

RESEARCH STUDY

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Determination of *Kembang Goyang* Snack Formulation Substituted with Organic Red Rice Flour Based on Dietary Fiber Content and Texture

Penentuan Formulasi Kue *Kembang Goyang* Hasil Substitusi Tepung Beras Merah Organik Berdasarkan Kadar Serat Pangan dan Tekstur

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Available online at:<https://e-journal.unair.ac.id/AMNT>**Keywords:**Dietary Fiber, *Kembang Goyang* Snack, Organic Red Rice, Texture**ABSTRACT**

Background: The *kembang goyang* snack has relatively good nutritional content but is considered to have less fiber. This has prompted efforts to substitute white rice flour, the main ingredient of *kembang goyang* snack, with red rice flour, which has higher fiber content.

Objectives: The research objective was to determine the best formulation of the *kembang goyang* snack based on dietary fiber content and texture.

Methods: The study was divided into two stages, the production of red rice flour (organic and non-organic) and the making of *kembang goyang* snack using various ratios of organic or non-organic red rice flour and white rice flour (0:100; 20:80; 40:60; 60:40; and 80:20). The analysis parameters included yield, moisture content, dietary fiber content, resistant starch content, and texture. The study was designed using a Completely Randomized Design, and data were analyzed using ANOVA.

Results: The study results showed that organic red rice had a lower yield, but higher dietary fiber and resistant starch content compared to non-organic red rice. In contrast, the moisture content was relatively similar between the two types of red rice. *Kembang goyang* snacks made with the addition of organic or non-organic red rice flour had higher dietary fiber content compared to the control. However, increasing the amount of organic or non-organic red rice flour in various ratios resulted in similar toughness to the commercial product.

Conclusions: The best formulation of the *kembang goyang* snack was obtained at a 40:60 ratio of organic red rice flour and white rice flour. This best *kembang goyang* snack formula can be classified as a fiber-rich product because it has 6.30% dietary fiber content and 6.30% resistant starch content. Also, it has a similar texture to commercial products.

INTRODUCTION

The *kembang goyang* snack is one of the traditional snacks from Betawi. Initially, this snack was only consumed on religious holidays, such as during the Eid al-Fitr feast. However, many *kembang goyang* snacks are currently sold as souvenirs, regardless of whether there is a particular celebration or not. Making *kembang goyang* snacks is relatively easy because the dough is fried by shaking it in a flower-shaped mold¹. *Kembang goyang* snacks are usually made from white rice flour as the main ingredient, added with tapioca flour, coconut milk, eggs, and sugar. Thus, with the composition of these raw materials, it can be stated that *kembang goyang* snacks have a fairly good nutritional value. However, white rice flour has a relatively low dietary fiber content compared to red rice. The dietary fiber content in white rice was reported to be 0.2% with 1.7% fat content, while red rice has 0.8% dietary fiber with 0.9% fat content. In addition, red rice is also considered superior to white rice

from its protein (10.49 g/100 g), iron (13.45 mg/100 g), calcium (8.71 mg/100 g), zinc (1.91 mg/100 g), and magnesium (192.27 mg/100 g)². The polishing process is thought to be responsible for the nutritional composition differences between white and red rice. The polishing process aims to remove the epidermis part, which reduces the fiber content of white rice. The decrease in fiber content due to the polishing process of white rice affects the dietary fiber content in *kembang goyang* snacks. The lack of dietary fiber content in the *kembang goyang* snacks can be overcome by substituting white rice flour with red rice flour in the formulation. White rice flour substitution with barley flour as a source of fiber in the *kembang goyang* snacks formulation has been carried out in another research³, but white rice flour substitution with red rice flour has never been done.

