Formulation of Analog Rice Made of White Corn *(Zea mays Ceratina)* and Mung Beans *(Vigna radiata L)* Flour as an Alternative Food in Maintaning a Complete Nutrition

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Abstract: Rice has been the only staple food for the majority of Indonesian. The demand for rice is increasing yearly as population growth. One alternative in achieving national food security is by food diversification. The aim of this study was to formulate an alternative food source as analog rice made of white corn and mung beans to improve nutrition in rice. The specific objective of this study was to obtain physical characteristics and the best formulation as well as chemical analysis of the best of analog rice formulated. This research was carried out in two stages. The first stage was to obtain the best formulation of physical analysis and sensory analysis of analog rice. These formulations were evaluated for sensory characteristic using hedonic method. The physical analysis was also conducted for these formulations. The results obtained in the first stage were physical analysis of bulk density, water absorption, swelling power and cooking time compared to rice which ranged from 0.571 to 0.790 (g/ ml), 33.3 to 63.9%, 8, 1-34.7%, and the cooking time was faster than ordinary rice which was ± 3 minutes. The best formulation based on sensory evaluation was analog rice produced from a ratio of 50% white corn and 50% mung beans. The chemical profile of the analogue rice was 8.4% of water content, 1.6% of ash content, 13.6% of protein, 1.3% of fat, 75.1% of carbohydrate, 5.7% of food fiber, 376 kcal of calories, 5.1 mg/100 g of iron, and, 0.57 mg/100 g vitamin B1.

1 INTRODUCTION

One of the basic needs for human life is food needs. Even though Indonesia has a diversity of local non-rice food sources that can be used as an alternative staple food to obtain a diversity of nutritional sources for the community. Public culture of eating rice as a staple food is difficult to change, so the need for rice becomes greater from year to year in accordance with population growth. One alternative in achieving food security through food diversification.

The population is relatively high with the need for national rice consumption reaching 2.3-2.4 million tons per month, the availability of rice reserves is crucial, leading to ongoing polemic in which some parties claim rice reserves are sufficient and some are inadequate. Meanwhile, the rice stock in Bulog is less than 10% of the total national needs. National rice consumption is around 33 million tons per year in 2018. The level of rice consumption will continue to increase along with population growth (Purwanto, 2018).

This needs to be diversified by utilizing local food sources such as white corn and green beans. The choice of corn in addition to carbohydrate sources, also has high food fiber and contains vitamins and various essential minerals (Noviasari et al., 2017). This needs to be done by combining white corn with nuts to obtain protein intake. Therefore, efforts are needed to develop white corn and green beans as an alternative to food diversification.

Efforts to implement food diversification are needed to attract public interest, one of them by processing food into analog rice. Analog rice is rice made from non paddy made from local flour (Widara, 2012). Based on that, the aim of this research is to prepare alternative food sources to support the supply of complete nutrition in the form of analog rice from white corn and green beans based on the best formulation. The existence of analog rice based on white corn and green beans is expected to be a source of food diversification and support the provision of high nutrition.

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2 MATERIALS AND METHOD

2.1 Materials

The materials used in this study include the main ingredients of waxy corn, green beans, rice and glycerol monostearate (GMS). Analysis materials include distilled water, HCl 0.1, thiamine, NaOH, petroleum benzene, H_2SO_4, H_3BO_3, HNO_3, phenoptalein indicators and other supporting materials such as aluminum foil and whatman filter paper No. 41.

2.2 Formulation and Production of Analog Rice

In this stage, white corn was sorted. Furthermore, washed and then dried using oven blower. After that, it was milled using disc mill and white corn flour was produced (Suarni, 2009). For to making mung bean flour, mung beans was sorted and soaked for 4 hours, then washed and dried. After that, it was milled using disc mill and produced mung bean flour. (Nurcahyani, 2016). All flours were then mix stage, then 40% water and 2% GMS were added. The next, process was extrusion the dough in extruder at 85 °C until the grains were formed. After drying the analog rice was weighed and packaged (Budi et al., 2013).

