

# Study of Rice Analog from Cassava–Soybean and Processed Product

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## ABSTRACT

The purpose of this study was to determine the level of preference of panelists on rice analog which is processed into steamed rice, savory rice and fried rice, as well as its nutritional content. This experimental research method was carried out in 3 stages, namely to obtain a standard recipe, find out the composition of the use of cassava and soybeans, and make preparations from rice analog including steamed rice, savory rice and fried rice. Techniques of data collection were carried out by means of observation using an organoleptic test, precisely with a preference test. Data was collected by 20 trained and somewhat trained panelists. The data was processed by a percentage, and to find out the nutritional content was calculated based on DKBM. The results of the organoleptic assessment showed a degree of preference for analog rice, as follows: 60% expressed liking for texture, 80% expressed liking for grains, 60% expressed liking for aroma, 80% liking for color. The level of panelists' preference for analog rice preparations, most said they liked enough to like the texture, grain, flavour, color and taste of ordinary steamed rice, savory rice and fried rice. The nutritional content per 100 g of rice from rice analog ware: energy 230.2 cal, protein 9 g, fat 3.64 g, carbohydrates 41.78 g, calcium 121.4 mg, phosphor 160.4 mg, iron 3.1 mg, and fiber 1.54 g.

**Keywords:** *analog rice, cassava, soybean*

## I. INTRODUCTION

Rice is a staple food for most Indonesian people. In its development, the amount of rice available was not proportional to the consumption of Indonesian people. Along with the increasing number of population that is not balanced with the amount of food, especially rice, which is increasingly decreasing. According to the OECD-FAO [1], from 2012 to 2014 on average, Indonesia has consumed the largest amount of rice, compared to other Asian countries such as Thailand, Japan, China, and India. Indonesia's dependence on rice will have an impact on food security in Indonesia. Because of this dependence on rice, the government encouraged rice imports. According to Kompas news, Indonesia always imports rice from 2000 to 2015 or for 15 years [2]. Furthermore, Badan Pusat Statistik (BPS) stated that in 2016 to 2017 the government stopped importing rice and in 2018 the Indonesian government would again import rice.

Dependence of people's basic foodstuffs on rice will have an impact on food security in Indonesia. Judging as the main source of carbohydrates, Indonesia has local food that can be used as a substitute for rice from rice plants. One of the local foodstuffs is cassava. Cassava is one type of food plant that has long been known and cultivated by farmers and the people of Indonesia. Cassava is a source of carbohydrates and a source of calories (energy) which is quite high, but it is also a source of vitamins and minerals

[3]. Cassava production in Indonesia is generally abundant, but its utilization has not been maximized and cassava itself has a relatively low sale value. Cassava is usually consumed as food by processing it first, for example boiled, shaken, fried or burned or used as a snack [4].

As a source of carbohydrates, cassava can be processed into rice analog because cassava is the biggest calorie producer compared to other plants, namely cassava has greater calories (250 cal / ha / day) compared to corn (200 cal / ha / day), corn (176 cal / ha / hr), sorghum (114 cal / ha / hr) and 110 wheat (cal / ha / hr) [3]. Cassava and various processed products contain high nutrition and complete composition. The amount of nutrition contained in 100g cassava is 1.0g protein, 0.3g fat, 36.8g carbohydrates, 0.9g fiber, 0.5g ash, 77mg calcium, 24mg phosphor, 1.1mg iron, and 2mg sodium [5]. Analog rice is a product such as rice which is made from flour and cooked in a manner similar to rice [6]. Artificial rice is rice made from non-rice with carbohydrate content close to or exceeding rice made from local flour or rice flour [7,8]. Rice analog is artificial rice made only from local non-rice flour [9]. Until now rice analog making technology includes granulation or granulation methods [10,11,12] and extrusion methods [13,14,15]. The difference in the method causes the difference in the final form of the product. Low protein content is a major challenge in developing analog rice from cassava. The main need is to develop analog rice which is formulated with other ingredients that contain high protein. One of the best sources of protein comes from the legume family, namely

soybeans. Soybean contains 45% protein with 91.41% digestibility [16]. According to Graaff [17] soybeans can improve food quality (protein) in a very simple menu. High protein and fat content in soybeans is a complete food ingredient. Soybeans are the best source of protein among other plants. Soybeans not only contain high-quality protein, but the levels are much higher than the protein content of other foods. Soybeans are very rich in calcium, phosphor, iron, and magnesium. Addition of soy to rice analog formula is expected to increase its nutritional value,

especially protein content. Previous research by [18] stated that red beans combined with mocaf were able to produce rice analog with a higher nutritional value due to the red bean protein content which amounted to 23.2%. Thus, cassava and soy have the potential to become local raw materials for functional rice analog. Therefore, this study aims to develop rice analog from cassava-soybeans and to find out the level of panelists' preference for rice analog which is processed into ordinary or steamed rice, savory rice and fried rice, as well as its nutritional content.

