Vol. 14, No. 6 (2025): 2157 - 2163 http://dx.doi.org/10.23960/jtepl.v14i6.2157-2163

JURNAL TEKNIK PERTANIAN LAMPUNG

ISSN 2302-559X (print) / 2549-0818 (online)

Journal homepage : https://jurnal.fp.unila.ac.id/index.php/JTP

Analog Rice from Pedada Fruit Composite Flour as Functional Food with Low Glycemic Index

Diella Trisna Ayuningtyas[1], Avina Rachma Saraswati[1], Jariyah[1,✉]

[1] Food Technology Study Program, Faculty of Engineering, Universitas Pembangunan Nasional "Veteran" East Java, INDONESIA.

Article History:

Received : 02 January 2025
Revised : 22 April 2025
Accepted : 27 April 2025

Keywords:

Analog rice,
Diabetes Mellitus,
Glycemic index,
GMS,
Pedada mangrove fruit.

Corresponding Author:
✉ jariyahtp@upnjatim.ac.id
(Jariyah)

ABSTRACT

This study aims to determine the effect of composite flour proportion pedada fruit, white corn, and soybean flours as well as the addition of GMS on the physicochemical and organoleptic properties of analog rice as functional food that is safe for people with Diabetes Mellitus. This study was arranged in a factorial completely randomized design consisting of two factors with nine treatment combinations and three replications. Factor 1 was the proportion of flour materials pedada fruit-white corn-soybean (5%-75%-20%, 10%-70%-20%, 15%-65%-20%). Factor 2 was GMS addition (1%, 2%, 3%). The data was analyzed using ANOVA at the 5% level and continued with the Duncan Multiple Range Test (DMRT). The results showed that the best treatment was the A1B1 formulation consisting of 5% pedada fruit flour, 75% white corn flour, 20% soy flour and the addition of 1% GMS produced analog rice with organoleptic characteristics of color getting a value of 3.48 (like), aroma 2.92 (neutral), texture 2.76 (neutral), and taste 3 (neutral), antioxidant content of 47.73%, in vitro glycemic index of 42. The results of the RVA analysis showed that formulation A1B1 had a pasting temperature of 94.8°C, peak viscosity 184 cP, hold viscosity 183 cP, final viscosity 332 cP, breakdown 1 cP, setback 149 cP.

1. INTRODUCTION

Rice is the main commodity providing a source of carbohydrates for the people of Indonesia. This high dependence on one type of staple food poses serious challenges in facing food crises, price fluctuations, and supply limitations due to weather factors or global fluctuations. Therefore, food diversification is an important strategy in strengthening national food security. This diversification not only aims to reduce dependence on rice, but also to enrich local food choices that are more diverse and of high nutritional value. One innovation that supports these efforts is the development of analog rice, a food product designed to resemble rice in shape and texture, but derived from non-rice ingredients such as tubers, cereals, and local legumes processed through extrusion technology (Winarti *et al*., 2018).

Analog rice has great potential as a food alternative because it can be formulated from various local ingredients with varying nutritional content Extrusion technology enables the mixing and shaping of rice-like grains, while increasing the availability of nutrients through modification of starch and protein structures. In terms of nutritional value, rice generally contains 74.9-79.95 grams of carbohydrates, 6-14 grams of protein, 0.5-1.08 grams of fat, and significant levels of vitamins such as thiamine (B1), riboflavin (B2) and niacin (B3) (USDA, 2019). By adjusting the composition of the raw materials, analog rice can be designed to have equal or even superior nutritional value compared to conventional rice, including in the aspects of dietary fiber, low glycemic indes, and antioxidant content.

One potential local ingredient is pedada fruit (*Sonneratia caseolaris*) flour, which comes from mangrove plants and is known to have hypoglycemic activity and high dietary fiber content. In addition, this fruit also contains antioxidants that can counteract free radicals. Fresh pedada fruit contains 79.86% water content, 7.08% ash, 1.42% fat, 6.24% protein, and 65.12% carbohydrate, as well as various important vitamins such as vitamins A, B, and C (Muhammad *et al*., 2022). The content shows that pedada fruit is very suitable as a functional food ingredient in analog rice formulations.