Table 1: Analog Rice formulation.

White Corn Flour (%)	Mung Bean Flour (%)
90	10
80	20
70	30
60	40
50	50

2.3 Physicochemical Analysis

This research was divided into two stages. The first stage was the analysis of physical properties of analog rice including bulk density, swelling power, water absorption, and cooking time. Furthermore, analog rice was sensory analyzed to obtained the best formulation. Formulation for making analog rice can be seen in Table 1. To the second stage of research was the analysis of chemical properties of analog rice after obtaining the best formulation from first stage. The analysis was including proximate, dietary fiber, calories, vitamin B1and iron.

2.4 Statistical Analysis

The data obtained were processed using a completely randomized design method (CRD) with three replications. The analysis of variance was carried out to determine whether there were differences in the tested variables, in this case the physical analysis of analog rice with conventional rice and sensory analysis of analog rice. All parameters were analyzed by analysis of variance (ANOVA) with three replications. The differences for each treatment were further tested using the Duncan test. The software used for data processing is Microsoft Excel 2010 and SPSS version 16.

3 RESULT DISCUSSION

3.1 Bulk Density

Density is the specific gravity of the dry product, which is calculated based on its weight in a container. Based on statistical data, the bulk density has a very significant effect on several treatments (P> 0.01). The results of the analysis of the density of rice cages were showed in Figure 1.

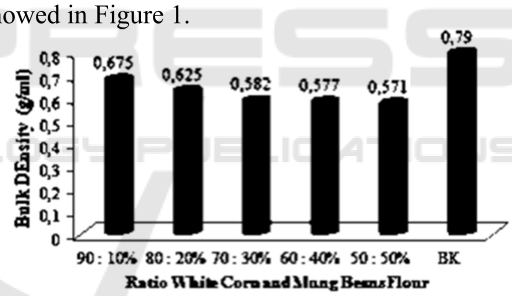

Figure 1: Comparison of Bulk Density of Analog Rice and Conventional Rice (BK, Conventional Rice).

Figure 1 showed bulk density value of analog rice from white corn and mung beans. Analog rice has smaller value than conventional rice. Based on these data, analog rice (90%:10%) has a greater bulk density than other analog rice. This showed that the porosity of the analog rice was lower, where the porosity of the analog rice was influenced by the process of rice grain formation and drying. The drying process resulted in water loss in rice. In addition, due to high water content will cause the weight of the material measured was greater. This caused the amount of density possessed was even greater. This was in accordance with the opinion of Hanifa (2016) which stated that high water content caused particles in rice become heavier and the drying process caused analog rice lose water.

3.2 Swelling Power

Swelling power is the swelling power of a material when absorbing water. Based on statistical data, the development power has a very significant effect on several treatments (P> 0.01). The results of the analysis of rice swelling power can be seen in Figure 2.

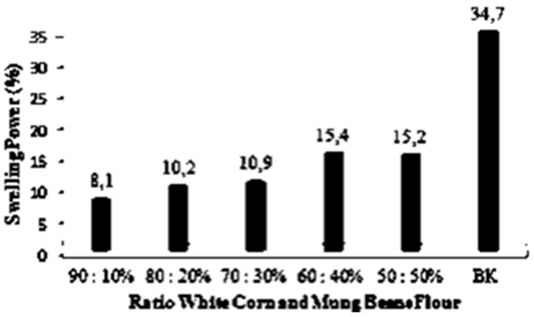

Figure 2: Comparison of Swelling Power between Analog Rice and Conventional Rice (BK, Conventional Rice).

Figure 2 showed that soaking of analog rice resulting in changes in diameter that become larger. The change occurred because of the entry of water into the rice analog granule. Based on the data obtained it could see that conventional rice was higher than analog rice. This was influenced by the presence of glycerol monostearate binder in analog rice thereby reducing the swelling of analog rice. In addition, high levels of analog rice fat thus preventing an increase in the amount of starch granules. This is in accordance with the opinion of Subagio (2012) which stated that the power of swelling was influenced by fat levels high enough to prevent an increase in the amount of starch granules.

