Journal of Applied Food Technology

Home page: https://ejournal2.undip.ac.id/index.php/jaft

Development of Functional Analog Rice from Air Potato Flour and Sorghum Enriched with Virgin Coconut Oil for Low Glycemic Potential

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Abstract

The increasing prevalence of diabetes mellitus has encouraged the development of functional foods with a low glycemic index as healthier staple food alternative. This study aimed to evaluate the effects of different proportions of Air Potato Flour (APF) and Sorghum Flour (SF), as well as Virgin Coconut Oil (VCO) addition, on the chemical characteristics and glycemic index of analog rice. The study employed a completely randomized factorial design with two factors: the proportion of APF to SF (30:70, 40:60, 50:50, and 60:40) and VCO addition (2%, 3%, and 4%). The resulting analog rice was analyzed for chemical properties, while the glycemic index was determined in vivo using healthy adult volunteers. The data were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test at a 5% significance level. The results showed that increasing the proportion of APF increased moisture, ash, and fat contents, but decreased amylose, protein, carbohydrate contents, and glycemic index. Similarly, increasing VCO addition decreased moisture, ash, amylose, protein, carbohydrate contents, and glycemic index, while increasing fat content. Based on the De Garmo method, the 50:50 ratio of APF to SF with 3% VCO was selected as the best-performing formulation. This formulation had a moisture content of 8.33%, ash content of 2.51%, fat content of 7.64%, protein content of 7.45%, carbohydrate content of 74.06%, amylose content of 19.89%, and a glycemic index of 30.61.

Article information:
Received: 10 August 2026
Accepted: 8 September 2026
Available online: 17 September 2026

Keywords:
air potato flour
analog rice
virgin coconut oil
glycemic index

doi: 10.17728/jaft.33954

Introduction

Nutritional problems and non-communicable diseases, especially diabetes mellitus, have continued to increase in Indonesia in recent years. According to the International Diabetes Federation (2025), the number of adults with diabetes in Indonesia increased from about 19.5 million in 2021 to 20.43 million in 2024. During the same period, the prevalence of diabetes also increased from 10.6% in 2019 to 11.3% in 2024. One of the factors contributing to this increase is an unhealthy diet. In particular, the glycemic index (GI) of carbohydrate-rich foods provides an estimation of how quickly carbohydrates are broken down during digestion and how rapidly they are absorbed into the bloodstream (Esfahani *et al.*, 2009). Carbohydrate-rich foods that are rapidly broken down and absorbed into the bloodstream are categorized as high-GI foods. High-GI foods lead to a rapid increase in blood glucose and insulin responses following food ingestion (Vlachos *et al.*, 2020). A high glycemic response is an important dietary concern, particularly for individuals who need to manage blood glucose levels. Therefore, the development of food products with a lower glycemic index has attracted increasing interest as an alternative to high-glycemic staple foods.

Analog rice is a functional food product that has a shape similar to rice grains. It can be produced from partially or completely broken rice flour or from non-rice ingredients. One of the main advantages of analog rice is that its nutritional composition can be adjusted to meet specific dietary needs, such as having a low glycemic index, high dietary fiber, and high resistant starch content (Noviasari *et al.*, 2017). Various local carbohydrate sources, including tubers, can be used to produce analog rice (Nadhifa *et al.*, 2025).

One of the main challenges in improving nutrition in Indonesia is that most people rely on rice as their staple food. (Lee *et al.*, 2020) reported that white rice has a high glycemic index (75), while sorghum has a much lower glycemic index (40). In addition, aerial yam has a glycemic index ranging from 41 to 44 (Orji, 2023). Therefore, sorghum and air potato were selected as the main ingredients for analog rice to provide a healthier alternative staple food without changing people's eating habits.

Air potato is one of Indonesia's local food resources that has not been widely used. This plant grows as a vine and produces tubers above the ground on its stem. Several species of air potato include *Dioscorea batatas, Dioscorea bulbifera, Dioscorea alata* (purple and yellow varieties), and *Dioscorea pentaphylla* (Winarti, 2018). According to Olatoye and Arueya (2023), aerial yam contains complex carbohydrates, dietary fiber, protein, fat, and minerals, making it a potential source of energy. In addition, air potato contains 21.6% amylose (Prasetyo *et al.*, 2018).