Red rice is produced by milling without polishing, producing a final product with the epidermis on the rice endosperm. Therefore, the fiber, vitamins, and minerals

content in red rice can be preserved due to the epidermis layer that coats the rice grains⁴. In contrast, the polishing process of white rice will produce polished rice that loses its epidermis layer, decreasing rice's nutritional content. Red rice epidermis contains 23.0% dietary fiber, 17.3% protein, 23.8% fat, and 0.74% phenolic compound⁵. The productivity of red rice in Indonesia (2021) has been reported to reach 31.36 million tons, with an average rice consumption of 1.451 kg per capita per week⁶. The average consumption of red rice is still relatively low, and its utilization as food is still limited. As a result, the overproduction of red rice induces an increased export quota of this product⁷, while it can be used as a functional food ingredient in various traditional Indonesian snacks, including *kembang goyang*.

Organic and non-organic rice can be easily found in the market and are differentiated according to their cultivating methods. Organic rice is usually cultivated from local rice varieties grown in an environmentally friendly way, using organic fertilizers, such as livestock manure and agricultural waste⁸. In contrast, chemical fertilizers, pesticides, and genetically modified seeds are considered non-organic rice cultivation methods⁹. These cultivation methods differences have significantly affected organic and non-organic rice's nutritional composition, such as protein, fat, and mineral content¹⁰. Moreover, organic red rice contains 1.62% dietary fiber, while non-organic varieties only contain 0.96% of dietary fiber¹².

Red rice has a higher dietary fiber content than white rice¹³. Dietary fiber is a complex polysaccharide that does not include starch and cannot be hydrolyzed by digestive enzymes¹⁴. Dietary fiber can be divided into soluble and insoluble dietary fiber. Polysaccharides other than cellulose, oligosaccharides, pectin, β -glucan, and gum are soluble dietary fiber, while cellulose, hemicellulose, and lignin are insoluble dietary fiber¹⁵. Dietary fiber is reported to have protective effects on degenerative diseases, such as diabetes, heart disease, colon cancer, autoimmune diseases, and stroke¹⁶. The *kembang goyang* snacks contain 2.36% dietary fiber, which does not meet the fiber content requirements for fiber-rich products. Food products in a solid form, such as *kembang goyang* snacks, can be classified as a source of fiber if they contain 3% fiber or as a fiber-rich product if they contain 6% dietary fiber¹⁷. Therefore, one effort to increase dietary fiber content in *kembang goyang* snacks is substituting white rice flour with red rice flour, which has a better dietary fiber content.

As a type of cookie, *kembang goyang* also has an important texture parameter. In general, increased dietary fiber levels will reduce the cookies' crispiness. In other food products, it was found that the redder rice added, the higher the toughness and crunchiness of the food products, such as in *semprong*¹⁸ and *rempeyek*¹⁹. This shows that the dietary fiber content affects the texture parameters of the cookies produced. In this research, the substitution of white rice flour as the main raw material for *kembang goyang* with organic and non-organic red rice flour was carried out. The study objective was to determine the best formulation of the *kembang goyang* snack based on dietary fiber content and texture.

METHODS

Materials

The materials needed in this research were organic red rice "RHT" from Sidomulyo village, Sleman (Yogyakarta), non-organic red rice (Cianjur), white rice flour "Rose Brand", tapioca flour "Gunung Agung", coconut milk "Kara", granulated sugar, domestic chicken eggs, salt, vanilla, oil, and commercially produced *kembang goyang* snacks "Cemilan Bu Supiyah". In addition, this study also requires distilled water and chemicals, such as hydrochloric acid (HCl) 25% and 1 N, sodium hydroxide (NaOH) 45% and 1 N, ethanol, acetone, phosphate buffer pH 7, and enzymes such as pepsin, α -amylase, and β -amylase.

Tools

The tools used in this research include a blender "Phillips HR 2115", a cabinet dryer "Automatic Thermo-Controller Type-IL-70", a disc mill "Maksindo MKS-ML 500", a mixer "Sharp Model EMS-51", an analytical weighing scale "Ohaus Adventurer AR2140", oven "WB 14 Memmert D-91126", centrifuge "Hermle type Z 206 A", vortex "DLAB MX-S", UV-VIS spectrophotometer "U-1800 Hitachi", texture analyzer "Stable Micro System TA.TX Plus", and a 0.25-inch spherical ball probe "Stable Micro System".