3.3 Water Absorption

Water absorption is the ability of a material to absorb or bind water. Based on statistical data, it showed that water absorption was very significant on several treatments (P> 0.01). The results of the analysis of rice water absorption can be seen in Figure 3.

Figure 3 showed that the water absorption rate in conventional rice was relatively low compared to analog rice treatment. The highest water absorption rate obtained by treatment (50%:50%) was 63.9% and the lowest in treatment (90%:10%) was 33.3%. It was suspected that the starch content in mung beans flour was high enough to produce higher water absorption. In addition, the fiber content in these materials has high water absorption because of the large size of the polymer and contained a lot of hydroxyl groups so that it could bind large amounts of water. This was consistent with Harper's opinion in Ginting (2007) which stated that the levels of mung bean starch were relatively high. Also supported by Mulyani (2017) which stated that fiber content could increase water absorption.

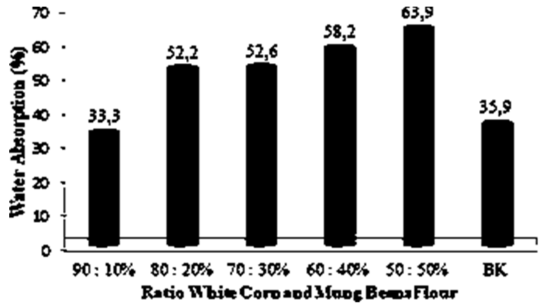

Figure 3: Comparison of Water Absorption between Analog Rice and Conventional Rice (BK, Conventional Rice).

3.4 Cooking Time

Cooking is one of the physical parameters of analog rice. The results of cooking time data in several treatments can be seen in Figure 4.

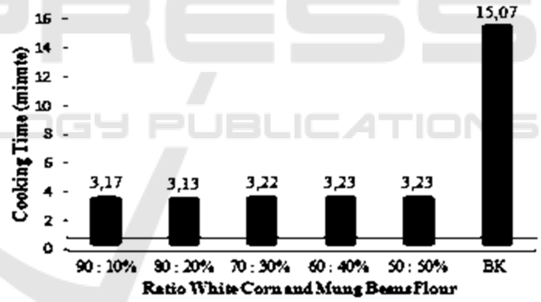

Figure 4: Comparison of Cooking Time between Analog Rice and Conventional Rice (BK, Conventional Rice).

Figure 4 showed that the cooking time of analog rice from several treatments ranged from ± 3 minutes while conventional rice is around ± 15 minutes. This indicated that analog rice has a shorter time because analog rice has gone through several stages in the cooking process. In addition, white corn flour and mung beans have high levels of starch and fiber compared to gelatinization so easy to cooked quickly. This was in accordance with the opinion of Noviasari (2017) which stated that cooking time is influenced by the concentration of added flour and analog rice will be easy to gelatinization faster than ordinary rice.

3.5 Chemical Analysis

Table 2: Chemical Characteristics of Analog Rice and Conventional Rice.

Characteristic Chemical	Analog Rice	Ordinary Rice
Water Content (%)	8,4	13,99
Ash Content (%)	1,6	0,8
Protein (%)	13,6	7,1
Fat Content (%)	1,3	0,7
Carbohydrate (%)	75,1	79
Dietary Fiber (%)	5,7	0,5
Calories (Kcal)	376	360
Iron (mg/100 g)	5,1	1,3
Vit B1 (mg/100 g)	0,57	0,10

3.5.1 Water Content

Water content is one important component. Based on the results of the study, analog rice with a ratio of 50% white corn flour and 50% mung bean flour has a moisture content of 8.4% while conventional rice is 13.99%. Water content of white corn flour and green beans is lower than conventional rice water content. This is because analog rice experienced a cooking process in the extruder and drying with an oven so that analog rice experienced a great loss of water content. This was in accordance with the opinion of Hanifa (2016) which stated that analog rice experiences a cooking process in the extruder and drying it with an oven so that analog rice experiences a large loss of water content of analog rice was lower than conventional rice.