In addition to air potato, sorghum (*Sorghum bicolor* L.) was also used as a raw material for analog rice in this study. Sorghum contains 24.32% amylose, which is classified as a medium amylose content (Haryo *et al.*, 2017). It also contains tannins that can interact with amylose to form starch-tannin complexes (Awika, 2017). These complexes contribute to the formation of resistant starch, which can slow glucose absorption (Cardoso *et al.*, 2017).

To further improve the functional properties of analog rice made from air potato flour and sorghum, Virgin Coconut Oil (VCO) was added because it is rich in Medium Chain Triglycerides (MCTs). Virgin Coconut Oil contains about 91% saturated fatty acids, including 46% lauric acid and 17% myristic acid, both of which are classified as medium-chain fatty acids (Sabahannur & Alimuddin, 2022). Previous research by (Tan *et al.*, 2017) showed that adding coconut oil to a carbohydrate-rich meal resulted in a lower increase in blood glucose during the early postprandial period, which was suggested to be related to slower gastric emptying and glucose absorption. More recently, Kodama *et al.* (2026) reported that adding MCT oil to cooked rice reduced postprandial glucose concentrations and incremental area under the curve (iAUC) compared with rice alone. In addition, the lauric acid present in VCO has been reported to stimulate insulin production and contribute to blood glucose regulation (Rahmawati *et al.*, 2023). These findings suggest that the addition of coconut oil to carbohydrate-based foods may influence the postprandial glycemic response.

Several studies have explored the utilization of tubers and cereals in the development of analog rice and other functional food products. For example, Olatoye & Arueya, (2023) have utilized aerial yam (*Dioscorea bulbifera*) in the production of extruded snack products, demonstrating its potential for food product development. Budijanto *et al.* (2018) incorporated sorghum into an analog rice formulation in combination with corn and palm sago, while Rosida *et al.* (2024) investigated the use of Virgin Coconut Oil as a fat source in kimpul (*Xanthosoma sagittifolium*) cookies. However, based on the literature search conducted using combinations of air potato flour, sorghum, VCO, and analog rice, no closely related study was identified that investigated the incorporation of these three components into a single analog rice formulation. This gap provides an opportunity to develop an analog rice product by combining air potato flour and sorghum flours with VCO enrichment. Therefore, this study aimed to evaluate the effects of different proportions of air potato flour and sorghum flour, with the addition of VCO, on the chemical characteristics and glycemic index of the resulting analog rice.

Materials and Methods

Materials

The materials used in this study included air potato obtained from local farms in Cianjur Regency, West Java, sorghum flour (Tambiyaku) purchased from PT Serambi Botani, Virgin Coconut Oil (Nutrifarm) purchased from PT Nutrifarm Prima Indonesia, water, distilled water, n-hexane, sulfuric acid (H_2SO_4), potassium sulfate, copper sulfate, boric acid, bromocresol green–methyl red (BCG-MR) indicator, hydrochloric acid (HCl), sodium hydroxide (NaOH), sodium phosphate buffer, α-amylase, protease, amyloglucosidase, 78% ethanol, 95% ethanol, acetone, pure amylose, iodine solution, and acetic acid..

Procedure for Making Air Potato Flour

The preparation of air potato flour (APF) in this study was modified from the method described by Agustin *et al.* (2019). The process included sorting the air potato tubers, peeling, washing, blanching at 80°C for 12 minutes, slicing the tubers into 0.5 cm thick pieces, and drying them in a cabinet dryer at 60°C for 8 hours. The dried tubers were then ground and passed through an 80-mesh sieve to obtain air potato flour.

Procedure for Making Analog Rice

The analog rice production process was modified from the method described by Andika *et al.* (2021). The dry ingredients were first mixed for 10 minutes. The flour formulations consisted of different proportions of air potato flour and sorghum flour (30:70, 40:60, 50:50, and 60:40). Glycerol monostearate (GMS, 2%), carboxymethyl cellulose (CMC, 1.5%), skim milk powder (1%), and salt (0.5%) were added based on the total flour weight of 550 g. Water (30%) and Virgin Coconut Oil (VCO; 2%, 3%, or 4% of the total flour weight) were then added, and the dough was mixed using a mixer until homogeneous. The dough was steamed at 80°C for 15 minutes and then extruded using a single-screw extruder with a cutter speed of 1600 rpm. Finally, the analog rice was dried in a cabinet dryer at 60°C for 5 hours.