## II. METHOD

Engineering methods are used for making rice analog and its preparations. Engineering is used to find rice analog formula that fits the criteria. The engineering was carried out 3 times so that it met the results of good rice criteria.

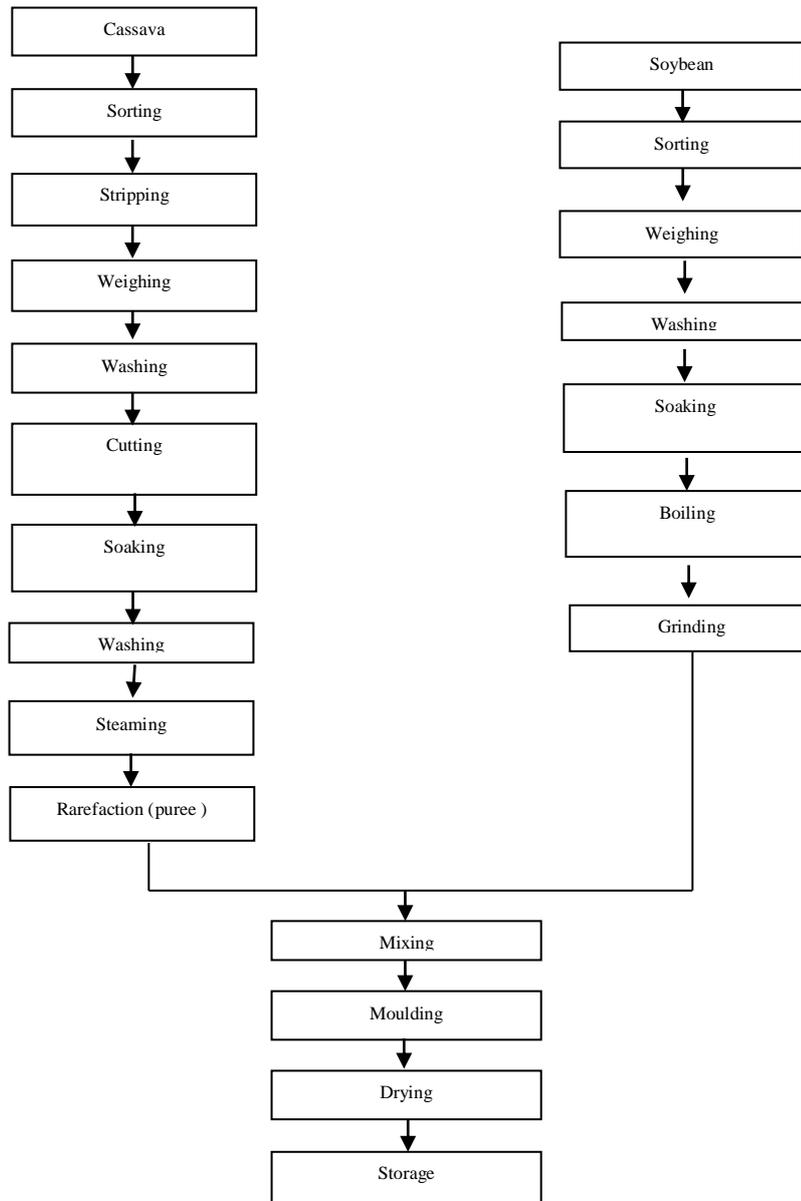


Figure 1. The process of Rice analog making

In the first engineering aims to obtain a standard recipe in order to obtain a standard recipe standard from analog rice that produces rice with good criteria that are hard-textured, tastes plain (neutral), slightly aromatic scent and cream-colored yellow. Engineering I uses cassava and soybeans. Cassava used is the type of cassava butter and soybean used is yellow soybeans. The ingredients used are 1100g cassava

and 100g soybeans. The way of making rice analog as showed in Figure 1.