Research Design

The factor tested in the phase I research was the type of red rice; organic and non-organic. Data in the phase I research were analyzed by independent sample T-test. A Completely Randomized Design was used in the phase II research with red rice type test factors (organic and non-organic red rice), and substitution ratio of red rice flour and white rice flour (0:100; 20:80; 40:60; 60:40; 80:20). Phase II research data were further analyzed by ANOVA and Duncan's test.

Research Procedure

Phase I Research

The red rice flour production (organic and non-organic) was done in the phase I research. First, red rice was soaked in water (ratio 1:3) for 2 hours. Next, red rice was crushed and dried at 50°C for 4 hours. The crushed red rice was then mashed and sieved until it passed through an 80-mesh sieve⁴.

Phase II Research

In the phase II research, the *kembang goyang* snack was made according to the formulation in Table 1, with a total formulation of 400 g. First, the sugar, salt, vanilla, and chicken eggs were mixed until they formed a homogeneous dough, then water and coconut milk were added. White rice flour, red rice flour, and tapioca flour were mixed in a separate container. Next, all the ingredients were mixed and stirred until homogeneous. First, the *kembang goyang* mold was dipped into hot boiling oil (180°C), then the mold was dipped into the dough until the surface of the mold was thoroughly covered. Furthermore, the dough attached to the mold was fried until golden brown and released from the mold²⁰.

Table 1. *Kembang goyang* snack formulation per 400 g²⁰

Ingredients (%)	Formulation								
	I	II	III	IV	V	VI	VII	VIII	IX
White rice flour	25	20	15	10	5	20	15	10	5
Organic red rice flour	0	5	10	15	20	-	-	-	-
Non-organic red rice flour	-	-	-	-	-	5	10	15	20
Tapioca flour	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Coconut milk	20	20	20	20	20	20	20	20	20
Granulated sugar	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Domestic chicken eggs	5	5	5	5	5	5	5	5	5
Water	29.62	29.62	29.62	29.62	29.62	29.62	29.62	29.62	29.62
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vanilla	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Analysis of Result Research

Analysis conducted in the phase I research includes yield²¹, moisture content²², dietary fiber²³, and resistant starch content²⁴. Furthermore, dietary fiber content²³ and texture²⁵ were performed in the phase II research. The resistant starch content analysis was only done on the best *kembang goyang* snacks²⁴.

RESULTS AND DISCUSSION

Phase I Research

Yield of Organic and Non-Organic Red Rice Flour

Table 2 shows that organic red rice flour yield was significantly different from the non-organic ($p < 0.05$). The non-organic red rice flour yield ($92.80 \pm 0.09\%$) was lower than that of organic red rice flour ($91.47 \pm 0.23\%$). The difference in the yield of organic and non-organic red rice flour can be due to differences in the hardness of the rice

grains and the number of flour particles produced. Organic red rice is more easily broken or brittle than non-organic red rice, making it easier to make into flour. However, the larger number of flour particles in organic red rice is also easier to lose during the flouring process, reducing the yield of the flour produced. In addition, the flour yield can also be affected by the hardness of the rice. Based on previous research, non-organic red rice is harder than organic red rice; 6.74 kgF for non-organic red rice and 6.57 kgF for organic red rice²⁶. Lower grain hardness indicates that the rice grains break easily or have a brittle texture. The research results are in accordance with previous studies that organic red rice is more easily converted into flour so that it has more particles than non-organic red rice. Organic red rice also has more fragile characteristics than non-organic red rice¹².