The APF ratios of 30:70, 40:60, 50:50, and 60:40 were chosen to see the effect of increasing APF while still using enough sorghum to form good analog rice. These ratios also help find the best balance between APF and sorghum flour. The VCO levels of 2%, 3%, and 4% were chosen based on Loebis *et al.*, (2017), who used 3% oil in analog rice, while Damat *et al.* (2020) reported that too much lipid could reduce expansion. Therefore, the 2–4% range was used to see the effect of VCO around the 3% level without adding too much oil.

Raw Material Analysis

Analysis of raw materials for flour (air potato flour : sorghum flour) includes water content (AOAC, 2006), starch content (Ifmaily, 2018), amylose content, and amylopectin content by difference (Shanita *et al.*, 2011).

Chemical Analysis of Analog Rice

Chemical analysis of analog rice, including water content, ash content, fat content, protein content, carbohydrate content by difference (AOAC, 2006) and amylose content (Shanita *et al.*, 2011).

Glycemic Index

The in vivo glycemic index was determined using the method described by Fajriah *et al.* (2022). The study involved 10 students from the Department of Food Technology, Faculty of Engineering and Science, UPN "Veteran" East Java, as the participants. The inclusion criteria were healthy adults aged 18–25 years with a normal body mass index (BMI) according to the Asia-Pacific classification (18.5–24.9 kg/m²), no history of impaired glucose metabolism, good health status, and no participation in a diet program during the previous three months. This study was approved by the Ethics Committee of Universitas Airlangga on March 5, 2026, under ethical approval number 86/EA/KEPK/2026.

Before blood glucose measurement, all participants fasted overnight for 10 hours, consumed a normal dinner before fasting, and avoided strenuous physical activity. On each test day, participants consumed a reference food containing 25 g of available carbohydrate (dextrose monohydrate) and the test food containing an equivalent amount of available carbohydrate. Capillary blood glucose was measured at 0, 30, 60, 90, and 120 minutes after consumption. The glycemic index (GI) was calculated by comparing the incremental area under the curve (iAUC) of the test food with that of the reference food, with the iAUC calculated using the trapezoidal method and excluding areas below the baseline. The test foods were given in a randomized sequence, with a washout period of at least three days between tests, and participants consumed 250 mL of water with each treatment.

Data Analysis

The experiment was designed using a completely randomized design (CRD) with a factorial arrangement. The data were analyzed using analysis of variance (ANOVA). When significant differences were found, Duncan's Multiple Range Test (DMRT) was performed at a 5% significance level to compare the treatment means. The best performing formulation was determined using the De Garmo method based on the chemical characteristics and glycemic index. Each parameter was assigned a weight according to its relative importance, and the treatment with the highest total effectiveness index was selected as the best-performing formulation.

Results and Discussion

Characteristics of Raw Materials

The results of the analysis of the main raw materials, namely air potato flour and sorghum flour, are presented in Table 1. Based on Table 1, the moisture content of APF was 5.61%, which was lower than the value of 8.6% reported by Mingle *et al.* (2017). The moisture content of SF was 11.66%, which was close to the value of 11.96% reported by Pezzali *et al.* (2020). This difference may be related to differences in drying conditions, particularly drying temperature and duration, which can affect the amount of residual moisture in the flour. Moisture content is an important factor affecting food quality and shelf life. Higher moisture content can promote microbial growth and reduce flour quality during storage (Forsido *et al.*, 2021).

The starch content of APF was 71.81%, which was higher than the 52.87% reported by Argaw *et al.* (2024). In comparison, the starch content of SF was 81.58%, which was similar to the value of 83.81% reported by Pezzali *et al.* (2020). The difference may be related to differences in tuber variety, maturity, and growing conditions, which can affect starch accumulation in the tuber. Processing conditions, such as drying and milling, may also influence the starch content of the resulting flour. Since starch contributes to the formation of a compact gel structure during extrusion (Soker *et al.*, 2024), the different starch contents of APF and SF may contribute to the differences in physical properties observed among the analog rice treatments.

