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Charactherization Analog Rice based of White Canna Strach Adding with Soy Flour (Glicine Max) and Glycerol Monostearate

Jariyah*, Sri Winarti, Yushinta Aristina Sanjaya, Setyandari Ayu Larasati

Department of Food Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya, Indonesia

Corresponding author:
E-mail: jariyah.tp@upnjatim.ac.id

ABSTRACT

This research was aimed to analize the characteristics of analog rice made from white canna starch fortified with soybean flour and Glycerol Monostearate (GMS). The experimental design used was a completely randomized design (CRD) with two factors. The first factor is the proportion of white canna starch and soybean flour, the second factor is the concentration of the addition of GMS. The results of the analysis of raw materials showed that the water content of canna starch was 8.46%; ash content of 1.54%; starch content of 70.43%; amylose by 20.22% and amylopectin by 50.21%. The results of the analysis of the moisture content of soybean flour are 10.85%; ash content of 2.04%; and 39.18% protein content. The results of analog rice analysis showed that there was a significant interaction in the analysis of ash content, kamba density and protein content. The interaction results were not significant from the analysis of water content, rehydration power, expansion volume, starch content, amylose content and amylopectin content although each treatment showed significant differences. Sensory analysis was performed on analog rice. The results of sensory analysis of the aroma, taste, color and texture of analog rice obtained the best results at the proportion of 24% soy flour with the addition of 2% GMS. The results showed a moisture content of 7.18%, ash content of 1.9%5, protein content of 14.05%, starch content of 65.79%, amylose 18.81%, amylopectin 46.97%, rehydration power 67 (g/ml), kamba density 55.3 (g/ml). ml), and the expansion volume was 116.67 g/ml.

Keywords: Analog rice, extrusion cooking, white canna, glycerol monostearate, soybean flour

Introduction

Around 90% of rice is produced and consumed in Asia (Bandumula, 2018), especially rice consumption in Indonesia is still quite high because rice is the staple food of the Indonesian population. This high consumption is also influenced by the high population in Indonesia (Bashir & Yuliana, 2018). This condition causes the price of rice to remain a benchmark for various economic indicators. The purchasing power of food shows the level of people's welfare (Hermawan, et al. 2017).

The consumption pattern of the Indonesian people, which is difficult to change, has prompted the government to issue a policy of Presidential Regulation no. 22 of 2009 concerning the acceleration of diversification of food consumption based on local resources. One of the diversification of food consumption based on local resources is the manufacture of analog rice from White Canna tubber starch with the addition of soy flour and Glycerol Monostearate. Canna tubers contain starch between 12-16% and can be used as a substitute for starches that have been widely used

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in the food industry (Algar et al., 2019). Some of the uses of canna starch include the use of hydrocolloids in yogurt drinks (Umam et al., 2018), the bioplastic industry (Algar et al., 2019), and the use of canna flour in noodles and biscuits (Noriko et al., 2020). The use of soybean flour for fortified analog rice to increase the nutritional value of foodstuffs, especially protein. The use of soybean flour has also been widely used in the manufacture of analog rice. Research by Sanful and Darko (2010) showed that the addition of soy flour to wheat flour increased the protein content and improved the quality of bread. Soy protein was also an important ingredient for tuber-based extrusion because it can be extruded and produce a textured product. Soy protein displays an aniostrophic structure that is layered according to flow on the die. Friction that occurs in the mold allows denaturation, dissociation, and orientation of the protein matrix (Wu et al., 2018).

Glycerol monostearate is a mono-acyl ester of stearic acid with glycerol alcohol. Glycerol monostearate is a white powder, odorless and widely used as thickening, emulsifier, anticaking, body forming, and antistaling in the food industry (Yilmaz & Uslu, 2020). Glycerol monostearate has also been widely used in food products, plasticizers, pharmaceuticals and cosmetics. Monoglycerides are usually synthesized from glycerolysis, hydrolysis of triglycerides and direct esterification of glycerol with fatty acids. The esterification reaction is usually catalyzed by strong acids, such as sulfuric acid and phosphoric acid leading to a mixture of mono, di, and triglycerides (40:50:10) (Gu et al., 2014). This study aims to determine the best proportion of white canna starch and soybean flour, as well as the addition of glycerol monosterate. This study also aims to determine the physicochemical and organoleptic characters of analog rice made from white canna starch.

