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**Research Article**

# THE EFFECT OF STEAMING DURATION ON NUTRITION COMPOSITION, GLYCEMIC INDEX AND LOAD OF ANALOG RICE FROM NATURAL PRODUCTS EAST KALIMANTAN

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**ABSTRACT**

The development of analog rice is a way to ensure that there is adequate food in Indonesia through food diversification. This research is aimed at determining the effect of steaming duration on nutrition composition, glycemic index and glycemic load of analog rice. The analog rice produced is based on natural products from east Kalimantan which comprises of modified cassava flour, excrescence banana flour and mayas rice flour. This research used non factorial completely randomized design with 6 treatments intervals (0 minute, 2 minute, 4 minute, 6 minute, 8 minute and 10 minute) and 3 repetitions. Data were analyzed using analysis of variance. The best treatment was found in analog rice with a steaming duration of 10 minutes. The result showed the water content to be 5,04%, the ash content 1,49%, the protein content 22,54%, the fat content 4,67%, the carbohydrate level 65,45%, the energy level 394,04 kcal, while the hedonic color, texture, aroma and taste remains neutral. The Glycemic index and glycemic load obtained are 61 (medium criteria) and 40 (high criteria) respectively.



## INTRODUCTION

One of the ambitions the government is looking to accomplish is the establishment of food sovereignty and guaranteeing food security through enhancing local production. As a result, food diversification is required to ensure a desirable impact on public health. Analog rice with minimal glycemic index is an instance of food diversification providing benefits to prevent diabetics.The results from a research, it was depicted that there were number of times when cassava was being put to use as the primary food ingredient, particularly when there is a limitation in the consumption of rice being exerted by the society to promote endurance foods like corn and varieties of tubers. Cassava substitute are being used as food or ingredients in the form of cassava or namit jabau granules commonly by the Dayak people of the West Kutai Regency in the Indonesian province of East Kalimantan. East Kalimantan has various local foodstuffs which can be utilized as alternative sources for food (Saragih, 2017). East Kalimantan's indigenous foodstuffs are cassava, banana, and mayas rice (Saragih *et al*., 2013). These three local produces can be processed into flour which is the primary ingredient for manufacturing MONGGOMAS analog rice (Mocaf Flour, Banana and Mayas Rice). This idea is in accordance with the visions of the Food Crops Service of the East Kalimantan Province, which is to engage in a well-developed food crop and horticultural agribusiness based on local benefits.

This study is basically about the preparation, as well as the quality and glycemic index of banana flour and major rice flour. In this study, we will be adopting the steaming method for the MONGGOMAS analog rice as an effort towards developing previously conducted researches. The steaming technique is carried out in the form of gelatinization on analog rice to produce a suitable texture for the rice while being careful to ensure the rice is not over cooked into becoming porridge. When making analog rice with tofu flour as the major ingredient, mocaf flour and cornstarch are being steamed for 10 minutes with a temperature of 90 ± 5°C (Yuwono *et al*., 2013). Meanwhile, for preparing analog rice made from sago starch and red bean flour, it is required for the steaming process to last for duration of 15 minutes (Wahjuningsih, *et al*., 2016). The background of this research is to examine the long-term effect steaming method is having on the nutritional composition, index and glycemic load of analog rice MONGGOMAS (MOcaf flour, boGGGOl banana and MAyaS rice).

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**Table 1** Effect of steaming time on MONGGOMAS analog rice nutrition

| Nutrition | Steaming time (minutes) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | 8 | 10 |
| Water (%) | 7,25±0,14a | 7,28±0,15a | 6,85±0,12b | 5,53±0,21c | 5,33±0,07cd | 5,04±0,04d |
| Ash (%) | 1,58±0,002a | 1,54±0,003b | 1,52±0,001c | 1,51±0,004c | 1,50±0,003d | 1,49±0,002e |
| Protein (%) | 11,16±1,23a | 15,10±0,43b | 17,14±0,66b | 19,77±1,10c | 21,37±0,50cd | 22,54±0,87d |
| Fat (%) | 9,60±0,02a | 9,16±0,04b | 7,99±0,02c | 6,43±0,04d | 5,49±0,01e | 4,67±0,02f |
| Carbohydrat (%) | 70,44±1,35a | 66,64±0,19b | 66,15±0,37b | 66,71±0,28b | 66,2±0,20b | 65,45±0,10b |
| Energy (Kcal) | 412,99±0,62a | 409,47±1,15ab | 405,19±1,89abc | 403,89±4,95bc | 399,74±2,04cd | 394,04±3,37d |

- The number followed by the same letter on the same line shows a non-significant difference in the level of α 5%.