The amylose content of APF was 18.61%, which was higher than the 16.92% reported by Argaw *et al.* (2024). The amylose content of SF was 24.22%, which was close to the value of 21.35% reported by Gunawan *et al.* (2021). This difference may be related to differences in tuber variety, maturity, and growing conditions, which can affect the amylose-to-amylopectin ratio of starch. Rice with a higher amylose content generally has a firmer texture because amylose content could prevent rice swelling and help to maintain the swollen starch granules (Zhu *et al.*, 2021). The amylose content of analog rice decreased as the proportion of APF increased, indicating that APF and SF proportions affected starch composition. The lower amylose content may also influence starch-lipid interactions, as amylose can form complexes with lipids from VCO. These interactions may contribute to variations in the moisture, fat, and protein contents of the analog rice.

The dietary fiber content of APF was 11.41%, and no previous studies have reported the dietary fiber content of APF. The dietary fiber content of SF was 7.46%, which was higher than the 6.6% reported by Omer *et al.* (2023). This variation may be related to differences in variety, maturity, processing conditions, and analytical methods. The relatively high dietary fiber content of APF may contribute to the glycemic characteristics of the resulting analog rice, as dietary fiber can slow starch hydrolysis and glucose release during digestion (Kurek *et al.*, 2018). However, dietary fiber in this study was measured in the raw materials

Table 1. Chemical characteristics of APF and SF

Parameter	APF		SF	
	Analysis	Literature	Analysis	Literature
Moisture (%)	5.61 ± 0.32	8.6[a]	11.66 ± 0.34	11.96[b]
Starch (%)	71.81±1.35	52.87[c]	81.58±0.40	83.81[b]
Amylose (%)	18.61±0.58	16.92[c]	24.22±0.66	21.35[d]
Amylopectin (%)	53.20±0.58	35.95[c]	57.36±0.66	57.03[d]
Dietary Fiber (%)	11.41±0.11	-	7.46±0.11	6.6[e]

Source: Mingle *et al.* (2017)[a], Pezzali *et al.* (2020)[b], Argaw *et al.* (2024)[c], Gunawan *et al.* (2022)[d] , Omer *et al.* (2023)[e] . APF= Air Potato Flour, SF= Sorghum Flour

Table 2. Effect of the varying proportions of Air Potato Flour and Sorghum Flour on the chemical properties

APF:SF	Moisture (%)	Ash (%)	Amylose (%)
30 : 70	8.07 ± 0.45[a]	1.79 ± 0.13[a]	22.87 ± 0.46[a]
40 : 60	8.07 ± 0.56[a]	2.06 ± 0.06[b]	21.05 ± 0.40[b]
50 : 50	8.38 ± 0.41[a]	2.46 ± 0.14[c]	19.80 ± 0.38[c]
60 : 40	9.09 ± 0.49[b]	2.57 ± 0.10[c]	19.27 ± 0.20[d]

*Different notations in one column indicate significant differences ($p \leq 0.05$). APF= Air Potato Flour, SF= Sorghum Flour

rather than the final analog rice; therefore, its contribution to the observed GI values should be considered a possible factor rather than a confirmed mechanism.

Moisture, Ash, and Amylose Contents of Analog Rice

Analysis of variance showed that there was no significant interaction ($p \geq 0.05$) between the proportion of APF and SF and the addition of VCO on the moisture content, ash content, and amylose content of analog rice. However, the proportion of air potato flour to sorghum flour (Table 2) had a significant difference ($p \leq 0.05$) on these parameters, whereas the addition of VCO (Table 3) showed no significant difference ($p \geq 0.05$).

The moisture content of analog rice ranged from 8.07% to 9.09% (Table 2). Increasing the proportion of air potato flour and decreasing sorghum flour increased the moisture content. This was mainly due to the higher dietary fiber content of air potato flour (11.41%) compared with sorghum flour (7.46%), which improves water retention (Fajariyanti *et al.*, 2022). Similar results were reported by de Erive *et al.* (2020), who found that products with higher dietary fiber had higher moisture content. In addition, sorghum flour contained more amylose (24.22%) than air potato flour (18.61%). Higher amylose content promotes the formation of a more porous structure during gelatinization, allowing water to evaporate more easily during drying (Biduski *et al.*, 2018). This finding is consistent with Novikasari *et al.* (2022), reported that higher amylose content reduced the moisture content of analog rice. Nevertheless, all analog rice samples met the Indonesian rice quality standard (SNI 6128:2015), with moisture content below the maximum limit of 14%.

The moisture content (Table 3) ranged from 8.32% to 8.55%. The addition of VCO did not have a significant effect on the moisture content of the analog rice. During the extrusion process, lipids from VCO may interact with starch to form amylose-lipid complexes, which can reduce water absorption (Wang *et al.*, 2021). However, the VCO levels used in this study (2-4%) were likely too low to produce a significant change in the moisture content of the final product.