Material and Methods

Material

The ingredients used in the manufacture of analog rice are white canna starch, soybean flour, water, oil, salt, and GMS. Material for analysis analog rice was 0.1 M phosphate buffer solution pH 7, aquadest, 1 N HCl, 1 N NaOH solution, ethanol, acetone, HCl 25%, and 45% NaOH solution.

Method

The method of making soybean flour is based on the method of Sanful and Darko (2010) with slight modifications. The manufacture of analog rice from white canna flour with the addition of soybean flour and glycerol monostearate was carried out based on the method (Havena et al., 2020) with slight modifications. Moisture content, starch content, ash content and protein content were measured using the AOAC method (AOAC, 1995). Amylose content was determined using the method of Juliano (1971), while amylopectin levels were determined by different. Analysis of kamba density and rehydration capacity was determined using the method of Wang et al. (2013). The experimental design used a two-factor Completely Randomized Design (CRD). The first factor is the proportion of white canna starch and soybean flour, while the second factor is the concentration of glycerol monostearate (w/v). The proportions of canna starch and soy flour used were 82% canna starch: 12% soybean flour; 76% canna starch: 24% soybean flour; and 70% canna starch: 30% soybean flour. The concentration of glycerol monostearate used was 1.5%; 2.0%; and 2.5%. The data obtained were analyzed using analysis of variance test (ANOVA).

Results and Discussion

The raw materials that will be used for the manufacture of analog rice are analyzed first. Analysis of raw materials includes water content, ash content, starch content, amylose content, amylopectin content in white canna starch. Analysis of moisture content, ash content, and protein content was carried out for soybean flour. The results of the analysis of raw materials for white canna starch, and soybean flour can be seen in Table 1. Analysis of the water content of white canna starch was 8.46%, ash content was 1.54%, starch content was 70.43%, amylose content was

20.22% and amylopectin content was 50.21%. According to Carolina and Ilmi (2016), the water content of white canna starch is 6.49%, the ash content is 0.37%, the starch content is 98.53%, the amylose content is 25.54% and the amylopectin content is 61.05%. According to Tritipraphunkul et al. (2003), the amylose content of some canna cultivars is between 19-25%. The amylopectin content of white canna starch is higher, which is 50.21%. This is in accordance with the results of research by Handajani and Pangesthi (2019), which states that the carbohydrate content of canna starch is around 84.34% with amylopectin content of 50-60%. The high content of amylopectin causes the ability to absorb water so that the resulting viscosity is higher and produces a harder and sticky gel.

Table 1. Proximate analysis white canna starch and soybean flour

Parameter	White Canna Starch		Soybean Flour	
	Result	Reference [a]	Result	Reference [b]
Moisture content	8.46±0.002	6.49	10.85 ±0.141	6.84
Ash	1.54±0.003	0.37	2.04 ±0.003	4.92
Starch	70.43 ±0.127	98.53	-	-
Amylose	20.22±0.141	25.54	-	-
Amylopectin	50.21±0.268	61.05	-	-
Protein	-	-	38.19 ±0.098	35.60

Note: a: Carolina & Ilmi (2016) b. Uwem et al. (2017)

Soybean flour has a moisture content of 10.85%, ash content was 2.04%, and protein content was 38.19%. According to Uwem et al. (2017), soybean flour has a moisture content of 6.84%, an ash content of 4.92%, and protein content of 35.60%. According to Akubor and Ukwuru (2003), soybean flour has a moisture content of 8.0%, an ash content of 6.0%, and protein content of 38.2%.

Characteristic of analog rice

Characteristic of analog rice is influenced by several factors, including the chemical composition of the basic ingredients used (canna starch and soybean flour), the extrusion process that uses high temperature and pressure, pre-steaming before the extrusion process, and other technical factors during the process (Wahjuningsih & Susanti, 2018). The choice of starch used must be selected which has the appropriate amylose amylopectin ratio in order to obtain the desired final product. The pre-gelatinization ratio (pre-cooked) for flour that is not gelatinized in the composition is also important. If less than 30% of the flour has been previously gelatinized, the rice product formed will have an unfavorable character. On the other hand, more than 70% proportion of pre-gelatinized starch will affect the extrusion characteristics and it is difficult to control the size and shape of analog rice (Mishra et al., 2012). The results of analog rice analysis can be seen in Table 2.

