
0	100:00:00	9.87^{bcde}	0.59^{cdef}
	95:05:00	9.82^{defg}	0.58^{defg}
	90:10:00	9.78^{bcdef}	0.58^{fghi}
	85:15:00	9.72^{gh}	0.57^{jkl}
	80:20:00	9.68^{hi}	0.57^{kl}
	75:25:00	9.55^{j}	0.57^{l}
	70:30:00	9.53^{j}	0.56^{kl}
1	100:00:00	9.92^{bc}	0.59^{bc}
	95:05:00	9.87^{bcde}	0.59^{bc}
	90:10:00	9.82^{defg}	0.59^{cdef}
	85:15:00	9.77^{fgh}	0.58^{ghij}
	80:20:00	9.72^{gh}	0.58^{hijk}
	75:25:00	9.62^{ij}	0.58^{ijkl}
	70:30:00	9.6^{ij}	0.57^{kl}
2	100:00:00	10.12^{a}	0.61^{a}
	95:05:00	10.07^{a}	0.61^{a}
	90:10:00	10.03^{a}	0.60^{b}
	85:15:00	9.93^{b}	0.60^{b}
	80:20:00	9.88^{bcd}	0.59^{defh}
	75:25:00	9.83^{cdef}	0.58^{defg}
	70:30:00	9.78^{efg}	0.58^{efgh}

Values with different superscripts within the same column are statistically significantly different with a confidence level of 0.95% based on Duncan's Test.

The results of the moisture content analysis on biscuit premix flour (Table 1) show that the formula of 75% MOCAF: 25% rice flour has a higher moisture content compared to the 70% MOCAF formula: 30% rice flour but, based on the results of Annova at test level 5% the water content resulting was not significantly different from the two types of premix flour. The water content of two premix flours produced is still below the SNI (maximum 12%).

The moisture content of biscuit premix flour,

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according to Kumar *et al*. (2015), is comparable to that of biscuit premix flour (8.1%), around 7.27-8.13%. The average moisture content of biscuit premix flour is still in accordance with the Indonesian National Standard (SNI) regarding ready-to-use mixed flour, maximally 12%. The water content of premix flour decreases with the addition of rice flour because the water content of rice flour (13%) is lower than that of MOCAF (14%). On the other hand, the longer storage time indicates an increase in the water content of premix flour but the increase is still within the minimum water content required for ready-to-use mixed flour based on SNI (12%).

3.1.2 Water activities

The results of water activity analysis on biscuit premix flour ranged from 0.56 to 0.61. Based on the results of ANOVA at the 5% test level, there were significantly different values in the MOCAF formula and rice flour and the storage time for biscuit premix flour. The water activity value of premix flour is presented in Table 1. The range indicates that the water activity of biscuit premix flour has met the specified value, not more than 0.7. The value of water activity is proportional to the value of water content. If the value of the water content of premix flour increases, the value of water activity will increase as well. Water activity increases with longer storage time. Table 1 shows a significant increase during 0 to 2-week storage. The increase in water activity during storage, according to Estiasih and Ahmadi (2009), is caused by the absorption of water in the environment by the product. Flour-based products absorb the surrounding water more easily, leading the water activity of the product to tend to increase.

3.1.3 Protein level

The results of protein analysis on the biscuit premix flour formula of 75% MOCAF: 25% Rice flour is slightly lower than that of the formula of 75% MOCAF: 30% Rice flour. Based on the results of ANOVA at the 5% test level, there was a significant difference in protein content values between the two premix flour formulas. The protein content of premix flour can be seen in Table 2. The protein content of flour-based biscuits with the addition of eggplant flour is higher (8.12-8.40%) (Uthumporn *et al*., 2015), rice flour (9.88-7.95%) (Mounika *et al*., 2017), and sorghum-taro-nut (4.85-1989%) (Okpala *et al.,* 2012) compared to the original MOCAF biscuit. This is because the protein content of MOCAF is lower (max. 1.2%) than that of rice flour (9.8%) (Wulandari and Handarsari, 2010).