The ash content of analog rice (Table 2) ranged from 1.79% to 2.57%. Increasing the proportion of air potato flour and decreasing the proportion of sorghum flour resulted in a higher ash content. This is because air potato flour has a higher ash content than sorghum flour. Agustin *et al.* (2019) reported that the ash content of air potato flour was 3.6%, whereas Pezzali *et al.* (2020) reported an ash content of 1.26% for sorghum flour. The ash content of the analog rice in this study was also higher than that of white rice, which was reported to be 0.21% by (Fajriah *et al.*, 2022a).

The ash content of analog rice with different levels of VCO addition (Table 3) ranged from 2.15% to 2.27%. Increasing the amount of VCO reduced the ash content of the analog rice because VCO contains very low amounts of minerals. Olateru *et al.* (2020) reported that the ash content of VCO was only 0.09%. As more VCO was added, the proportion of fat in the product increased, while the relative mineral content decreased, resulting in a lower measured ash content.

The amylose content of analog rice (Table 2) ranged from 19.27% to 22.87%. Increasing the proportion of air potato flour and decreasing the proportion of sorghum flour resulted in lower amylose content. This is because air potato flour contains less amylose (18.61%) than sorghum flour (24.22%). The amylose content of analog rice influences its cooking and eating quality. Rice with a high amylose content produces cooked rice with a firmer and less sticky texture, and it tends to become harder after cooling. In contrast, rice with a low amylose content produces cooked rice that is softer and stickier (Farooq & Yu, 2025).

The amylose content of analog rice with different levels of VCO addition (Table 3) ranged from 20.61% to 20.93%. Increasing the amount of VCO resulted in lower measured amylose content. Amylose has a helical structure that can bind fatty acid molecules to form amylose-lipid complexes (Panyoo & Emmambux, 2017). The formation of these complexes reduces the amount of free amylose, resulting in a lower measured amylose content.

Fat Content of Analog Rice

The proportion of APF and SF, with the addition of VCO, significantly affects ($p \leq 0.05$) the fat content of analog rice. The fat content of analog rice ranged from 4.38% to 10.75% As shown in Figure 1. Increasing the

Table 3. Effect of Virgin Coconut Oil addition on the chemical properties

VCO addition (%)	Moisture (%)	Ash (%)	Amylose (%)
2	8.32 ± 0.79[a]	2.27 ± 0.32[a]	20.93 ± 1.58[a]
3	8.55 ± 0.59[a]	2.24 ± 0.37[a]	20.70 ± 1.53[a]
4	8.34 ± 0.50[a]	2.15 ± 0.35[a]	20.61 ± 1.43[a]

*Different notations in one column indicate significant differences ($p \leq 0.05$). VCO= Virgin Coconut Oil

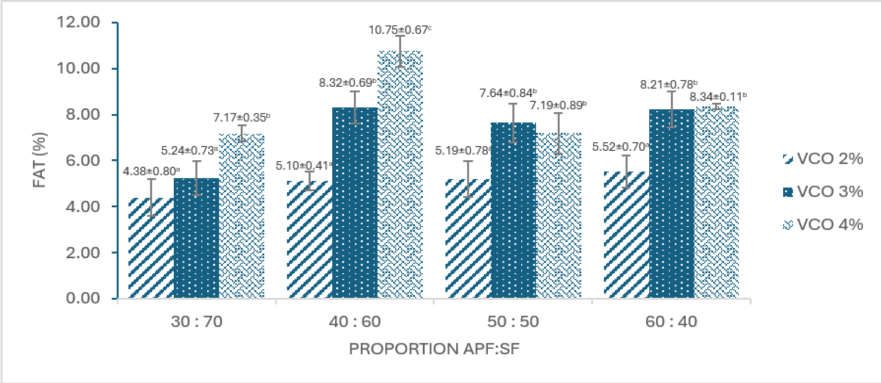

Figure 1. Effect of adding VCO and varying ratios of APF to FS on the fat content of analog rice.
APF= Air Potato Flour, SF= Sorghum Flour