Another main component used in the formulation is white corn (*Zea mays* L.), which is a cereal with a high carbohydrate content, reaching 83.64%. White com flour also has good nutritional value, with a moisture content of 5.72%, protein of 8.01%, and total starch of about 73% consisting of amylose and amylopectin in equal proportions. This amylose and amylopectin content plays an important role in determining the final texture and glycemic index of the product (Augustyn *et al*., 2019).

Meanwhile, soybeans were chosen for their high protein content, reaching 34.9 grams per 100 grams of ingredients, as well as healthy fats and various minerals such as calcium and phosphorus. As one of the best sources of plant-based protein, soybeans not only enrich the nutritional content of analog rice, but also contribute to the functional and flavor properties of the final product (Saryani *et al*., 2019).

In the extrusion process, the addition of additional ingredients such as glycerol monostearate (GMS) is also required. GMS is resulted from glycerol esterification with vegetable fatty acids, which functions as an emulsifier and lubricant during the analog rice forming process. The addition of GMS helps to reduce the viscosity of the dough, facilitate molding, and prevent sucking of the product on the surface of the extruder machine, resulting in more uniforn and stable analog rice grains (Darmanto *et al*., 2017; Nidia, 2020).

Thus, making analog rice from a combination of pedada fruit flour, white corn, soybean, and the addition of GMS is an innovative approach in producing food products that not only physically resemble rice, but also have advantages in terms of nutrition. texture stability, and functional value. Research that examines the best composition of the three raw materials is important to produce an optimal analog rice formulation, both in terms of physicochemical and organoleptic characteristics and low glycemic index value so that it is safe for consumption by people with Diabetes Mellitus.

2. RESEARCH MATERIALS AND METHODS

2.1. Materials and Tools

The raw materials were pedada fruit obtained from mangrove farmers of Gunung Anyar Surabaya, white corn flour and soy flour obtained from flour shop “Aneka” Yogyakarta. GMS, salt and palm oil were obtained from Tri Star shop Surabaya. Materials used in testing analog rice include 99% methanol DPPH (2,2-diphenyl-1-picrylhydrazyl), amyloglucosidase enzyme and distilled water.

The equipment used are a set of steamer, filter cloth, cabinet dryer, 80 mesh sieve, oven, desiccator, disk mill, and extruder for analog rice printer. Equipment for testing included Pyrex Iwaki measuring cups, Ohaus Pioneer analytical balance, Rapid Visco Analyzer (RVA), RVA tubes, UV-Vis spectrophotometer, vortex, dropper pipettes, and test tubes.

2.2. Research Design

Analog rice research with organoleptic characteristics analysis was conducted using Friedman test. The analysis data will be the basis for determining the combination of ingredients and GMS concentration that gives the best results in the process of making analog rice which will then be analyzed for antioxidant activity, RVA analysis, and glycemic index analysis in vitro.

This research design uses a completely randomized design (CRD) factorial pattern consisting of two factors. The first factor is the proportion of a mixture (A) of pedada fruit flour (PFF), white com flour (WCF), and soybean flour (SBF) consisting of three treatments, namely A1 (5:75:20), A2 (10:70:20), and A3 (15:65:20). The second factor is the percentage of GMS addition (B), which consists of three levels: B1 (1%), B2 (2%), and B3 (3%). Thus, there are a total of 9 treatment combinations. Each treatment was repeated 2 times, resulting in 18 samples in total.

The data were analyzed using Analysis of Variance (ANOVA) at the 5% significance level to determine the effect of treatment. If there is a significant difference, it will be followed by Duncan's Multiple Range Test (DMRT) to determine the difference between treatments. All data analysis was performed using IBM SPSS Statistics 25.0 software.