3.1.4 Fat level

The results of fat analysis on biscuit premix flour were 1.8% (75% MOCAF: 25% rice flour) and 1.84% (75% MOCAF: 30% rice flour). Based on the results of ANOVA at the 5% test level, the fat content values were significantly different with the different ratios of MOCAF and RICE. The fat content value of biscuit premix flour is lower than that of sorghum-taro-nut premix (5.64-6.84%) (Okpala *et al*., 2012), and brown rice-wheat (27.19-27.28%) (Mounika *et al*., 2017).

3.1.5 Ash content

The results of the analysis of biscuit premix flour ash were 0.76% (75% MOCAF: 25% rice flour) and 0.78% (75% MOCAF: 30% rice flour). Based on the results of ANOVA at the 5% test level, the ash values were significantly different in different formulas. The ash content value of MOCAF premix flour is lower than that of biscuits made of brown rice-wheat (0.96-1.12%) (Mounika *et al*., 2017), wheat-eggplant (1.57-1.97%) (Uthumporn *et al*., 2015), and sorghum - taro-nut (2.37-2.73%) (Okpala *et al*., 2012).

3.1.6 Carbohydrate level

The results of the carbohydrate analysis on biscuit premix flour were 86.75% and 86.7%. Based on the ANOVA results at the 5% test level, there was no significant difference in of carbohydrate values between the formulas of 75% MOCAF: 25% Rice Flour and 75% MOCAF: 30% Rice Flour. The carbohydrate content of premix flour is greater than that of biscuits made of brown rice-wheat (60.66-60.98%) (Mounika *et al.,* 2017), wheat-eggplant (61.10-63.94%) (Uthumporn *et al*., 2015), and sorghum- taro-nuts (57.77-72.28%) (Okpala *et al*., 2012).

3.2 Physical properties

3.2.1 Hardness

The results of biscuit hardness analysis range from

Table 2. Chemical properties of biscuit premix flour.

Sample	Analysis				
	Water Content (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
75% MOCAF: 25% Flour Rice	8.34[a]	2.11[b]	1.80[b]	0.76[b]	86.75[a]
70% MOCAF: 30% Flour Rice	8.32[a]	2.18[a]	1.84[a]	0.78[a]	86.70[a]

Values with different superscripts within the same column are statistically significantly different with a confidence level of 0.95% based on Duncan's Test.

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0.055 to 0.15 g/mm. Based on the results of ANOVA at the 5% test level, there is a significant difference of value between the addition of biscuits and the length of storage time for biscuit premix flour. The hardness value of biscuit premix flour can be seen in Figure 1. The biscuit hardness decreases with the increasing rice flour and the decreasing MOCAF. This is because the MOCAF constituent components still contain fiber (1.9-3.4%) (Subagio *et al*., 2008). The addition of more rice flour increases the hardness of the biscuit because the largest component in the biscuit is starch, ranging from 95.37% to 97.98% with amylose content of 37.10-57.29% (Rambitan, 1988; Tovar *et al*., 2002).

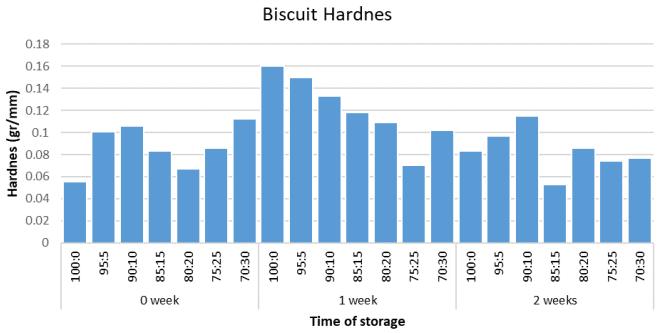

Figure 1. Biscuit hardness level

The crystalline form of amylose makes starch molecules more brittle when it is added as a raw material (cassava flour, sago, wheat flour, corn starch) in the manufacture of products (Tongdang *et al.,* 2008; Saeleaw and Schleining, 2010; Taewee, 2011). Apriyani *et al.* (2011) reported that the product has a relatively hard linear texture with a higher hardness level and is less crunchy compared to a product with a lower hardness level. The decrease in the hardness of biscuits indicates that the product is crispier and therefore easier to break. The longer the storage time, the higher the hardness of the biscuit. The addition of rice flour affects the texture of the biscuits significantly at room temperature storage.