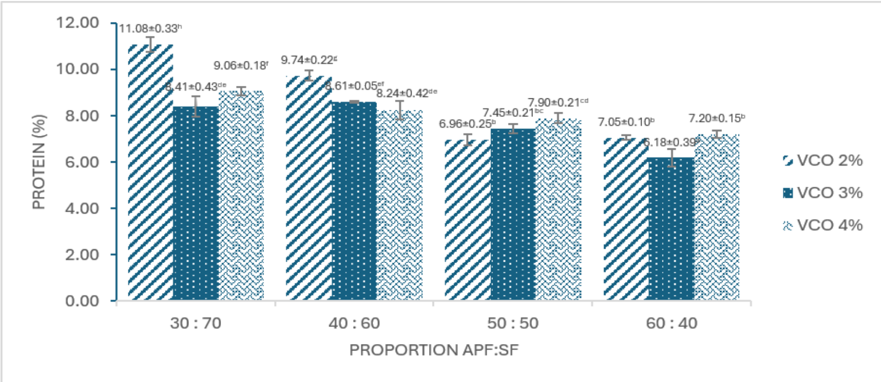

Figure 2. Effect of adding VCO and varying ratios of APF to FS on the protein content of analog rice.
APF= Air Potato Flour, SF= Sorghum Flour

proportion of air potato flour while decreasing sorghum flour, along with higher levels of VCO addition, resulted in higher fat content. This is because air potato flour contains more fat than sorghum flour. Ayo *et al.* (2018) reported that the fat content of air potato flour was 3.86%, whereas Pezzali *et al.* (2020) reported that sorghum flour contained 2.69% fat. In addition, VCO contains approximately 98.91% fat, thereby increasing the overall fat content of the formulation (Olateru *et al.*, 2020). During gelatinization, lipids, proteins, and starch in sorghum flour form molecular complexes that reduce the proportion of free lipids, resulting in lower measured fat content as the proportion of sorghum flour increases (Chao *et al.*, 2024). A similar finding was reported by Akajiaku *et al.* (2017) who observed that incorporating sorghum flour into noodle formulations led to a reduction in fat content.

Protein Content of Analog Rice

The proportion of APF and SF, with the addition of VCO, significantly affects ($p \leq 0.05$) the protein content of analog rice .The protein content of analog rice ranged from 6.19% to 11.08% (Figure 2). Increasing the proportion of air potato flour while decreasing sorghum flour, along with higher levels of VCO addition, resulted in lower protein content. This is because air potato flour contains less protein than sorghum flour. Sanful and Engmann (2016) reported that the protein content of air potato flour was 7.12%, whereas Pezzali *et al.* (2020) reported a protein content of 9.95% for sorghum flour. The addition of VCO decreased the protein content in the formulation, as well as the dilution effect caused by VCO, which contains only 0.71% protein and increases the total product weight without substantially contributing to protein (Olateru *et al.*, 2020). Although starch-lipid-protein complexes may form during heating, the Kjeldahl method quantifies both free and bound proteins as crude protein (Sáez-Plaza *et al.*, 2013). all analog rice formulations exhibited higher protein content than white rice, which contains only 3.81% protein (Fajriah *et al.*, 2022).

Carbohydrate Content of Analog Rice

The proportion of APF and SF, with the addition of VCO, significantly affects ($p \leq 0.05$) the carbohydrate of analog rice. The carbohydrate content of analog rice ranged from 70.51% to 76.72% As shown in Figure 3. Increasing the proportion of air potato flour and decreasing the proportion of sorghum flour higher levels of VCO addition tended to reduce the carbohydrate content of the analog rice. The carbohydrate content was influenced by the composition of the raw materials used. Adebo and Kesa (2023) reported that white sorghum flour contains 78.82% carbohydrates, while Ayo *et al.* (2018) reported a carbohydrate content of 78% for air potato flour. The addition of VCO reduced the carbohydrate content of the analog rice. Olateru *et al.* (2020) reported that VCO contains approximately 98.91% fat and does not contain carbohydrates. As more VCO was added, the proportion of fat in the formulation increased, while the amount of carbohydrates remained unchanged. As a result, the percentage of carbohydrates relative to the total product weight decreased, leading to a lower measured carbohydrate content.