The results of rice analog in engineering I, were evaluated as follows: hard texture, whole grains/not brittle, neutral flavour, not unpleasant soybeans, cream yellow color. The addition of soy ingredients is too little (less than 10%), so it does not cause unpleasant taste and flavour of rice.



Figure 2. Rice analog of cassava-soybean

The results of the finished rice in the first stage were evaluated after steaming the rice into a rice dish as follows: The texture is rather hard because at the time the cooking process is not soaked first. Grains remain intact but rather sticky, because cassava contains starch. The color of the resulting rice changes, from the color of the rice before it is processed ie yellowish to brownish yellow. The flavour of

rice produced has a neutral flavour. The taste of rice produced is neutral but not perfect because the addition of soybean ingredients is too little, so that only cassava is felt. For that, in the second engineering, soybean puree will be added. The texture of the resulting rice is rather harsh, because in the process of steaming analog rice is not soaked first, so the starch content of the rice absorbs less water.



Figure 3. Steamed Rice Cooked I

In engineering II, two experiments were carried out, namely rice analog A and rice analog B. In the experiment carried out the addition of soybeans and reduction of cassava material, as shown in Table. 1

Table 1. Material used in Making Analog Rice in Engineering II

No	Material	Amount of A	Amount of B
1	Cassava	1000 g	900 g
2	Soybean	200 g	300 g

The process of making rice is the same as engineering I. In this engineering only reduce cassava puree and add soy puree, while making cooked rice there is a difference that is the process before being steamed soaked with warm water and added with melted butter, so that the rice is not hard and not sticky.

The results of analog rice in engineering II A and II B are evaluated as follows: Hard texture. Whole grains / not

fragile. The resulting flavour has a slightly unpleasant flavour in rice A, while in rice B is very aromaticly unpleasant from soy. The resulting color is already well seen from the bright yellow color of engineered rice A, while the results of rice B are a rather yellow color, due to the addition of more soybeans than rice A.

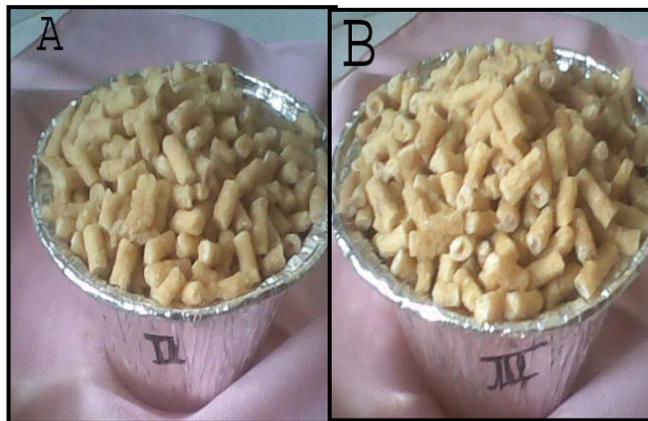


Figure 4. Rice A and B Result of Engineering II

The resulting finished cooked rice is as follows: the resulting rice texture is soft, because during the cooking process it is soaked with warm water and margarine is added. Whole grains are not sticky, because margarine is added during the soaking process. The color of the resulting rice changes, from the color of the rice before it is processed ie yellow, after being cooked to brownish yellow,

the result of the color of rice A and B there is a difference namely in rice B the color is darker because there is too much soy material. The flavour of rice produced has a slightly unpleasant flavour in rice A while in rice B the rice is very scented. The taste of rice, the resulting flavor is slightly unpleasant on rice A while on rice B tastes very unpleasant from soy.

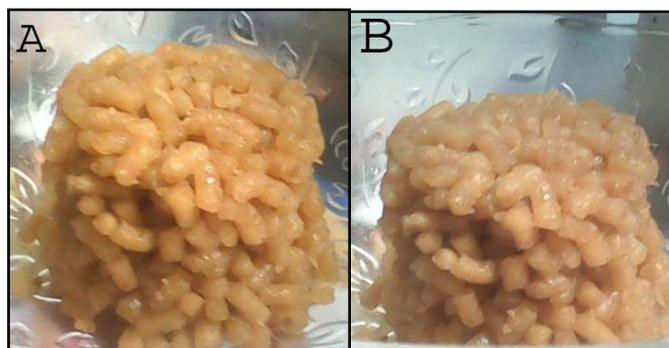


Figure 5. Steam Rice A and B Result of Engineering II

In engineering III that is making various dishes from rice analog, namely steamed rice, savory rice and fried rice. The materials used are as seen in Table 2.