2.3. Research Procedures

a) Procedure for making pedada fruit flour (PFF)

The preparation of PFF referred to (Jariyah *et al*., 2015), started with preparing the pedada fruit and peeling and washing. Then, boiling was done for 5 min at 80°C. Next, the fruit was softened and filtered. The result of the screening in the form of fruit pulp was dried using a cabinet dryer at 50–60 °C for 15–18 h. After the drying process completed, the dried pedada was crushed using and sieved with an 80 mesh sieve.

b) Procedure for making white corn flour (WCF)

The WCF production process referred to (Augustyn *et al*., 2019), began with sorting the white corn kernels to ensure good quality kernels. After that, the corn was washed using clean water to remove any dirt. The com kernels were then dried using a cabinet dryer at 60 °C for 6 h. After the drying process completed, the corn was crushed using a disk mill and sieved with an 80 mesh sieve.

c) Procedure for making soybean flour (SBF)

Soybean flour was processed according to (Rahmawati *et al*., 2020), started by sorting the soybean seeds to ensure good quality. Then the soybeans were washed using clean water to remove any dirt. After that, soaking was carried out with a ratio of water-to-soybeans 1:3 for 8 h and peeling was carried out to remove the epidermis. Then washed again using clean water, then steamed for 60 min and dried using an oven at 60 °C. After the drying process completed, the soybeans were crushed using and sieved with an 80 mesh sieve.

d) Procedure for making analog rice (Darmanto *et al*., 2017)

The preparation of analog rice begins with preparing raw materials which include the composition of PFF:WCF:SBF, included A1 (75:5:20); A2 (70:10:20); and A3 (65:15:20) with GMS (1%, 2%, 3%). Then mix all the ingredients and add water as much as 50% and palm oil 2% of the total weight of 150 g. After that, steaming was done at 60 °C for 15 min. Then, put the steamed mixture into an extruder at 70°C, 1 mm die, 1 atm, and 167 rpm. The results of the extruder in the form of rice-like grains was dried using a cabinet dryer at 60 °C for 6 h.

The quality of analog rice was analyzed through organoleptic characteristics using the Friedman test which refers to research of (Rohmah et. al, 2019) that the characteristics of analog rice tested using the hedonic test include color, aroma, texture, taste. Then, antioxidant activity analysis was carried out by referring to the research of Samhana & Indrasti (2024) with the DPPH method. Furthermore, the best treatment was determined using the method of De Garmo *et al*. (1984). The analog rice was also analyzed by in vitro glycemic index test and RVA (Rapid Visco Analyzer) (Faridah *et al*., 2014).

2.4. Data Analysis

Organoleptic characteristics data were analyzed using Friedman analysis to detect significant differences. Meanwhile, antioxidant activity data were analyzed by linear regression using analysis of variance (ANOVA). Data that showed differences were further tested using DMRT with IBM SPSS Statistics 25.0 software.

3. RESULT AND DISCUSSION

3.1. Organoleptic Test

Friedman test results showed that the analog rice formulation treatment did not affect the panelists' preference scores on the color attribute of analog rice ($p \geq 0.05$). Based on Table 1, panelists preferred the color of analog rice using 5% pedada fruit flour and 75% white corn flour with the addition of 1% GMS which had a score of 3.48 (liked). Meanwhile, the color of analog rice with a mixture of 15% pedada fruit flour and 65% white corn flour with 2% GMS concentration was less preferred with a score of 2.92 (neutral). This indicates that the formulation of flour portion and the addition of GMS in analog rice did not cause significant color changes in the product, so the color attribute can be considered stable.