3.2.2 Fracture (break strength)

The results of the analysis on the fracture strength of biscuits range from 68.242 g/mm to 163.86 g/mm. Based on the ANOVA result at the 5% test level, significantly different values were obtained for the addition of rice flour and the length of time for the premix flour storage. The fracture strength of the biscuits can be seen in Figure 2. The range of average fracture strength indicates a tendency that the addition of rice flour results in an increase in the fracture strength of biscuits. The increase in crumb hardness can be caused by the recrystallization of amylose and amylopectin, the formation of complexes between starch and protein and the redistribution of water with components in the product as occurring in bakery product storage. The amylose content of more rice flour added makes the biscuits break more easily because amylose has a high water absorbability so the starch granules expand during the gelatinization process during baking. In the baking process, the water absorbed by the starch can leave empty spaces in the dough and the texture of biscuits becomes crunchy so that they are broken easily (Seyhun *et al*., 2003; Prameswari and Estiasih, 2018).

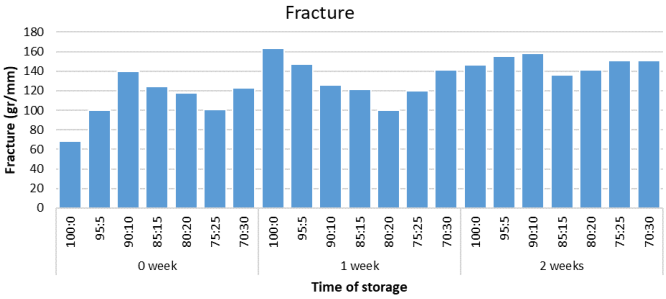

Figure 2. Histogram of biscuit fracture

3.2.3 Chroma

The results of the analysis on the value of chroma biscuits range from 22.96 to 28.59. Based on the results of ANOVA at the 5% test level, the chroma value is significantly different from the addition of rice flour and the storage time of premix flour made into biscuits. The chroma value of the biscuit can be seen in Figure 3. The more rice flour is added, the higher will be the chroma value produced. This is because rice flour has higher brightness or whiteness level (> 97%) compared to MOCAF (minimum 87% whiteness degree) (BSN, 2011). Meanwhile, during storage, the chroma biscuit value tends to decrease. Changes in the degree of flour color are affected by storage significantly causing a decrease in color value due to the oxidation process in the natural color of flour and the presence of oxygen and enzymes helping reshuffle during the storage (Ahmed, 2015).

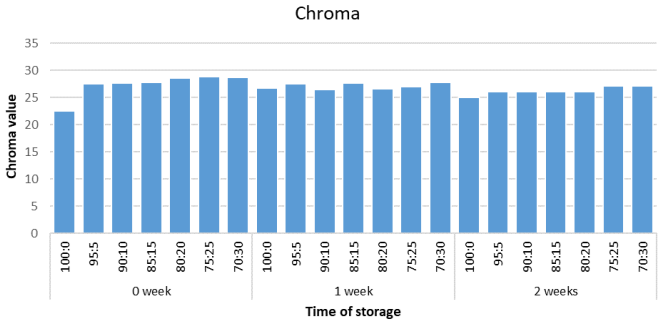

Figure 3. Histogram of biscuit chroma values

3.2.4 Lightness

The results of the analysis on the lightness value of biscuits ranged from 60.11 to 63.72. Based on the results of ANOVA at the 5% test level, the lightness value is significantly different from the addition of rice flour and

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the storage time of premix flour made into biscuits. The lightness value of biscuits can be seen in Figure 4. The more rice flour is added, the higher will be the lightness value resulting. Rice flour as raw material has a higher brightness than MOCAF does. Based on SNI, the whiteness value of rice flour > 97% (BSN, 1994) is whiter than MOCAF (min. 87% whiteness) (BSN, 2011). The longer the storage time for premix flour products, the lower the color of the biscuits produced. During storage, flour is easily oxidized due to the surrounding air, thereby reducing its brightness.