Process of making steamed rice

1. Melt the butter.

2. Wash rice in a container with running water twice, then soak the rice with hot water and mix the melted butter, for 3 minutes.

3. Drain the rice marinade.

4. Put the rice into the steamer, steam for 30 minutes, remove from heat.

5. Ready to serve.

Table 2. Materials used in processing various rice in Engineering III

No	Nama Bahan	Jumlah
<b>Steam Rice</b>		
1.	Rice <i>analog</i>	100 g
2.	Warm water	300 ml
3.	Butter	10 g
<b>Savory Rice</b>		
1.	Rice <i>analog</i>	100 g
2.	Coconut milk	300 ml
3.	Salt	5 g
4.	Lemon leave	1 g
5.	Lemon grass	5 g
6.	Pandan leave	2 g
7.	Coriander	1 g
<b>Fried Rice</b>		
1.	Rice <i>analog</i>	300 g
2.	Carrot	75 g
3.	Sweet corn	50 g
4.	Bean	25 g
5.	Butter	20 g
6.	Red Chili	30 g
7.	Shallot	20 g
8.	Garlic	15 g
9.	Shrimp paste	2 g
10.	Salt	5 g
11.	Pepper	1 g
12.	Soy sauce	10 ml
13.	Sesame oil	5 ml

The finished rice in stage III is evaluated after steaming is as follows: The texture of the rice produced is soft, because during the cooking process it is soaked with warm water and butter is added. The grains are whole and a little sticky, because butter is added during the soaking process. The color of the resulting rice changes, from the color of the rice before it is processed ie yellow, after being cooked to brownish yellow. The resulting flavour has a neutral flavour.

How to cook savory rice:

1. Heat the coconut milk and add all the spices, stir until boiling.
2. Wash rice in a container with running water twice, then soak the rice with seasoned coconut milk liquid, for 3 minutes.
3. Put the analog rice into the steamer, steam for 30 minutes, remove from heat.

4. Ready to serve.

The results of savory rice

The results become savory rice are as follows: Soft texture, because during the cooking process soaked with coconut milk. Whole grains and not sticky, because it uses liquid coconut milk during the immersion process. The resulting color changes, from the color of rice before being processed ie yellow, after being cooked to brownish yellow. The flavour and taste of savory rice.

How to process fried rice:

1. The initial process is like cooking steamed rice, then processed into fried rice.
2. Blend all seasoning
3. Saute seasoning, then add rice from analog rice
4. Taste the taste
5. Ready to serve

Results of fried rice processing

The results become fried rice: Soft texture. Rice grains are whole and not sticky, because butter is added during the soaking process. The color of the resulting rice changes, from the color of the rice before it is processed ie yellow, after being cooked red, because the fried rice seasoning uses red chili. The flavour of rice produced has a delicious flavour of fried rice seasoning.

Data collection was carried out by means of observation through organoleptic tests. The purpose of the organoleptic

test is to assess the results of finished analog rice along with its preparations, in terms of the panelists' preference level which includes the appearance, texture, grain, color, flavour and taste aspects of the 20 trained and semi-trained panelists. The assessment of each aspect is divided into 4 levels of liking which include: (1) Likes, (2) Enough or Quite likes, (3) Rather likes, and (4) Do not likes. The data analysis technique used is quantitative descriptive technique with a percentage.