Table 2. Properties of analog rice based white canna starch fortified soybean flour and gycerol monostearate

Treat-ment	Moisture Content (%)	Ash (%)	Protein (%)	Starch (%)	Amylose (%)	Amylopectin (%)	Rehidra-tion (%)	Bulk Density (g/ml)	Swelling Volume (g/ml)	Aroma	Calour	Flavour	Tex-ture
A	8.61	1.54	11.33	68.91	19.73	49.18	93	45.23	123.94	93.00	114.50	119.00	113.50
B	8.28	1.78	11.21	68.76	19.67	49.08	87	48.54	122.40	107.00	122.00	143.00	131.50
C	8.06	1.83	11.07	68.61	19.62	48.99	86	48.83	120.35	122.00	105.00	116.00	117.50
D	7.45	1.95	14.08	65.86	18.85	47.01	72	50.89	118.11	111.00	108.00	108.00	151.50
E	7.18	1.95	14.05	65.79	18.81	46.97	67	55.30	116.67	136.50	125.00	136.00	145.50
F	7.09	2.01	14.02	65.72	18.78	46.94	64	56.40	115.93	135.00	145.00	124.00	134.50
G	6.42	2.05	15.89	63.76	18.25	45.51	61	58.77	114.50	145.00	150.00	134.00	126.00
H	6.31	2.08	15.84	63.73	18.21	45.52	58	59.28	112.95	136.50	127.00	135.00	100.50
I	6.08	2.12	15.94	63.71	18.18	45.53	50	60.89	111.76	144.50	129.50	116.00	90.50

Description of the treatment:

A. Canna starch 82% : 18% soybean flour : GMS 1.5%
B. Canna starch 82% : 18% soybean flour : GMS 2.0%
C. Canna starch 82% : 18% soybean flour : GMS 2.5%
D. Canna starch 76% : 24% soybean flour : GMS 1.5%
E. Canna starch 76% : 24% soybean flour : GMS 2.0%
F. Canna starch 76% : 24% soybean flour : GMS 2.5%
G. Canna starch 70% : 30% soybean flour : GMS 1.5 %
H. Canna starch 70% : 30% soybean flour : GMS 2.0%
I. Canna starch 70% : 30% soybean flour : GMS 2.5%

Moisture content

The moisture content of analog rice was quite low, 6.27 – 8.32%. This low moisture content causes the product to have a long shelf life because it prevents mold growth and spoilage. According to SNI, the maximum water content of analog rice with various compositions was 14% because rice with moisture content above 14% is easier to spoil (Khairunnisa et al., 2017). Table 2 shows that the decreased the proportion of canna starch and increased the soybean flour as decreased moisture content of analog rice. This is due to the decreased proportion of canna starch on the formulation. Starch has properties that can bind water. Moisture content of analog rice was influenced by the starch composition in analog rice, so that the decreased the starch content causes decreased the moisture content of analog rice. According to Susi et al. (2019), this is strongly related to the ability of starch to bind more water. The water used in the formulation was the water from the steaming process when pregelatinization was carried out. The composition of amylopectin and amylose from canna white starch also greatly influences the moisture content of this analog rice. The results showed that white canna starch contains more amylopectin composition than amylose, so that it affects the moisture content. Low water content indicated that white canna starch had more long-chain amylopectin. According to Cornejo-Ramirez et al. (2018), short-chain amylopectin binds to water molecules more easily through hydrogen bonds, while amylose, amylose-lipid complexes, and long-chain amylopectin which interact to each other through helical bonds, delicate interact to water molecules.

Table 2 shows that the higher the concentration of GMS followed, the lower the moisture content of analog rice. This could be due to the interaction between monostearate glycerol molecules and canna starch. The results showed that the amylopectin content of white canna starch was higher than amylose. It might mainly cause the increased GMS on the formulation as lower the moisture content of analog rice. According to Yang et al. (2017), GMS adhere to the amylopectin surface and change the water distribution, interact with branched chains through altered hydrogen bonds, and reduce the water capacity of starch.

Ash content

Table 2 shows the average ash content in analog rice was1.544 - 2.12 %. The addition of 18% soybean flour and 1.5% GMS resulted in lower ash content. Meanwhile, the addition of 30% soybean flour and 2.5% GMS resulted in the highest ash content of 2.12%. The ash content of analog rice is more influenced by the proportion of soybean flour. The higher the proportion of soybean flour, the higher the ash content. The use of soybean flour in analog rice has been widely used (Khairunnisa et al., 2017; Handajani et al., 2019).