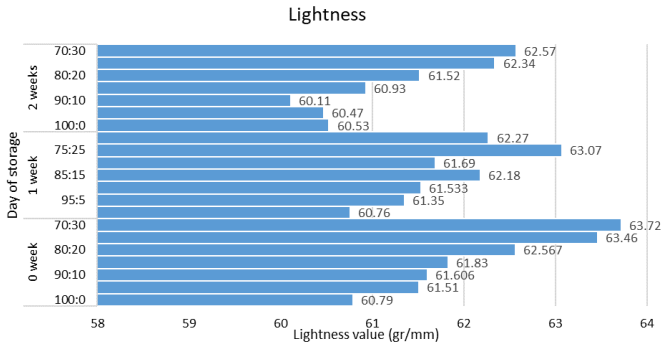

Figure 4. Biscuit's lightness histogram

3.3 Best treatment

The best formulation was determined using an effectiveness test. The determination of best biscuit premix flour was determined based on the chemical properties (moisture content, Aw) of premix flour, and the physical properties of the biscuit (texture: hardness, fracture; color: lightness, chroma). The results of the effectiveness test on biscuit premix flour can be seen in Figure 5. The graph indicates that the two best formulas are 75% MOCAF: 25% Rice flour treatment with an effectiveness value of 0.75 and 70% MOCAF: 30% Rice flour treatment with an effectiveness value of 0.72 and a long storage time, 2 weeks for both treatments.

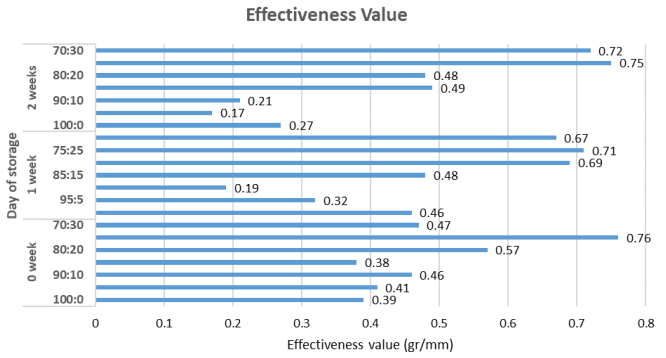

Figure 5. Histogram biscuit's effectiveness value

3.4. Organoleptic properties

One of the factors determining the quality of biscuits is organoleptic value including color, taste, aroma, texture, appearance, and overall acceptance. The results of organoleptic biscuits are shown in Figure 6.

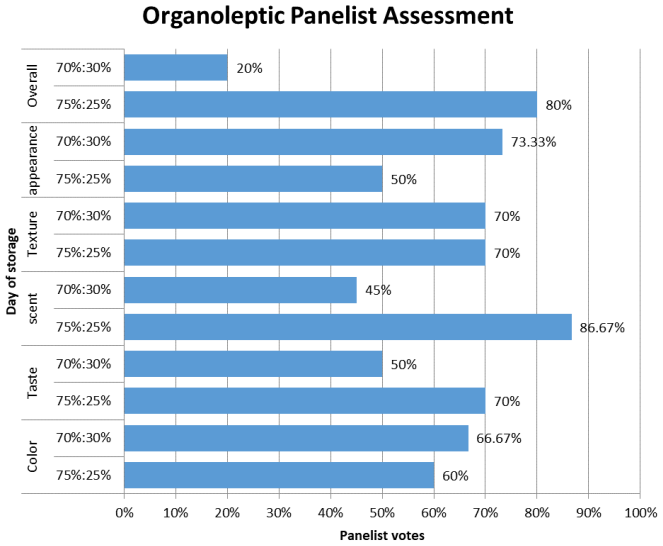

Figure 6. Histogram of organoleptic panelist assessment

3.4.1 Color

Color is a parameter that influences the preference and acceptance of panelists for food products and gives an impression most quickly, but it is difficult to measure so it is very subjective. About 60% of panelists received biscuits with a 75% MOCAF: 25% rice flour formula, while 66.67% panelists received cookies with a 70% MOCAF: 30% rice flour formula. Biscuits with the formula of 70% MOCAF: 30% Rice flour tends to produce colors that are more acceptable to the panelists compared to those with the formula of 75% MOCAF: 25% rice flour because they are considered more attractive in terms of color. The addition of more rice flour resulted in a brighter biscuit color.