III. RESULTS AND DISCUSSION

A. Rice Analog

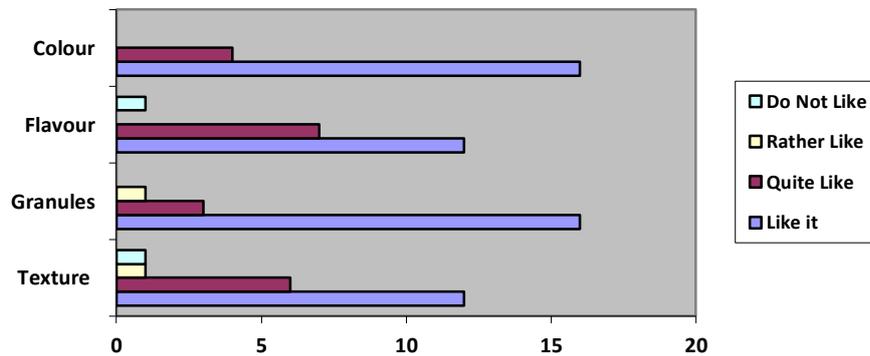


Figure 6. Preferred Assessment Criteria Results of the Rice Analog

The results of the panelist preference test on the texture of rice analog turned out to be like the texture of the rice, because the rice has a hard texture (not brittle), which is due to the nature of cassava starch when exposed to moist heat will form a gel, and when dry analog rice will harden because of the starch contained amylose which gives hard properties [19].

The results of the favorite test assessment of analog rice granules turned out to be a panelist who liked the rice grains, because analog rice had whole grains, was uniform and not fragile. Whole grains of rice because during the process of making there is no addition of liquid at all so that the dough is not soft, so that the dough is easy to form. Water absorption is one of the factors affecting rice quality. The ingredients used are cassava puree and soybeans. Pure is a cooked food material that is mashed so that it still contains water.

The results of the assessment of the preference test for the aroma of analog rice turned out to be less like panelists, because it has a slightly unpleasant aroma. The aroma of rice is unpleasant because in soybeans there is a lipoxidase enzyme that causes the flavour of rice to be unpleasant. Lipoxidase enzymes react with fat when the cell wall is broken by grinding, especially if the grinding is done wet in cold temperatures, the pH of the lipoxidase enzyme is easily damaged by heat [20].

The results of the test of preference for analog rice color turned out to be like the panelists. The color of analog rice was cream yellow, because the type of cassava used was yellow cassava and soybean used brownish, when mixing the dough the color turns yellow to slightly brown, after drying the cream yellow dough. because when the dough is dried, it already has no water content which makes the color of the soybean brown.

**B. Steamed Rice**

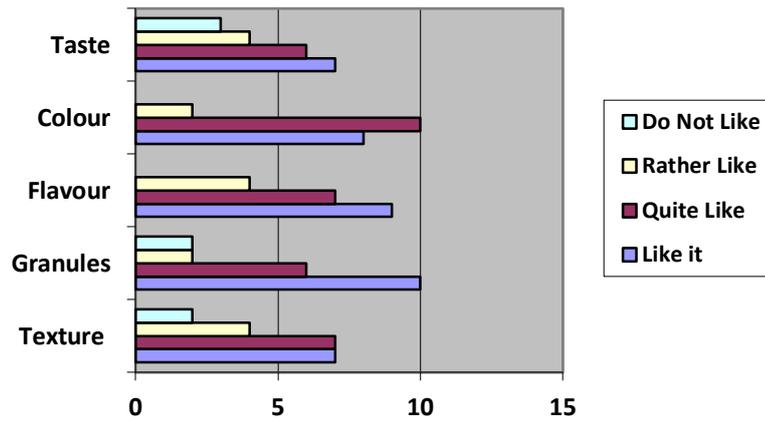


Figure 7. Preferred Assessment Criteria Results of Steamed Rice

The results of the favorite test assessment about the texture of rice from analog rice turned out to be panelists less or rather like the texture of rice from analog rice, because rice has a rather hard texture, hard on rice because soybeans have a hard texture and soaking the rice before it was steamed too short. As research [21] that the best product was using 20% soybeans. In this study using 17% soy puree The results of the panelists' preference test for rice grains from analog rice turned out to be quite favorable for the panelists, because rice from analog rice had rather sticky granules, clumping of rice occurred because of the nature of starch on cassava material if steamed (heated) gelatinization would occur, so that the rice would become sticky/clot [19]. The results of the assessment of the preference test on the flavour and color of rice from analog rice turned out to be less like panelists, because rice from analog rice had a slight unpleasant flavour, the unpleasant flavour was caused by the lipoxidase substances found in soybeans [17]. Increasing the amount of soybean causes brownish color to rice and analog rice. Processing analog rice with high temperatures encourages Maillard's reaction between protein in soybeans and reducing sugars from cassava so that the rice or rice becomes brownish [22]. Similar results also occurred in glutinous rice [23]. All analog rice was less

yellow, presumably due to the addition of cassava in the formula [21].