Friedman test results showed that the analog rice formulation treatment did not affect the panelists' preference scores on the aroma attribute of analog rice ($p \geq 0.05$). Based on Table 1, panelists preferred the aroma of analog rice using 5%

Table 1. Organoleptic analysis of analog rice

Treatment		Average hedonic score of analog rice			
PFF:WCF:SBF	**GMS (%)**	**Color**	**Aroma**	**Texture**	**Taste**
5:75:20	1	3.48	2.92	2.76	3.00
	2	2.92	2.84	2.80	2.40
	3	3.16	3.24	2.76	2.68
10:70:20	1	3.28	2.92	2.76	2.68
	2	3.08	2.92	2.96	2.52
	3	3.12	3.36	2.96	2.96
15:65:20	1	3.48	2.60	2.60	2.32
	2	2.92	2.96	2.32	2.04
	3	3.04	3.20	2.96	2.64

pedada fruit flour and 75% white corn flour with the addition of 1% GMS which has a value of 3.36 (like), compared to the mixed composition of 15% pedada fruit flour and 65% white corn flour with 1% GMS concentration which has a value of 2.60 (neutral). Similar to the color attribute, this indicates that the formulation of flour proportion and the addition of GMS in analog rice does not cause significant changes in aroma in the product, so the aroma attribute can be considered stable.

Friedman test results showed that the analog rice formulation treatment did not affect the panelists' preference scores on the texture attribute of analog rice ($p \geq 0.05$). Based on Table 1, panelists preferred the texture of analog rice using 10% pedada fruit flour and 70% white corn flour with the addition of 3% GMS which had a score of 2.96 (neutral to like). Meanwhile, the color of the analog rice with a mixture of 15% pedada fruit flour and 65% white corn flour with 2% GMS concentration was less preferred with a score of 2.32 (neutral). These results show that although there are different treatments in the formulation of making analog rice, there are no striking differences in texture, so the characteristics of the analog rice texture remain consistent.

The Friedman test results showed that the analog rice formulation treatment had an influence on the panelists' preference scores on the taste attributes of analog rice ($p \leq 0.05$). Based on Table 1, panelists preferred the taste of analog rice using 5% pedada fruit flour and 75% white corn flour with the addition of 1% GMS which had a score of 3.00 (liked), compared to a mixture of 15% pedada fruit flour and 65% white corn flour with a concentration of 2% GMS which had a score of 2.04 (disliked). The higher proportion of pedada fruit flour caused a decrease in the panelists' preference value for the taste of analog rice. Pedada fruit has a sour taste, the more pedada fruit will cause a higher degree of acidity (Rudianto, 2015), thus affecting the taste of analog rice.

3.3. Antioxidant Content

Testing the antioxidant content of analog rice was carried out using the total antioxidant method. ANOVA statistical test showed that the difference in flour formulation with the addition of analog rice GMS did not significantly affect the antioxidant activity of analog nice ($p \geq 0.05$). The treatment of flour proportion significantly influenced the antioxidant content of analog rice ($p \leq 0.05$), while the addition of GMS did not give significant effect ($p \geq 0.05$).

Table 2 shows that the proportion of pedada fruit flour, white corn flour, and soy flour with a percentage of 15:65:20 shows the highest antioxidant content which has a value of 56.90%. The lowest value of 43.34% was obtained from the proportion of pedada fruit flour, white corn flour, and soy flour with a percentage of 5:75:20. Increasing the substitution of white com flour resulted in lower antioxidant levels compared to decreasing the percentage of pedada fruit flour. This is because the antioxidant content of pedada fruit flour is higher than that of white com flour. The anti-

Table 2. Antioxidant content of analog rice treatment proportion of pedada fruit flour: white corn flour: soy flour

Proportion of PFF:WCF:SBF	5:75:20	10:70:20	15:65:20
Average Antioxidant Content (%)	43.34±10.43[a]	49.75±8.62[a]	56.90±8.34[b]

Notes: Mean values accompanied by different notations indicate significant differences.

oxidant activity value of pedada fruit flour ranges from 15.49±0.03 to 71.63±0.01 (Verdiantika, 2022). This increase is in line with the increasing content of pedada fruit flour, which is inversely proportional to the concentration of white corn flour, thus increasing the total amount of antioxidants. Differences in the amount of flour in each formulation are thought to cause variations in the antioxidant activity detected (Damat, 2021). The addition of glycerol monostearate (GMS) was not subjected to DMRT because it did not significantly affect the antioxidant content of analog rice.