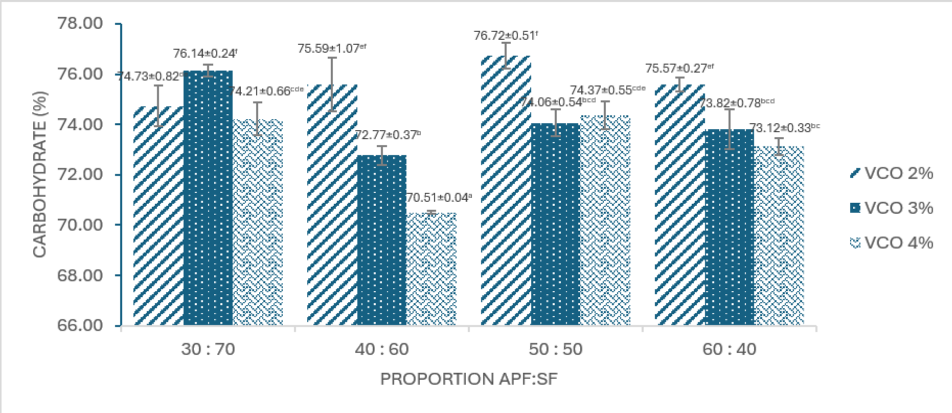

Figure 3. Effect of adding VCO and varying ratios of APF to FS on the carbohydrate content of analog rice. APF= Air Potato Flour, SF= Sorghum Flour

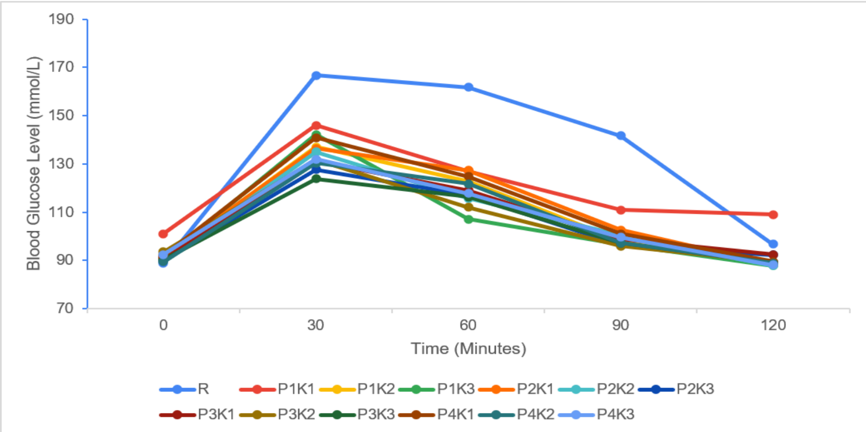

Figure 4. Changes in Blood Glucose Levels Following Consumption of Different Analog Rice Formulations. P1–P4 represent APF:SF ratios of 30:70, 40:60, 50:50, and 60:40, respectively; K1–K3 represent VCO concentrations of 2%, 3%, and 4%, respectively; and R represents the reference food (dextrose monohydrate)

Glycemic Index of Analog Rice

Interaction between the proportion of APF and SF, with the addition of VCO not significantly affects ($p \geq 0.05$) the glycemic index of analog rice. Furthermore, each treatment factor individually also had no significant effect on the glycemic index of the analog rice. Figure 4 shows that blood glucose levels increased and reached their highest level at 30 minutes, then gradually decreased until 120 minutes. All analog rice treatments showed a lower increase in blood glucose than the reference food. Overall, the analog rice treatments showed a lower increase in blood glucose after consumption.

As shown in Table 4, the glycemic index of the analog rice ranged from 35.30 to 42.43. Increasing the proportion of air potato flour and decreasing sorghum flour showed a tendency to lower the glycemic index, but the difference was not statistically significant. This tendency may be related to the higher dietary fiber content of air potato flour (11.41%), which may slow starch breakdown and glucose release during digestion (Kurek *et al.*, 2018). Dietary fiber may also increase the viscosity of the digestive contents, making it harder for enzymes to break down starch and potentially reducing the glycemic response (Grundy *et al.*, 2016).