The results showed that ash content increased as soybean fluor and GMS in the formulation. It was because soybeans are not only a source of protein but also a source of minerals. Results The ash content of soybean flour is 2.04%. According to Uwem (2001) the ash content of soybean flour was 4.92%, while according to Etiosa et al. (2019). The ash content of soybean seeds was 4.29%. The ash content of a food item shows the number of minerals contained in the food. The ash content in the material indicates the high mineral content in the food. Ash content means the number of minerals and organic substances contained in the product (Wahjuningsih & Susanti, 2018; Tangjaidee et al., 2019). The analysis results also showed that the higher the concentration of glycerol monostearate added increased the ash content of analog rice. This is due to the chemical nature of the emulsifier (Arshad et al., 2019).

Protein content

The results shows (Table 2) the average protein content was 11.33% – 15.94%. Proportion of 18% soybean flour with the addition of 1.5% GMS resulted in the lowest protein content (11.33%). Increased soybean flour and GMS on the formulation as increased protein content analog rice. This is because the protein content contained in soy flour, as increased in soy flour, proportionally the protein content will also increase in line with the increase in the use of soy flour. The protein content appropriated with SNI for analog rice, which is a minimum of 6.8%. The presence of protein in analog rice affects several characteristics of the extruded starch. According to Wang et al. (2013), protein is denatured during the extrusion process. The stabilizing forces of tertiary and quaternary structures are attenuated by the combination of temperature and friction in the extruder. The previously hidden amino acid residues become free and react with reducing sugars and other food components. The occurrence of protein denaturation was proven by Wu et al. (2018), who extruded soybean composites. The results of SDS-Page analysis showed that the extruded samples showed some changes in the molecular weight distribution compared to the protein raw materials. Treatment of 30% soybean flour with the addition of 3.0% GMS resulted in the highest protein content, 15.94%. The higher proportion of soy flour influences this. However, the interaction of GMS and protein can affect the texture of the extrudate. Yang et al. (2017), stated that GMS is a hydrophobic emulsifier, while the lipophilic part is attached to the non-polar side of the protein complex chain, forming an intermolecular matrix through hydrogen bonds and cross-linking among proteins and reducing the level of the hardness.

Starch content

The average value of analogous rice starch content of canna starch flour: soybean flour can be seen in Table 2. The results of the analysis show that the lower the proportion of canna starch and the higher the soybean flour, the analog rice starch content decreases. Analog rice with the main ingredient white canna tuber starch has a high starch content of 70.43%. Soybean flour has a starch content of 8.66% (Ratnawati et al., 2018). The starch content increased as white canna tuber starch, and soybean flour increased in the formulation. The starch content of the analog rice decreased as GMS increased in the formulation. Addition GMS in formulation does not affect the starch content of analog rice. This is because the addition of GMS serves to bind the material, which affects the water content, rehydration powder, bulk density, and fracture strength but does not affect the starch content of analog rice. GMS is an emulsifier that aims to facilitate the extrusion process in the extruder (lubricant) and reduce the rice stickiness level to each other. It is easily separated from each other during the gelatinization process. GMS can reduce the friction between particles in the dough and between the surface the coupler and the dough. The use of GMS can strengthen the water content in the dough, which functions as a plasticizer so that the plasticity characteristics in the dough can be maintained (Susi et al., 2019).

Amylose content

The result showed that decreased of the canna starch and increased of the soybean flour as decreased amylose content. The amylose content of analog rice is between 19.67 – 18.22%. Soybean flour has a fairly low amylose content of 1.79% (Ratnawati et al., 2018). This causes the amylose content of soybean flour to have less effect and decrease with the increase in soy flour in analog rice.

Fortification of GMS in analog rice does not affect the amylose content of analog rice. This is because the addition of GMS serves to bind the material, which affects the water content, rehydration powder, bulk density, and fracture strength but does not affect the amylose content of analog rice. GMS serves to bind materials, become lubricants in the extrusion process, prevent the development of extrudates, make extrudates not stick to each other in the product during the cooking process into rice (Kaur et al., 2004). However, the interaction between GMS and amylose affects the final quality of analog rice. Wang et al. (2013) stated that GMS is a lipophilic emulsifier with a non-polar group, which can form a complex with amylose hydrophobic helix during extrusion. GMS complex with amylose will prevent leaching with amylose during gelatinization, inhibit swelling of starch granules in water, and reduce the water binding capacity of starch.