3.4. Best Treatment Based on De Garmo Method

Decision analysis requires data that includes quantitative aspects, namely antioxidants and qualitative aspects in organoleptic tests which include color, aroma, taste, and texture. The best treatment was determined from the treatment that obtained the highest result. Determination of the best treatment for analog rice products made from pedada fruit flour, white com flour, and soy flour was carried out using the effectiveness index method (De Garmo, *et al*., 1984). The best treatment was chosen as a basis for consideration in decision making by comparing the variables and treatments carried out, where the weight of the variables was determined by the author based on their level of importance.

The result of the best treatment based on 5 parameters is analog rice with 5% pedada fruit flour formulation, 75% white com flour, and 20% soy flour (A1B1). This product has an antioxidant content of 43.34%, the color attribute gets a score of 3.48 (like), aroma 2.92 (neutral), texture 2.76 (neutral), and taste 3 (neutral) with a total NH of 0.88. This best treatment will then be further tested against RVA (Rapid Visco Analyzer) and In vitro.

Table 3. Effectiveness value of analog rice based on De Garmo method

Treatment	Total Result Value (NH)					Total NH
	Color	Aroma	Texture	Taste	Antioxidant Activity	
A1B1	0.19	0.18	0.23	0.24	0.04	**0.88**
A1B2	0.00	0.06	0.17	0.09	0.02	0.34
A1B3	0.08	0.16	0.16	0.16	0.00	0.55
A2B1	0.12	0.08	0.16	0.16	0.10	0.61
A2B2	0.19	0.08	0.16	0.23	0.08	0.74
A2B3	0.07	0.08	0.23	0.12	0.06	0.55
A3B1	0.05	0.00	0.10	0.07	0.16	0.38
A3B2	0.00	0.09	0.00	0.00	0.13	0.22
A3B3	0.04	0.15	0.23	0.15	0.12	0.68

Table 4. RVA Value of Best Treatment Analog Rice

No	Sample / Parameter	Analysis Result	Unit
1	Pasting Temperature	94.8	ºC
2	Peak Viscosity	184	cP
3	Hold Viscosity	183	cP
4	Final Viscosity	332	cP
5	Breakdown	1	cP
6	Setback	149	cP

3.5. RVA

Based on Table 3, it can be seen that the best treatment is the treatment with the proportion of pedada fruit flour (5%), white corn flour (75%), and soy flour (20%) with the addition of 1% GMS in analog rice. The best treatment of analog rice was carried out the RVA (Rapid Visco Analyzer) test with test results that can be seen in Table 4. Pasting temperature as a parameter to determine the initial temperature when starch granules begin to absorb water, swell, and break (initial gelatinization) was 94.8°C. Analog rice containing flour with high starch content produces a high peak viscosity of 184 cP. This is because amylose has the ability to inhibit the swelling of starch granules through the formation of complexes with fat, which in turn causes the peak viscosity to be lower and the pasting temperature to increase (Chumsri *et al*., 2022).

Breakdown viscosity results from calculations based on subtracting peak viscosity from hold viscosity. It indicates the granule's resistance to breakage upon heating. The ideal value for analog rice products that need to hold their shape during cooking is medium-low breakdown. The results of the test showed a breakdown of 1 cP (low) which indicates that the starch is more stable, so it does not break down quickly. The final viscosity shows the ability of starch to re-gel (retrogradation). The results from Table 4 show a good final viscosity of 332 cP, so it is able to maintain its physical characteristics during the heating and cooling procedures.