Table 2. Yield, Moisture Content, Dietary Fiber, and Resistant Starch of Organic and Non-Organic Red Rice Flour

Phase I Research Parameter	Type of Red Rice	
	Organic	Non-Organic
Yield (%)	91.47 ± 0.23^a	92.80 ± 0.09^b
Moisture content (%)	6.35 ± 0.60^a	5.91 ± 0.08^a
Dietary fiber content (%)	8.09 ± 0.04^a	6.46 ± 0.07^b
Resistant starch content (%)	3.95 ± 0.00^a	1.76 ± 0.03^b

Different letter notations (^{a, b}) in the same line were significantly different at $p < 0.05$

Moisture Content of Organic and Non-Organic Red Rice Flour

Based on Table 2, the moisture content of organic red rice was not significantly different from non-organic red rice ($p > 0.05$). The moisture content of organic and non-organic red rice flour can be categorized as low because it is less than 10%. Moisture content that was not significantly different between organic and non-organic red rice could be due to the similarities in the drying and flouring processes. The drying process was carried out at 50°C for 4 hours. In addition, the moisture content of flour can also be affected by the drying conditions, including time, temperature, and drying method used²⁷. The drying method used in the study for the two types of red rice was the same, so the moisture content of the two types of red rice flour was not significantly different. When compared with the quality requirements of rice flour according to SNI, it can be stated that the water content of organic and non-organic red rice flour in Table 1 already meets the quality requirements for rice flour moisture content, which is a maximum of 13%²⁸.

Dietary Fiber Content of Organic and Non-Organic Red Rice Flour

The dietary fiber content of organic red rice flour was significantly different ($p < 0.05$) from non-organic red rice flour, as shown in Table 2. The dietary fiber content of organic red rice flour was $8.09 \pm 0.04\%$, which was higher than the non-organic red rice flour ($6.46 \pm 0.07\%$). Differences in dietary fiber levels in organic and non-organic red rice flour are caused by differences in the cultivating methods of the two types of red rice. The organic red rice varieties used in this study were cultivated using the "jajar legowo" method, while the non-organic variety was cultivated with a conventional system. The "jajar legowo" is a rice planting system that alternates between rows intending to optimize soil fertility by taking advantage of the altitude conditions. The wider the spacing applied, the more fertile the soil will be²⁹. In addition, organic red rice-producing varieties are planted using organic rice cultivation methods and organic fertilizers. Organic fertilizers can be derived from plant and/or animal residues, contain potential sources

of nutrients for plants, and function to improve soil physical properties. These conditions benefit the metabolism of organic red rice plants, including affecting the nutritional composition, such as dietary fiber. The results of this research were in line with previous studies, which stated that the levels of dietary fiber in organic red rice were higher than in non-organic red rice. The dietary fiber content of organic red rice (1.62%) is higher than that of non-organic red rice (0.96%)¹².

Resistant Starch Content of Organic and Non-Organic Red Rice Flour

The resistant starch levels of the two types of rice flour are shown in Table 2. The resistant starch content test was performed to increase the functional value of red rice apart from the dietary fiber content parameter. In addition, resistant starch has similar characteristics to dietary fiber and can be classified as soluble dietary fiber. The resistant starch content of organic red rice flour was significantly different ($p < 0.05$) from non-organic red rice flour. The resistant starch content of organic red rice flour was 3.95%, higher than in the non-organic red rice flour ($1.76 \pm 0.03\%$). Significantly different levels of resistant starch between organic and non-organic red rice flour could be influenced by differences in amylose content in the two types of red rice studied. The amylose content of organic rice was reported at 23.9% and was higher than non-organic rice (21.2%)³⁰. The difference in amylose content between organic and non-organic rice can be due to a complete nutrient composition in manure, affecting plant metabolism optimization in forming complex carbohydrates, such as amylose. The correlation between amylose content and resistant starch content is directly proportional. High amylose content in a material will also increase the resistant starch content³¹. Amylose molecules in helical shape can form double-helix bonds, which are more stable and strengthen the crystalline structure. As a result, more resistant starch is formed, making it more difficult to hydrolyze by digestive enzymes such α -amylase³².