**Table 2** Effect of steaming time on MONGGOMAS analog rice sensory properties

| Sensory Properties | Steaming time (minutes) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | 8 | 10 |
| Color | 3,69±1,37a | 4,22±1,33ab | 4,44±1,31bcd | 4,32±1,34abc | 4,86±1,26bcde | 5,16±1,26e |
| Aroma | 4,00±1,39a | 4,24±1,25abc | 4,21±1,34ab | 4,41±1,42abcd | 4,46±1,30abcde | 4,80±1,39bcde |
| Texture | 3,97±1,34a | 4,22±1,19ab | 4,54±1,21abc | 4,58±1,15abcd | 5,06±0,97cde | 5,01±1,2cde |
| Taste | 4,34±1,22ab | 4,21±1,24a | 4,58±1,11abc | 4,64±1,24abcd | 4,93±1,10cde | 4,88±1,21bcde |

Information
- Hedonic test value:
1-7 (Very dislikes, Dislikes, Ordinary, and Neutral, Somewhat likes, likes and likes very much)
- The number followed by the same letter on the same line shows a non-significant difference in the level of α 5%.

## METHODS

### *Research Materials*

The ingredients put to use for the production of analog rice are: fresh kepok banana cobs collected from Lempake area, white rice purchased from traditional markets in Samarinda, mocaf flour from BPTP (Institute of Agricultural Technology Assessment) Samarinda, and Autocheck AD03025847 MDSSGmbH (Germany).

### *Experiment Design*

The experimental design employed in this study is a completely randomized design (CRD) single factor with 6 treatments and 3 repetitions. The variable in the treatments in this study was the steaming length. The steaming durations were: P0 = 0 minutes, P1 = 2 minutes, P2 = 4 minutes, P3 = 6 minutes, P4 = 8 minutes, P5 = 10 minutes. Some parameters were also put to test in this study, and these parameters were: water content, ash content, fat content, protein content (Sudarmadji *et al*., 2010), carbohydrate levels[9] and energy levels (AOAC, 2005). Organoleptic tests were also performed, and they included color, aroma, texture and taste. In addition, other executed tests were glycemic index test (Miller *et al*., 1996; Saragih *et al*., 2013)). and glycemic load (Passos *et al*., 2015). The collected data is initially processed with variance to determine if a significant difference exists in the level of α 5%, and then followed by a test of honest difference.

## RESULTS

### *Nutrition*

The results obtained from the variance test established that the old method of steaming had a significant effect on the moisture, water content,ash, fat, carbohydrate and energy of the MONGGOMAS analog rice (Table 1).

### *Sensory Properties*

The variance based on the results, shows that the steaming treatment of MONGGOMAS analog rice has a significant effect on the all sensory properties of the end product (Table 2).

### *Glycemic index and load*

The responses from the results on blood glucose of those who consumes MONGGOMAS analog rice are presented in the following figure. Based on the results from the above glycemic response, in 0 minutes, the blood sugar of the respondents before consuming MONGGOMAS analog rice is 95.7 m /dL. In the 30th minute it increased to 128.7 mg / dL, and then in the 60th minute there was a decrease to 98.2 mg / dL and a decrease thereafter in the 90th minute to 86.2 mg / dL and in 120 minutes to 77.7 mg / dL. The blood glucose level as seen in the 120th minute became lower than the levels in the 0th minute.