Setback is obtained from subtracting the final viscosity from the hold, resulting in an analog rice setback value of 149 cP. According to Bashir & Aggarwal (2019), setback viscosity serves to identify the extent to which the paste undergoes retrogradation and syneresis. Retrogradation occurs when gelatinized starch returns to form crystals, while syneresis refers to the escape of liquid from the starch gel. Low breakdown values and mild setback values indicate that the starch is stable, indicating that the analog rice in this study can produce a dense and stable texture when processed.

3.6. In Vitro Glycemic Index

The glyceric index value of the best treatment analog rice with the proportion of pedada fruit flour (5%), white com flour (75%), and soy flour (20%) with 1% GMS was 42 based on in vitro tests. This value is included in the low category when compared to the reference material, namely pure glucose and the comparison, namely porang rice brand 'Fukumi' because it is less than 55. The glycemic index value ≤55 is classified as low (Atkinson, 2021). In vitro testing of the glycemic index of this analog rice can mimic the human digestive process and provide insight into how this rice formulation affects blood sugar levels. This method involves simulating starch digestion in a controlled laboratory setting using enzymatic hydrolysis, followed by glucose measurement. In vitro results usually give an early indication of how analog rice will behave in vivo (in the body). This test can show that the combined proportions of pedada fruit flour, white corn flour, and soy flour result in a slow and steady release of glucose, thus classifying the product as a low-GI food.

4. CONCLUSION

Based on the results of analog rice analysis, it shows that the best treatment of organoleptic characteristics parameters and antioxidant activity with the de Garmo method is found in the AlBI formulation, namely 5% pedada fruit flour, 75% white com flour, and 20% soy flour with the addition of 1% GMS. The AlB1 product sample produced analog rice with color parameters getting a score of 3.48 (liked), aroma 2.92 (neutral), texture 2.76 (neutral), and taste 3 (neutral) with antioxidant content of 47.73%. Analog rice with these proportions also produces a low glycemic index of 42 which can be utilized as functional food

ACKNOWLEDGMENTS

The authors would like to thank LPPM UPN "Veteran" Jawa Timur which has provided funding for this research under the Student Research Creativity Program funding program with contract number 118/UN63/LPPM/2024 dated 24 March 2024. The contribution enabled the authors to collect data and analyze the findings that have been presented in this paper.

REFERENCES

Atkinson, F.S., Brand-Miller, J.C., Foster-Powell, K., Buyken, A.E., & Goletzke, J. (2021). International tables of glycemic index and glycemic load values 2021: A systematic review. *The American journal of clinical nutrition*, ***114***(5), 1625-1632. https://doi.org/10.1093/ajcn/nqab233

Augustyn, G.H., Tetelepta, G., & Abraham, I.R. (2019). Analisis fisikokimia beberapa jenis tepung jagung (*Zea mays* l.) asal Pulau Moa Kabupaten Maluku Barat Daya. *AGRITEKNO: Jurnal Teknologi Pertanian*, ***8***(2), 58-63. https://doi.org/10.30598/jagritekno.2019.8.2.58

Bashir, K., & Aggarwal, M. (2019). Physicochemical, structural and functional properties of native and irradiated starch: A review. *Journal of Food Science and Technology*, ***56***(2), 513-523. https://doi.org/10.1007/s13197-018-3530-2

Chumsri, P., Panpipat, W., Cheong, L.-Z., & Chaijan, M. (2022). Formation of intermediate amylose rice starch–lipid complex assisted by ultrasonication. *Foods*, ***11***(16), 2430. https://doi.org/10.3390/foods11162430

Damat, D., Setyobudi, R.H., Burlakovs, J., Vincēviča-Gaile, Z., Siskawardani, D.D., Anggriani, R., & Tain, A. (2021). Characterization properties of extruded analog rice developed from arrowroot starch with addition of seaweed and spices. *Sarhad Journal of Agriculture*, ***37***(1), 159-170. http://dx.doi.org/10.17582/journal.sja/2021.37.s1.159.170

Darmanto, Y.S., Riyadi, P.H., & Susanti, S. (2017). *Beras Analog Super*. Undip Press.