Although a decreasing trend in glycemic index was observed with increasing proportions of air potato flour, the differences among treatments were not statistically significant. This may be due to the relatively small changes in flour proportion, which were insufficient to produce significant differences in glycemic index. Similar findings were reported by Salgado *et al.* (2011), who found that the addition of 6% and 10% inulin to white bread reduced the glycemic index but did not result in significant differences. Furthermore, the effect of dietary fiber on glycemic index depends not only on the total fiber content but also on the type of fiber, its ability to form viscous gels, and its interaction with starch during processing and digestion (Giuntini *et al.*, 2022). Nevertheless, all formulations were classified as low

Table 4. Effect of the varying proportions of Air Potato Flour and Sorghum Flour on glycemic index

APF:SF	Glycemic Index
30 : 70	42.43[a]
40 : 60	41.73[a]
50 : 50	35.30[a]
60 : 40	41.37[a]

*Different notations in one column indicate significant differences ($p \leq 0.05$). APF= Air Potato Flour, SF= Sorghum Flour

Table 5. Effect of Virgin Coconut Oil addtion on glycemic index

VCO addition (%)	Glycemic Index
2	43.73[a]
3	39.58[a]
4	37.33[a]

*Different notations in one column indicate significant differences ($p \leq 0.05$). VCO= Virgin Coconut Oil

Table 6. De Garmo Effectiveness Analysis of Analog Rice

APF : SF	VCO (%)	GI	MC	AC	FC	PC	CC	AMC	Total NW
Normal Weight (NW)		0.40	0.1	0.05	0.05	0.05	0.2	0.15	1.00
	2	0.07	0.08	0.04	0.00	0.05	0.14	0.15	0.37
30:70	3	0.00	0.05	0.05	0.01	0.02	0.18	0.14	0.30
	4	0.21	0.08	0.05	0.02	0.03	0.12	0.12	0.51
	2	0.00	0.10	0.03	0.01	0.04	0.16	0.08	0.33
40:60	3	0.14	0.06	0.03	0.03	0.02	0.07	0.05	0.36
	4	0.20	0.04	0.03	0.05	0.02	0.00	0.08	0.34
	2	0.17	0.03	0.01	0.01	0.01	0.20	0.03	0.42
50:50	3	0.40	0.05	0.01	0.03	0.01	0.11	0.03	0.61
	4	0.27	0.06	0.01	0.02	0.02	0.12	0.02	0.51
	2	0.00	0.00	0.00	0.01	0.01	0.16	0.01	0.18
60:40	3	0.13	0.00	0.00	0.03	0.00	0.11	0.01	0.27
	4	0.23	0.02	0.01	0.03	0.01	0.08	0.00	0.38

*GI (Glycemic Index), MC (Moisture Content), AC (Ash Content), FC (Fat Content), PC (Protein Content), CC (Carbohydrate Content), AMC (Amylose Content)

glycemic index foods (GI < 55) according to the classification by Matthan *et al.* (2016).

The addition of VCO tended to reduce the glycemic index of analog rice (Table 5), although the effect was not statistically significant. This reduction may be attributed to the lipids in VCO, which can form amylose-lipid complexes, resulting in a more compact starch structure that is more resistant to enzymatic hydrolysis by α-amylase, thereby slowing starch digestion (Farooq & Yu, 2025). Furthermore, the fatty acids in VCO may delay gastric emptying, leading to a more gradual release of glucose into the bloodstream (Giuntini *et al.*, 2022). However, the 2–4% VCO levels used in this study were not sufficient to produce a significant change in glycemic index.

Best Performing Formulation

The results of the analysis presented in Table 6 showed that the treatment with a 50:50 ratio of APF to SF and 3% VCO was the best performing treatment based on the highest total Normal Weight (NW) value of 0.66. This treatment resulted in effectiveness index values of 0.40 for glycemic index, 0.05 for moisture content, 0.01 for ash content, 0.05 for fat content, 0.03 for protein content, and 0.11 for carbohydrate content. These results indicate that the combination of the two factors provided the highest overall effectiveness compared with the other treatments.

Conclusion

Analog rice formulated from air potato flour and sorghum flour with the addition of virgin coconut oil (VCO) produced a low glycemic index (GI < 55) product. Based on De Garmo method, the formulation consisted of a 50:50 ratio of air potato flour to sorghum flour combined with 3% VCO was selected as the best-performing formulation. This formulation had a moisture content of 8.33%, ash content of 2.51%, fat content of 7.64%, protein content of 7.45%, carbohydrate content of 74.06%, amylose content of 19.89%, and a glycemic index of 30,61. The low GI value indicates that the selected analog rice had a low glycemic response compared with high-GI foods.

Acknowledgments

The authors gratefully acknowledge the financial support provided by Indofood Riset Nugraha for this research. The authors also extend their sincere appreciation to all volunteers who participated in the glycemic index study for their willingness, cooperation, and valuable contribution to the successful completion of this research.

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