Phase II Research

Dietary Fiber Content of *Kembang Goyang* Snack Substituted with Red Rice

Table 3 shows the dietary fiber content of *kembang goyang* snack with the ratio of organic (ORRF) and non-organic (NRRF) red rice flour substitution compared to control (without substitution) and commercially produced *kembang goyang* snack. The dietary fiber content of the *kembang goyang* snack substituted with organic (ORRF) and non-organic (NRRF) red rice flour was significantly different from the control and commercially produced *kembang goyang* snack ($p < 0.05$). The highest dietary fiber content was found in the *kembang goyang* snack substituted with organic red rice flour (ORRF), while the lowest was the control. In general, substituting white rice flour with organic and non-organic red rice flour increased the levels of dietary fiber in the *kembang goyang* snack compared to the control. Dietary fiber content differences in *kembang goyang* snacks can be affected by the levels of dietary fiber content from the ingredients used to make the *kembang goyang* snack. This can be seen in Table 2, which shows the dietary fiber content of organic red rice flour was higher than that of non-organic red rice flour. Therefore, the dietary fiber content of *kembang goyang* snacks made from organic red rice flour substitution (ORRF) and non-organic red rice flour substitution (NRRF) was higher and significantly different than the control and the commercial type. The results of this research were also supported by previous studies, which reported the dietary fiber content of red rice was 0.8% and was higher than the dietary fiber content of white rice (0.2%)¹³. Red rice has dietary fiber, which includes soluble and insoluble dietary fiber. The insoluble dietary fiber content in red rice is higher than soluble dietary fiber³³. In addition, other studies also reported organic red rice dietary fiber levels of 1.62%, which was higher than dietary fiber found in non-organic red (0.96%)¹². The dietary fiber content of the *kembang goyang* snack made from organic red rice flour, as shown in Table 3, has met the requirements for a fiber-rich product¹⁷. According to BPOM, food in solid form is declared as a product rich in fiber if it has a dietary fiber content of at least 6%³⁴. Therefore, using organic red rice flour to substitute white rice flour in the formulation can increase dietary fiber levels in *kembang goyang* snack product.

Table 3. Dietary Fiber Content of *Kembang Goyang* Snacks; Commercial, Control, and Substituted with Organic dan Non-Organic Red Rice Flour

Treatment	Dietary Fiber Content (%)
Commercial	4.98 ± 0.13 ^b
Control	4.37 ± 0.13 ^a
ORRF	6.82 ± 0.78 ^d
NRRF	6.44 ± 0.70 ^c

ORRF (Organic Red Rice Flour), NRRF (Non-Organic Red Rice Flour), and different letter notations (^{a, b, c, d}) in the same column were significantly different at $p < 0.05$

The dietary fiber content of the *kembang goyang* snacks substituted with red rice flour at several ratios can be seen in Table 4. The different red rice flour substitution ratios had a significant effect ($p < 0.05$) on the dietary fiber content of the *kembang goyang* snack due to the difference in the dietary fiber content of the red

rice flour. The more the addition of red rice flour, the higher the dietary fiber levels in *kembang goyang* snacks. The dietary fiber content in the *kembang goyang* snacks was also associated with the dietary fiber content of organic and non-organic red rice flour. The dietary fiber levels in organic and non-organic red rice were 8.09% and

6.46%, respectively, as shown in Table 2. The dietary fiber levels in organic and non-organic red rice in this research were higher than the dietary fiber levels in white rice from previous studies. White rice was reported to have 0.2% of dietary fiber content¹³. The red rice flour to white rice flour (RRF:WRF) ratio of 40:60 in Table 4 gives a dietary fiber content of 6.34% in *kembang goyang* snacks, which was higher than the (RRF:WRF) 20:80 ratio, control, and commercial. The control and commercial *kembang goyang* snacks were made without adding red rice flour, resulting in a lower dietary fiber content than

in *kembang goyang* snacks substituted with red rice flour. The highest dietary fiber content was found in the red and white rice flour (RRF:WRF) ratio of 80:20 (7.55 ± 0.32%). Based on Table 4, the use of red rice flour to white rice flour ratios (RRF:WRF) of 20:80, 40:60, 60:40, and 80:20 could increase the dietary fiber levels in the *kembang goyang* snacks compared to the control. The *kembang goyang* snacks made with red rice flour to white rice flour (RRF:WRF) ratio of 40:60 to 80:20 has a dietary fiber content of more than 6% and can be classified as fiber-rich product³⁴.