De Garmo, E.P., Sullivan, W.G. & Candra, C.R. (1984). *Engineering Economy* (7th ed.). Macmillan.

Faridah, D.N., Fardiaz, D., Andarwulan, N., & Sunarti, T.C. (2014). Karakteristik sifat fisikokimia pati garut (*Maranta Arundinaceae*). *Agritech*, ***34***(1), 14-21. https://doi.org/10.22146/agritech.9517

Jariyah, J., Widjanarko, S.B., Yunianta., & Estiasih, T. (2015). Hypoglycemic effect of pedada (*Sonneratia caseolaris*) fruit flour (PFF) in alloxan-induced diabetic rats. *International Journal of PharmTech Research, 7*(1), 31-40.

Muhammad, F., Andriyono, S., & Pujiastuti, D.Y. (2022). Characterization of dry noodles with additional of pedada (*Sonneratia caseolaris*) mangrove flour as alternative food resource. *Earth and Environmental Science*, ***1036***(1), 012080. http://dx.doi.org/10.1088/1755-1315/1036/1/012080

Nidia, G. (2020). Pengaruh substitusi tepung kedelai (*Glycine Max* (L.) Merill) terhadap mutu organoleptik dan kadar zat gizi makro brownies sebagai alternatif snack bagi anak penderita kurang energi protein. *Jurnal Ilmu Gizi Indonesia*, ***4***(2), 1-13. https://doi.org/10.33653/jkp.v4i2.231

Rahmawati, L., Asmawati, A., & Saputrayadi, A. (2020). Inovasi pembuatan cookies kaya gizi dengan proporsi tepung bekatul dan tepung kedelai. *Jurnal Agrotek Ummat, 7*(1), 30-36. https://doi.org/10.31764/agrotek.v7i1.1906

Rohmah, S., Darmanto, Y.S., & Rianingsih, L. (2019). Penambahan nanokalsium dari jenis tulang ikan yang berbeda terhadap karakteristik beras analog dari tepung umbi garut (*Maranta Arundinacea*) dan tepung gracilaria verrucosa. *Jurnal Ilmu dan Teknologi Perikanan*, ***1***(2), 1-10. https://doi.org/10.14710/jitpi.2019.6741

Rudianto, R., Harun, N., & Efendi, R. (2015). Evaluasi mutu dodol berbasis tepung ketan dan buah pedada (*Sonneratia caseolaris*). *Jurnal Online Mahasiswa Fakultas Pertanian Universitas Riau*, ***2***(2), 1-15.

Samhana, H., & Indrasti, D. (2024). Perubahan komponen kimia fungsional pada umbi, tepung, dan beras analog ubi jalar ungu. *Jurnal Mutu Pangan: Indonesian Journal of Food Quality*, *11*(2), 78-88.

USDA.. (2016). *U.S. Department of Agriculture, Agricultural Research Service National Nutrient Database for Standard Reference Release 28*. Basic Report 11212, Edamame, frozen, prepared. Nutrient Data Laboratory.

Verdiantika, T.C., Pujiastuti, D.Y., & Andriyono, S. (2022). Karakterisasi sifat fisik dan aktivitas antioksidan pada tepung buah pedada (*Sonneratia caseolaris*) dengan suhu pengeringan berbeda. *Marinade*, ***5***(02), 99-109. http://dx.doi.org/10.31629/marinade.v5i02.4632

Winarti, S., Djajati, S., Hidayat, R., Jilian, L. (2018). Karakteristik dan aktivitas antioksidan beras analog dari tepung komposit (gadung, jagung, mocaf) dengan penambahan pewarna angkak. *Jurnal Teknologi Pangan.* ***12***(1), 27-40. http://dx.doi.org/10.33005/jtp.v12i1.1098