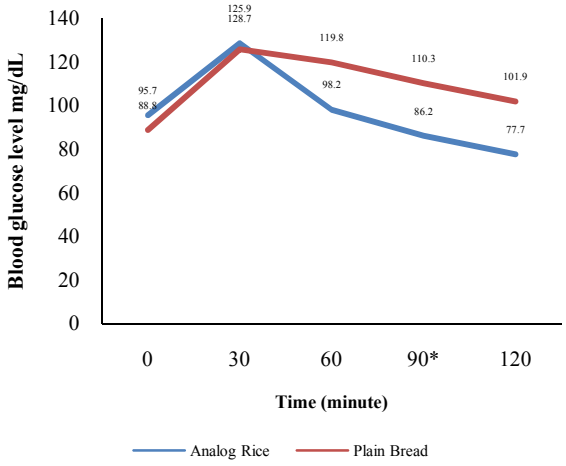


**Figure 1** Graph of Respondents' Blood Glucose Response after Consuming Analog Rice and Plain Bread

## DISCUSSION

***Nutrition***

The most efficient old steaming technique held 5.04% moisture content. The water content of analog rice is regulated by evaporation in the course of the steaming process which hereby results in a reduction of water content in food ingredients (Nurjanah *et al*., 2014). Even so, the result still meets the standard put in place by SNI (Standard Nasional Indonesia) which sets maximum water content in rice at 14% (Badan Standardisasi Nasional, 2015).

The ash content generated by the analog rice in this study ranged between 1.49% and 1.58%. As observed from the old technique, the best steaming length produced an ash content of 1.49%. From the experiment conducted, it can be observed that the generated ash content decreased with an increase in the steaming time, which makes both variables negatively related. This observation is considerably in accordance with the previously conducted research as regards to the effect of steaming time duration on the chemical composition genjer plants, which also states a reduction in ash content with an increase in the steaming time (Nurjanah *et al*., 2014). This is owing to the fact that, at the time of steaming, water escapes with minerals contained in the foodstuff.

Based on the variance analysis, it has been revealed that the old steaming technique significantly regulated the quantity protein present in the MONOGGOMAS analog rice. The resulting analog rice protein levels ranged between 11,16%-22,54%. The protein content realized from the most efficient steaming time length of the old procedure is 22.54%. Also, it has been established that the steaming time and the protein content level do correlate, which means that a lengthier steaming time results in an increase in protein level. The generated protein content is quite high as a result of the high quantity of protein in mayas rice, which is 7.20%(Saragih, *et al*., 2013). The protein content in mocaf flour is 2.29± 0.73%(Safitri *et al*., 2016). In addition to the types of ingredients used, processing methods can also regulate protein levels in foodstuffs.

The analog rice fat content observed from the results ranged from 4.67% to 9.60%. Through the long steaming process, the best fat content was recorded to be 4.67%. This study depicts that the longer the steaming process, the lower the fat content of the analog rice. This is of the reason that, the fat present in a food is eradicated over an increased steaming period (Susilo *et al*., 2014)

From the recorded data, we can discern the carbohydrate content existing in MONGGOMAS analog rice to be ranging from 65.45% to 70.44%. In the most satisfactory steaming duration process, the carbohydrate content was found to be at 65.45%. Based on the analyzed data, it is recognized that the lengthier the steaming, the lower the carbohydrate content in the analog rice. This is as a result of the heating process reforming the shape of the gelatinized starch which increases the rate at which the starch granules are damaged. The Gelatinization process of producing instant rice from black rice also defines the carbohydrate content of instant rice and black before. The longer the duration, and the higher the temperature of the steaming process, the more the starch granules(Saragih, *et al*., 2013).

From the collated data analysis of the lengthy steaming treatment in the production of the MONGGOMAS analog rice, shows that its energy content can be evidently stated range from 394.04 kcal to 412.99 kcal. The old technique of the best steaming analog rice contained energy content of 394.04 kcal / 100 g. Carbohydrate is a source of energy and the higher the content of carbohydrates on the analog rice, the more energy it contains. Foods with high energy contents tend to stimulate body resistance to insulin through increased glucose content in the blood (Fitri, 2014). The decrease in carbohydrate content and the addition of steaming time; reduces the energy level of the analog rice.