Table 4. Dietary Fibers Contents in *Kembang Goyang* Snacks; Commercial, Control, and with Different Ratios of Red Rice Flour Substitution

Treatment	Dietary Fiber Content (%)
Commercial	4.98 ± 0.13 ^b
Control	4.37 ± 0.13 ^a
RRF 20:WRF 80	5.70 ± 0.21 ^c
RRF 40:WRF 60	6.34 ± 0.25 ^d
RRF 60:WRF 40	6.92 ± 0.20 ^e
RRF 80:WRF 20	7.55 ± 0.32 ^f

RRF (Red rice flour), WRF (White rice flour), and different letter notations (a, b, c, d, e, f) in the same column were significantly different at p < 0.05

The Texture of *Kembang Goyang* Snack Substituted with Red Rice

Table 5 shows the texture parameters in the form of the toughness of the *kembang goyang* snacks, which was significantly different (p<0.05) between the control and treatment. The difference in the toughness of the *kembang goyang* snacks is due to nutritional composition differences between white rice and red rice and different dietary fiber levels between organic and non-organic red rice, but the *kembang goyang* snacks made with a ratio of organic red rice flour:white rice flour (ORRF:WRF) of 20:80; non-organic red rice flour: white rice flour (NRRF:WRF) of 20:80; organic red rice flour:white rice flour (ORRF:WRF) of 40:60; and non-organic red rice flour:white rice flour (NRRF:WRF) of 40:60, had a toughness that was not significantly different from commercial *kembang goyang* snacks. This was because the amount of white rice flour at these ratios was greater than that of red rice flour – both organic and non-organic – resulting in a toughness of texture that was not

significantly different from commercial *kembang goyang* snacks. Toughness is measured as the compressive force on the sample, which shows the toughness and strength of the food product being measured³⁵. Toughness is also used to determine the breaking strength of food. Crunchy food has dry and firm but brittle characteristics³⁶. Based on Table 5, the increasing red rice flour ratio to all treatment groups aligned with the increased toughness of the *kembang goyang* snacks. The toughness characteristic is influenced by dietary fiber found in red rice flour. The higher the red rice flour was added to the formulation, the higher the toughness of the *kembang goyang* snacks. Dietary fiber can increase water absorption, interfere with starch gelatinization, and cause reduced porosity³⁷. The results of this study were in line with a study that substituted polished red rice flour for *semprong* snacks. The higher the addition of red rice flour into the formulation, the higher the toughness and breaking strength of *semprong* snacks due to the more dietary fiber content¹⁸.

Table 5. The Texture of *Kembang Goyang* Snacks; Commercial, Control, and with Different Ratios of Organic and Non-Organic Red Rice Flour Substitution

Treatment	Texture Parameter	
	Toughness (g.sec)	Fracturability (g)
Commercial	22834.66 ± 1276.66 ^b	740.15 ± 15.34 ^{de}
Control	15115.96 ± 539.73 ^a	476.82 ± 34.66 ^a
ORRF 20:WRF 80	22521.40 ± 1397.07 ^b	693.70 ± 22.49 ^{cd}
NRRF 20:WRF 80	22507.67 ± 831.15 ^b	625.40 ± 13.82 ^b
ORRF 40:WRF 60	24613.64 ± 208.92 ^b	763.68 ± 40.20 ^e
NRRF 40:WRF 60	23514.35 ± 2072.50 ^b	641.43 ± 56.75 ^{bc}
ORRF 60:WRF 40	30201.27 ± 2572.21 ^c	841.35 ± 19.98 ^f
NRRF 60:WRF 40	33880.12 ± 1979.03 ^d	904.95 ± 23.89 ^e
ORRF 80:WRF 20	33307.23 ± 2774.64 ^d	989.10 ± 22.28 ^f
NRRF 80:WRF 20	31527.04 ± 1494.68 ^{cd}	921.43 ± 26.11 ^e