The results of the assessment of the preference test for the taste of rice from analog rice turned out to be less or rather like panelists, because rice from analog rice has a slight unpleasant taste, unpleasant taste from rice because in soybeans contained lipoxidase which causes unpleasant taste. The lipoxidase enzyme reacts with fat when the cell wall is broken by grinding, especially if the grinding is done wet in cold temperatures, the lipoxidase enzyme is easily damaged by heat [19]. The high protein content in soybean contributes to the increase in final protein content of rice and rice analog. However, too much protein in the dough combined with high temperature processing will produce a Maillard reaction which results in an undesirable taste of the final product [22].

**C. Savory Rice**

The results of the assessment of preference tests on the texture of savory rice from The results of the assessment of preference tests on the texture of savory rice from rice analog turned out to be quite like it, because savory rice has a slightly soft texture. The hard texture of savory rice because the use of soybean material is not peeled, so the epidermis of soybean affects the hard texture of savory rice.

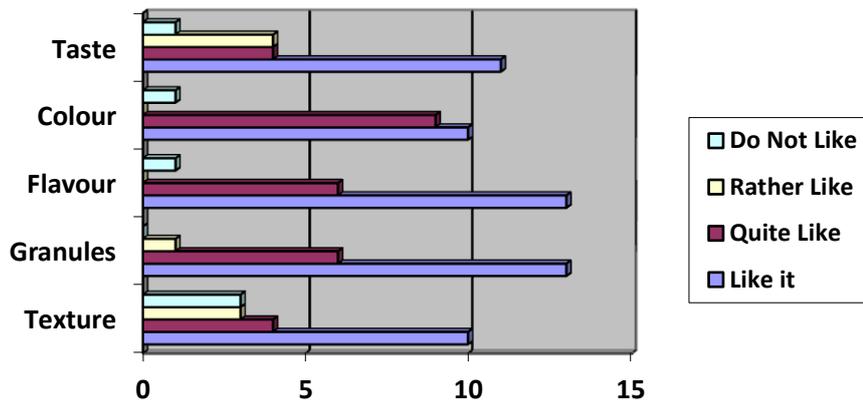


Figure 8. Preferred Assessment Criteria Results of Savoury Rice

Organoleptic test results on savory rice grains from analog rice turned out to be panelists like, because savory rice grains from analog rice have a whole texture not lumpy or destroyed, because the cooking process uses coconut milk, coconut milk has fat content, including the nature of fat is slippery so that rice not sticky.

The results of the assessment of the preference test for the flavour of savory rice from rice analog turned out to be panelists like, because the flavour of savory rice from analog rice had a savory flavour. The savory flavour is obtained from coconut milk and the combination of herbs and spices used. The spices that make savory flavour are from orange leaves, pandan leaves and coriander, so that the savory rice flavour becomes savory from the combination of spices and coconut milk.

Organoleptic test results about the color of savory rice from analog rice turned out to be panelists said they did not like it, because the color of savory rice from analog rice was brown, brown color from savory rice, due to the browning

process of soybeans and the use of coconut milk where coconut milk contains fat that could cause discoloration.

Organoleptic test results about the taste of savory rice from rice analog turned out to be quite like the panelists, because savory rice has a savory taste, the taste of the rice becomes savory because in cooking this savory rice uses coconut milk and the use of herbs and spices. Savory taste obtained from a combination of coriander, orange leaves and coconut milk.

**D. Fried Rice**

The results of the assessment of preference test on the texture of fried rice from rice analog turned out to be less like, because fried rice has a rather hard texture, because the nature of starch gelatinized when heated and the protein will harden if exposed to heat. Another factor that causes the texture of hard rice is a fairly short soaking process [19].