***Sensory Properties***

The results of the test produced which ranged from 3.69 (somewhat disliked) to 5.16 (somewhat like) shows that the treatment of with a steaming time of 10 minutes is the best treatment and has the highest value with a score of 5.16 and a commendable rating from the panelists. Consumers in Indonesia argue that white rice has a better quality and this makes it a more preferable choice to them. This is however not plausible because the white rice has the less aleuronic layer which reduces its nutritional value (Mardiah *et al*., 2016). The rice produced in this case study is a brown rice affected by the color of the banana weevil flour and the steaming process. We can then conclude that the lightest of the brown rice is determined by the length of the steaming process.

The average result of the test on the scent produced which ranges from 4.00 (normal) to 4.80 (normal) indicates that the products is still acceptable as it has a higher value than the dislike category which lead to the neutral choice of the panelists. The best obtainable treatment and has the highest score with a steaming time of 10 minutes and a score of 4.80 (normal). Generally, lots of people prefer rice that has an aroma. The panelists believe that the aroma of the analog rice is the same with that of a cassava owing to the fact that mocaf flour consists of 80% of the raw material used. The mayas rice flour which constitutes 10% doesn't influence the aroma of analog rice. Considering the highest score and the best treatment obtained on assessment, the steaming time of 10 minutes treatment has a normal ratings and is still acceptable.

The texture of the rice is however determined by three main factors: amylose content, gel consistency and gelatinization temperature (Mardiah *et al*., 2016). The result in the texture is found in the medium category, which is in between fluffy and dry. It is influenced by the steaming process in the dough before it is printed into analog rice. Steaming function in the gelatinization process is decided when the cooked rice does not break or turn to porridge. A long steaming process affects the texture of rice produced and the addition of 2% GMS (Glyceryl Monostearate) affects the total formation of the analog rice texture. The GMS functions as an emulsifier to ensure proper mixture and not too brittle texture. The texture level is however determined by the dominant raw material in the manufacturing process. The hardness level is caused by a higher level of amylose content over the mocaf flour and this affects the

gelatinization process leads to hardness in the texture. The panelists gave a Favorable assessment of the best treatment, it is therefore necessary to improve in the quality of the texture so that the products would become accepted by the panelists (Yuwono *et al*., 2013).

The result from the study shows that the flavor is normal and contains the same description for each of the treatment. According to the panelist, the taste produced from cooked analog rice is almost the same in each of the treatment, and has made it difficult to distinguish with the aid of just the 5 senses.

***Glycemic Index and Load***

The response gotten before consuming fresh bread in the 0th minute is 88.8 mg / dL. 30 minutes after consumption, it increased to 125.9 mg/dL. In the 60th minute, it decreased to 119.8 mg / dL and another decrease in the 90th and 120th minutes with the blood glucose levels at 110.3 mg / dL and 101.9 mg/dL. In this study, the result from the index calculation is 61 (medium category). The steaming process warms up and causes the starch to undergo a gelatinization process which is known to reduce the glycemic index. This glycemic index of the analog rice is lower compared to the index of other products found in the market such as the IR 64 rice which has a glycemic index of 69.96 and the IR 42 which has a glycemic index of 68.52 (Septianingrum *et al*, 2016). In foodstuff, the general glycemic index is influenced by several factors ranging from type of material to the processing method and the biological components. The food might be the same but when processed in a different ways would lead to differences in the glycemic index (Saragih, 2014).

The results in calculations of the MONGGOMAS analog rice glycemic load is 40 (high category). And based on this study, a moderate category in the glycemic index does not necessarily lead to a moderate category of the glycemic load as carbohydrate consumption can affect the glycemic load of a food which reflects on insulin response to food [18]. The Glycemic content is however directly proportional to carbohydrate content. The lower the carbohydrate content, the lower the glycemic charge and triggers an increase in blood glucose levels (Handayani and Ayutasningwarno, 2014).

## CONCLUSIONS

The steaming treatment highly influences the nutritional composition of the MONGGOMAS analog rice. In the longest steaming treatment leads to a nutritional components which includes 5.04% moisture, 1.49% ash, 22.54% protein, 4.67% fat, 65.45% carbohydrate and the level energy at 394.04 kcal for the analog rice. The 10 minutes steaming treatment which is the best treatment shows that MONGGOMAS analog rice has a glycemic index of 61 (moderate) and glycemic load of 40 (high)

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