ORRF (Organic Red Rice Flour), NRRF (Non-Organic Red Rice Flour), White Rice Flour (WRF), different letter notations (a, b, c, d, e, f, g, h, i) in the same column were significantly different at p < 0.05

In Table 5, the difference in the ratio of red rice flour and white rice flour resulted in a significantly different fracturability of the *kembang goyang* snacks ($p < 0.05$). The ratio of organic red rice flour to white rice flour (ORRF:WRF) of 20:80 and 40:60 produces the same fracturability as commercial *kembang goyang* snacks. Adding organic red rice flour increased the fracturability of the *kembang goyang* snacks compared to non-organic red rice flour. This is because the dietary fiber levels found in organic red rice were higher than in non-organic red rice, as shown in Table 2. Furthermore, a higher ratio of organic red rice flour results in increased fracturability of the *kembang goyang* snack. In general, the crispiness of food is inversely proportional to the fracturability³⁵. The decrease of crispiness in a food product is usually indicated by an increase in fracturability³⁸. Based on Table 5, it can be concluded that the use of organic red rice flour causes the *kembang goyang* snacks to become less crunchy. This can also be due to dietary fiber in the red rice flour. Dietary fiber is reported to produce a stronger food texture³⁷. Strong food texture tends to cause food to have high fracture characteristics³⁹.

The Best *Kembang Goyang* Snacks Formulation

The best *kembang goyang* snacks formulation based on dietary fiber content, toughness, and crunchiness, was found in the ratio of organic red rice flour and white rice flour of 40:60. In addition, the best *kembang goyang* snacks formulation has additional functional value in the form of higher resistant starch content, compared to control and commercial *kembang goyang* snacks. The resistant starch content in the best *kembang goyang* snacks, control, and commercial was $6.30 \pm 0.01\%$, $4.19 \pm 0.01\%$, and $4.56 \pm 0.01\%$, respectively. When the flour composition was compared, the best *kembang goyang* snacks formulation had increased resistant starch levels due to the water evaporation during frying. Water evaporation can increase the amylose molecules' cohesiveness and affect resistant starch formation. The frying process is reported to increase the resistant starch content in food product⁴⁰. In addition, the formation of amylose-lipid complexes may occur during the frying process due to amylose in rice, tapioca flour, and fatty acids in coconut milk. The amylose content of red rice was reported to be higher than white rice. The amylose content of red rice is 23-27%, while white rice's is 15-22%^{41, 42}. Coconut milk is reported to have a fat content of 18.03%, with lauric acid as the dominant fatty acid composition⁴³. The high percentage of amylose and fat in the formulation causes amylose molecules to trap fatty acids more and form amylose-lipid complexes⁴⁴. The formation of an amylose-lipid complex interferes with starch gelatinization during the *kembang goyang* snack frying, making starch more resistant to hydrolyzing by digestive enzymes.

CONCLUSIONS

Based on the results of this research, it can be concluded that the best formulation of the *kembang goyang* snacks is in the ratio of organic red rice flour to white rice flour of 40:60. Determination of the best *kembang goyang* snacks formulation is based on the final product fiber content ($6.34 \pm 0.25\%$) and texture

parameters, including toughness (24613.64 ± 208.92 g.sec) and fracturability (763.68 ± 40.20 g). In addition, the best *kembang goyang* formulation had a higher resistant starch content than the control and commercial products. The best *kembang goyang* formulation from this study can be recommended as a fiber-rich snack with a texture similar to commercial *kembang goyang* snacks, but with added functional value, in the form of resistant starch.

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All authors have no conflict of interest in this article.

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