3.5.2 Ash Content

Ash content is a mixture of inorganic and mineral content in a material. Based on the results of research, the analog ash content of rice was higher compared to conventional rice. Analog rice ash content was 1.6% while conventional ash content was 0.8%. Ash content indicated the amount of mineral content in an ingredient. Mung beans have high mineral content because the calcium content of green beans is around 223 mg and phosphorus 319 mg. This showed that the analog rice produced contained quite high minerals. This was in accordance with the opinion of Sediaoetama in Mamuaja (2015) which stated that the higher ash content of a food indicated the higher minerals content in the food.

3.5.3 Protein

Protein is one of the macro-molecular components needed by the body. Based on the results of the study, the levels of analog rice were higher than those of conventional rice. Analog rice protein content was 13.6% while conventional rice was 7.1%. This showed that analog rice can meet protein needs in the body because analog rice was influenced by the addition of green beans which have high protein content. This was in accordance with the opinion of Yusuf (2014) which stated that green beans have a protein content of around 22%.

3.5.4 Fat Content

Fat is an organic component that has hydrophobic properties and can function as shortening. Based on the results of research, analog rice fat content was quite higher compared to conventional rice. Analog rice fat content was 1.3% while conventional rice was 0.7%. This was influenced by the high concentration of white corn in analog rice which has a high enough fat content which is around 3.9 grams and green beans have fat content around 1.2 grams. This was consistent with the opinion of Suarni (2007) which states that white corn has a high fat content ranging from 3-8%.

3.5.5 Carbohydrate

Carbohydrates are the main source of energy needed by the body. Based on the results of the study, carbohydrate content of analog rice and conventional rice was almost equivalent, namely 75.1% and 79%. This was due to the high carbohydrate commodities used namely white corn and mung beans. It was consistent with the opinion of Suarni (2007) which stated that the carbohydrate content of white corn was around 74% which is a source of energy needed by the body. Also supported by the opinion of Yusuf (2014) which stated that mung bean is a type of legume that has a fairly high carbohydrate range of 63%.

3.5.6 Food Fiber

Dietary fiber is an important component of plant foods in the human digestive system. Based on the results of the study, the content of analog rice fiber was higher than that of ordinary rice namely 5.7% and 0.4%. This showed that white corn and mung beans were high-fiber commodity while conventional rice fiber which contained in rice shells that was lost during milling so that white rice contained low food fiber. Fiber is known to delay the process of emptying the stomach thereby reducing the rate of digestion in the intestine. This was consistent with the opinion of Yusuf (2014) which stated that mung beans have fiber content of around 4% which was included as a source of fiber.

3.5.7 Calories

Calories are units used to measure the value of energy obtained by the body. Based on research results, analog rice has a calorie value of 376 kcal while conventional rice was 360 kcal. This showed that the calorie value of analog rice was higher than the calorific value of conventional rice because the protein and fat content of conventional rice were still relatively low than analog rice. The calorie value based on rough calculation was influenced by the amount of protein, fat and carbohydrate.

3.5.8 Iron

Iron (Fe) was a micronutrient that was needed by the body. Based on research results, analog rice has iron content of 5.7 mg/100 gram while conventional rice was 1.3 mg/100 gram. Based on this iron content of analog rice is higher than that of conventional rice due to the ingredients contained in the analog rice itself. Mung beans have iron levels 7.4 mg/100 grams, this indicated that analog rice can meet iron needs for the body. This was in accordance with the opinion by Yusuf (2014) which stated that the iron content of mung beans is 7.4 mg/100 grams which was able to increase the need for iron for the body.