3.4.2 Flavor

Panelists are more likely to accept biscuits with a 70% MOCAF: 30% rice flour formula by 70% compared to the 75% MOCAF: 25% rice flour formula. This is because the addition of rice flour can reduce the dominant taste of MOCAF. MOCAF is a modified cassava flour using lactic acid bacteria so that it has a slightly sour taste due to the presence of lactic acid produced (Subagio *et al*., 2008).

3.4.3 Aroma

The results of the panelist's assessment of the biscuit aroma show that 86.67% of panelists were more receptive to biscuits with the 75% MOCAF: 25% rice flour formula compared to the 70% MOCAF: 30% rice flour formula. The addition of rice flour can reduce the dominant aroma of MOCAF because the distinctive slightly sour smell of MOCAF is produced by the activity of lactic acid bacteria in the fermentation process of its manufacture. Subagio *et al.* (2008) state that the

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fermentation process during the manufacture of MOCAF involves microbes that are able to produce enzymes that can hydrolyze starch into simple sugars and then into organic acids, especially lactic acid resulting in the distinctive odor of MOCAF.

3.4.4 Texture

The results of the panelists' assessment show that 70% of panelists received cookies with the 75% MOCAF: 25% rice flour formula as much as the biscuit texture assessment with the 70% MOCAF formula: 30%. The strong biscuit structure is produced by amylopectin which has an adhesive ability (Harzau and Estiasih, 2013). In addition, the water content of rice is quite low (15%) (BSN, 1994) so as to produce a crunchy product.

3.4.5 Appearance

The results of the panelists' assessment show that 73.33% of panelists received the appearance of biscuits with the formula of 70% MOCAF: 30% rice flour. The addition of rice flour in the manufacture of biscuits resulted in a better appearance in the quality attributes of biscuits. Corn starch has higher amylopectin than amylose does. The comparison of amylose and amylopectin has an effect on the formation of biscuit texture so that the appearance of biscuits also increases.

3.4.6 Overall

The results of panelists' research show that 80% of panelists received biscuits with the formula of 75% MOCAF: 25% Rice Flour. Overall the panelists were more receptive to biscuits with the formula of 75% MOCAF: 25% Rice Flour. The overall level of acceptance was determined based on the accumulation of all the organoleptic characteristics tested by the panelists including the color, taste, aroma and texture of the biscuits. Validity test. Based on the effectiveness test, it can be concluded that biscuit acceptance from the existing questionnaire data was valid, so it can be used as research. The results of the calculation using validity test showed that all values of r statistic > r table are at a significance value of 5% (Table 3). Acceptance of biscuits based on the reliability test can be accepted by the panelists, so that they can be used as instruments in research with an alpha value of more than r table (0.361) as seen in Table 4.

Table 4. Biscuit acceptance questionnaire reliability results.

Variable	rcount	r_{table} 5% (30)	Description
123	0.85	0.361	Reliable
321	0.665	0.361	Reliable

4. Conclusion

The proportion of raw materials and storage time of biscuit premix flour affects the water content and water activity. The best MOCAF biscuit formula based on the effectiveness test is the ratio of 75% MOCAF: 25% Rice flour additions with a storage time of 2 weeks. The characteristics of the best formula premix flour are water content of 8.55%, ash content of 0.76%, protein content of 2.11%, fat content of 1.80%, carbohydrate content of 86.75%, while the biscuit products from the best formula have characteristics of hardness 0.07 (g/mm), fracture strength 151.62 (g/mm), chroma 27.25, brightness 62.37.

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Table 3. Results of the validity of the biscuit acceptance questionnaire.

Characteristics	r123	r321	r_{table} 5% (30)	Description
Color	0.763	0.518	0.361	Valid
Flavour	0.491	0.486	0.361	Valid
Aroma	0.734	0.474	0.361	Valid
Texture	0.635	0.563	0.361	Valid
Appearance	0.572	0.692	0.361	Valid
Overall	0.817	0.803	0.361	Valid

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