Amilopectin content

The results showed a decrease of the canna starch and increase of the soybean flour as decreased the amylopectin content of analog rice. Analog rice amylopectin levels ranged from 45.53 to 49.18%. Soybean flour has an amylopectin content of 6.87% (Ratnawati et al., 2018). It indicates that analog rice amylopectin levels are more influenced by canna starch. The decrease in starch levels in analog rice was due to a decrease in the proportion of canna starch used in analog rice.

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Rehydration properties

The average value of the rehydration power of canna starch analog rice and soybean flour is shown in table 2. The lower the proportion of canna starch and the higher the soybean flour can reduce the rehydration of the analog rice. It is because the ratio of starch of formulation was decreased. Water absorption was influenced by the composition of starch contained in foodstuffs which bond water. Decreased proportion of starch in the formulation as decreased rehydration power. According to Wahjuningsih and Susanti (2018), the effect of increasing starch content on the water absorption value is related to the composition of amylose and amylopectin in starch. Foodstuffs with a high starch content will more easily absorb water due to the availability of amylopectin molecules that are reactive to water molecules, so the amount of water absorbed in the food ingredients will be higher.

Table 2 showed the higher the addition of GMS, as decreased rehydration power of analog rice. GMS formed a complex with amylose, which was hydrophobic, causing obstruction of water into analog rice, so that the higher the concentration of GMS decreased rehydration power. This is in accordance with the statement of Yang et al. (2015) amylose in starch tends to form inclusion polymers with hydrophobic ligands, such as lipids, fatty acids, and esters. GMS has lipophilic properties of emulsifiers with non-polar groups. The hydrophobic group in GMS binds to the alpha-helical structure of gelatinized amylose with starch to form a stable amylose lipid complex. Putsey et al. (2010), state that the reaction resulted in a change in the formation of amylose double helix to a single helix called V-amylose. The V-amylose is compact and has a central hydrophobic cavity in which the ligand hydrocarbon chain can reside.

Bulk density

Table 2 shows that the average bulk density was 45.24 g/ml – 60.89 g/ml. The treatment of 18% soybean flour with the addition of 1.5% GMS resulted in the lowest bulk density, which was 45.24 g/ml. The 30% soybean flour treatment and addition of 2.5% GMS resulted in the highest bulk density, which was 60.89 g/ml. The results showed that decreased the canna starch and increased the soybean flour, and the addition of GMS increased the bulk density of analog rice. This is because the bulk density is influenced by the size of the material, porosity, and moisture content. According to Wang et al. (2013), bulk density is closely related to the ability to float or sink when poured into water. The bulk density indicates the relative volume of packaging material required. A higher bulk density is desirable for ease of dispersion.

The moisture content of analog rice increased as soy flour and GMS. It is caused by the bulk density of analog rice. Increased moisture content caused the particles to become denser so that the volume in the particle cavity gets smaller and particles formed are getting bigger. This is in accordance with the statement of Charununch et al. (2014), water content affects the density of the product. Increasing the moisture content during extrusion lowers the expansion ratio and increases the density of the Kamba. The high dependence of kamba density and expansion on moisture content reflects its effect on the elasticity of starch-based materials. The results of research by Tangjaidee et al. (2019) Extrusion properties and variables on rice products show that kamba density depends on water content and extrusion temperature. The temperature effect and moisture content on the bulk density was related to the composition of the material, such as the presence of protein, emulsifier, and gelatinization of starch. The increase in protein content between 10-25% causes an increase in the expansion ratio of extruded products made from rice. The high degree of starch gelatinization at high extrusion temperatures can increase the density of the extruded product.

Swelling properties

The results showed the decreased proportion of canna starch and increased soybean flour could reduce the swelling volume of analog rice. According to Omohimi et al. (2014), swellability is the ability of starch to absorb water so that the starch granules increase in size, which indicates the level of exposure of the internal structure/matrix of starch granules to water. The results showed that decreased starch contained in analog rice as decreased swelling volume of analog rice. This is because, at the time of soaking and cooking analog rice, analog rice absorbs hot water until it cannot return to its original shape, which results in a larger diameter change. According to Wu et al. (2017), during the extrusion process, water plays a very important role in determining the protein denaturation temperature. Protein molecules will assemble through hydrophobic interactions with higher water content. The intermolecular correlation between the disulfide bonds will be very dominant and reduce the absorbed water content.