3.5.9 Vitamin B1

Vitamin B1 or thiamine is one that is needed to cause appetite and help the use of carbohydrates in the body (Almatsier, 2009). Based on the results of the study, analog rice has a vitamin B1 level of 0.57 mg/100 gram while conventional rice was 0.10 mg/100 gram. According to this the vitamin B1 content of analog rice was higher than that of conventional rice due to the ingredients contained in the analog rice itself. Mung beans contained vitamin B1 around 0.64 mg/kg which was useful for growth. This was consistent with the opinion of Ruslie (2012) which stated that the daily intake of vitamin B1 for adults was 1.2 mg/day while for children aged 1-8 years around 0.6 mg/day and ages 9-13 years around 0,9 mg/day.

4 CONCLUSION

Analog rice made from white corn and mung beans can be made as an alternative staple food. Physical analysis of analog rice was around 0.571-0.790 (g/ml) bulk density, swelling power 8.1-34.7%, water absorption 33.3-63.9% and analog rice cooking time around ± 3 minutes while rice conventional range ± 15 minutes. The chemical profile of analog rice produced from the ratio of 50% white corn and 50% mung beans were 8.4% moisture content, 1.6% ash content, 13.6% protein, 1.3% fat, 75 carbohydrates, 1%, food fiber 5.7%, calories 376 kcal, iron 5.1 mg/100 g, vitamin B1 0.57 mg/100 g.

REFERENCES

Almatsier. 2009. *Basic Principles of Nutrition.* PT. Gramedia Pustaka Utama: Jakarta

Budi FS, P Hariyadi, S Budijanto, and D Syaha. 2013. Extrusion Process Technology to Make Analog Rice. *IPB Food Magazine,* 22 (23), pp. 263–275. doi: 10.1021/cm050787y

Ginting E, Ratnaningsih, and R Iswanto. 2007. Physical and Chemical Characteristics 17 Genotypes of Mung Beans for Food Materials. Pp. 451-466

Hanifa N. 2016. *Development of Purple Sweet Potato Analogous Rice as Functional Food with High Fiber and Rich in Polyphenols*. Bogor Agricultural Institute.

Mamuaja CF and Y Lamaega. 2015. Analogous Rice Making from Cassava, Goroho Banana And Sago. *Journal of Food Science and Technology,* 3 (2): 8-14

Mulyani W, N Harun and Y Zalfiatri. 2017. Utilization of Red Bean Flour and Sago Starch in Making Crackers. *Jom Faperta,* 4 (1): 1-12

Noviasari S, F Kusnandar, and A Setiyono. 2017. Physical, Chemical, and Sensory Characteristics of Analog Rice Based on Non-Rice Food Ingredients. *Food Journal,* 6 (1): 1–12.

Nurcahyani R. 2016. *Experiments on Making Green Beans Flour Cookies with Banana Weevil Substitution.* Semarang State University: Semarang [Thesis]

Purwanto NP. 2018. Availability of National Rice Supply and Distribution. *Research and Development Center,* 10 (18), pp. 19–24.

Ruslie RH. 2012. The Role of Vitamins as Nutrition in Premature Babies. *Journal of Health,* 4 (1): 97-111

Suarni. 2009. Prospects of Using Corn Flour for Cookies (Cookies). *Journal of Agricultural Research,* 2 (28), pp. 63–71.

Subagio A and W Windrati. 2012. Effect of MOCAF (Modified Cassava Flour) Composition and Rice Flour on Characteristics of Smart Rice. *Journal of Food,* 21 (1): 29-38

Widara SS. 2012. *Study of Rice Analogue Production from Various Carbohydrate Sources Using Hot Extrusion.* Bogor Agricultural Institute. [Thesis]

Yusuf. 2014. The use of green beans as functional food supports food diversification in East Nusa Tenggara. *Proceedings of the Seminar on the Results of Research on Assorted Nuts and Tubers,* pp. 741–746