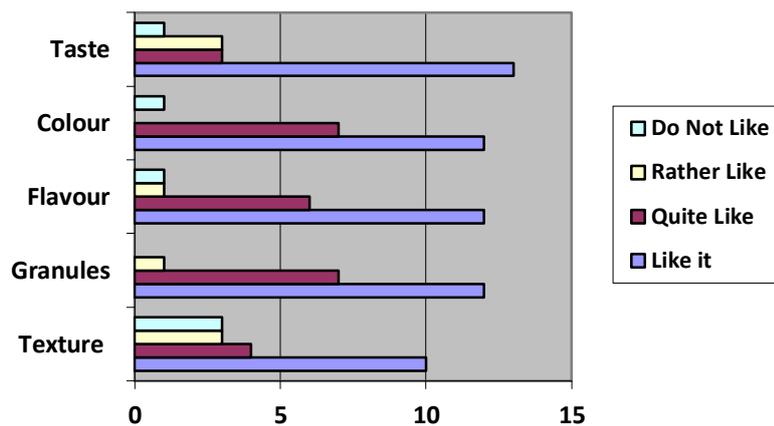


Figure 9. Preferred Assessment Criteria Results of Fried Rice

The result of the assessment of the preference test for fried rice granules from rice analog turned out to be a panelist

like, because fried rice has a non-sticky texture and is not destroyed, because in the process of cooking spices using

margarine, the nature of the margarine contains fat and fat properties namely slippery, so that the rice is not sticky .

The results of the assessment of the preference test for the flavour of fried rice from rice analog turned out to be panelists like, because fried rice has a pleasant flavour, delicious flavour from fried rice that is obtained from various types of seasonings, from a combination of onion seasoning, sweet soy garlic and a distinctive aroma from Sesame oil.

It can be concluded that 60% of panelists said they liked the color of fried rice from rice analog, based on the results of the organoleptic test assessment of the color of fried rice from rice analog, it turned out that the panelists liked, the color of fried rice was brownish red, because the fried rice seasoning used red chili which is red chili there are

carotenoids that produce red and brown colors from soy sauce.

The results of the assessment of the preference test for the taste of fried rice from rice analog turned out to be panelists saying they liked it, because fried rice had a delicious taste. The delicious taste of fried rice is available from herbs and spices in its manufacture. Delicious obtained from the combination of onion and garlic seasoning that makes a savory taste in combination with the typical taste of sesame oil and soy sauce so that the taste becomes delicious.

**E. Nutritional content of Rice Analog**

The composition of the nutritional content per 100g of rice from rice analog was higher than the nutritional content of white rice.

Table 3. Nutritional content per 100 g of Rice Analog and White Rice

Component	Unit	Rice Analog	White Rice
Energy	Kal	460.4	357
Protein	g	18	8.4
Fat	g	7.28	1.7
carbohydrates	g	83.56	77.1
Calcium	mg	242.8	147
Phosfor	mg	320.8	81
Iron	mg	6.2	-
Fiber	g	3.08	-
Thiamin	mg	-	0.2

From 100 g of rice from rice analog, if cooked rice will produce 200 g of rice from rice analog so that the nutrient content of rice analog per 100g is known, as shown in Table 4.

Table 4 Nutritional content per 100g Steam of Rice Analog and White Rice

Component	Unit	Steamed Rice Analog Cooked	Steamed White Rice Cooked
Energy	Kal	230.2	180
Protein	g	9	3
Fat	g	3.64	0.3
Carbohidrat	g	41.78	39.8
Calcium	mg	121.4	25
Phosfor	mg	160.4	27
Iron	mg	3.1	0.4
Fiber	g	1.54	0.2

The composition of the nutritional content of rice analog was higher, compared to the composition of white rice.

#### IV. CONCLUSION

1. The level of preference for rice analog, is as follows: 60% of panelists said they liked texture and flavour, 80% of panelists expressed their liking for grains and colors. Processing analog rice into rice in the aspect of texture and taste is preferred by 35% of panelists, in grains is preferred by 50% of panelists, in the flavour aspect is preferred by 45% of panelists, and in the color aspect is preferred by 40% panelists. The level of preference for savory rice analog rice, is as follows: 50% of panelists said they liked the texture, 65% of panelists said they liked granules and texture, 60% of panelists said they liked the color, 40% of the panelists said they liked the taste. The level of preference for analog rice fried rice, is as follows: 50% of panelists said they liked the texture, 60% of panelists said they liked granules, flavour and color, 65% of panelists said they liked the taste. So rice analog and processed rice can be accepted by panelists and suitable for consumption.
2. Engineered analog rice per 100g has the following nutritional content: energy 230.2 cal, protein 9 g, fat 3.64 g, carbohydrates 41.78 g, calcium 121.4 mg, phosphor 160.4 mg, iron 3.1 mg, and fiber 1.54 g.

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