Table 2 shows the increasing concentration of GMS accompanied by a decrease in the expansion volume. This result may be attributed to GMS interaction with amylose molecules in a helical manner which causes the ability of GMS to cause a complex layer to be formed on the surface of starch granules which causes the swelling to decrease. This is in accordance with the statement of Wang et al. (2013), GMS is a lipophilic emulsifier that has a non-polar group that can form a complex with amylose hydrophobic helix during extrusion. The GMS complex with amylose prevents the yield of amylose during gelatinization, inhibits the swelling of starch granules when exposed to hot steam, and reduces the water-binding capacity of the starch again. Cross-linking can also reduce the swelling capacity of starch.

Sensory analysis

Sensory analysis was carried out on the preference for aroma, taste, color, and texture of analog rice cooked. The analysis was carried out on 25 panelists. Sensory analysis used the hedonic scoring method. According to Lim (2011), this method was first introduced by Fechner in 1960, who discovered psychophysical science to study the relationship between physical stimulation and sensory response. This method uses the historical scaling method. This method is known as the single stimulus method or direct scaling method to measure sensory and hedonic responses.

Aroma

The aroma can be defined as something that can be observed with the sense of smell. Aroma is a very important physical parameter of food. The results of the organoleptic analysis of aroma preferences showed that the panelists' preference for analog rice aromas resulted in a number of rankings between 93 - 144.5. The addition of 30% soybean flour with GMS 2.5 resulted in the analog rice aroma with the highest level of preference. Each treatment did not have a significant effect on the aroma of analog rice. This is because canna flour and soybean flour have a neutral aroma so they do not change the aroma of analog rice.

Taste

Taste is one of the important factors to determine whether or not food or food is acceptable. Even though the color is good, if it is not followed by a good taste, then the food is not acceptable. The panelists' preference for the analog rice taste was obtained in the number of rankings between 108 - 136. The addition of 24% soy flour with GMS 2.0 resulted in the analog rice texture with the highest level of preference. Each treatment did not have a significant effect on the aroma of analog rice. This is because canna flour and soybean flour have a neutral taste. The addition of salt in the manufacture of analog rice does not affect the taste of analog rice. This is because a small amount of salt used is 0.2% of the raw material. Table salt can reduce the activity of protease and amylase enzymes so that the dough is not sticky and does not expand excessively. This is influenced by the role of table salt, which can reduce water activity in food. Water activity in food is the amount of free water used for microbial growth and various chemical reactions (Henney et al., 2010). The enzymatic reaction decreased along with the decrease in water activity (Belitz & Grosch, 1987).

Colour

Colour plays an important role in food. The visually of the color factor appears first, so it is very decisive. The panelists' level of preference for analog rice color results in the number of rankings between 105 - 145 (Table 2). The addition of 24% soybean flour with 2.5% GMS resulted in the analog rice color with the highest level of preference. Each treatment did not have a significant effect on the color of analog rice. This is because canna starch flour and soybean flour have a neutral color. Canna tuber starch has a white color and soybean flour has a yellow color, so analog rice has a neutral color.

Texture

The texture is one of the physical parameters to test consumer preferences for food products. The panelists' level of preference for analog rice texture results in the number of rankings between 90.5 - 151.5. The addition of 24% soybean flour with GMS 1.5 resulted in the analog rice color with the highest level of preference. Each treatment did not have a significant effect on the color of analog rice. This is because canna starch flour with the addition of soy flour and GMS produces a chewy and non-sticky texture. The texture of analog rice is influenced by several things, one of which is the water content during pre-gelatinization. According to Charununch et al. (2014), the moisture content may result in lower degrees of gelatinization and expansion and indicates the hardness of the extrudate. Previous studies have also shown that the hardness of the extrudate increases as the moisture content of the material increases.

Conclusion

Based on the analysis of physicochemical and sensory, the best treatment was obtained from the ratio of canna starch 76%: 24% soybean flour with the addition of 2% glycerol monostearate. The treatment characters obtained water content of 7.18%, ash content of 1.95%, the protein content of 14.05%, starch content of 65.79%, amylose content of 18.81%, amylopectin content of 46.97%, rehydration power of 67 g/ml, the density of kamba 55.30 g/ml, development volume 116.67%. The results of sensory analysis obtained a total score for the preference test for the aroma of 136.50, color 125, taste 136, and texture 145.50.

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