Characterization of Mixed Rice: Nutritional Value, Physicochemical Properties, Organoleptic, and Glycemic Index

Elis Septianingrum[1*], Shinta Dewi Ardhiyanti[1], Liyanan Liyanan[1], Bram Kusbiantoro[2], Dody Dwi Handoko[1]

[1]Indonesian Center for Rice Instrument Standard Testing (ICRIST)
[2]Research Center for Agroindustry, National Research and Innovation Agency, Agro and Biomedical Industry Technology Development Laboratory (LAPTIAB), Serpong, Tangerang, Indonesia
[*]Corresponding author: Elis Septianingrum, Email: elis.septianingrum@gmail.com

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ABSTRACT

The nutritional and physicochemical value of rice could be enhanced by mixing or combining white and brown rice with various beans. Besides nutritional and functional aspects, it is also crucial to consider organoleptic properties. Therefore, this study aimed to characterize nutritional value (proximate), physicochemical properties, organoleptic and Glycemic Index (GI) of mixed rice. A total of 10 mixed rice formulas, ranging from F1 to F10, and consisting of white rice, brown rice, black rice, aromatic rice, sticky rice, black-eyed peas and mung beans, were determined. These samples were analyzed for proximate, total phenolic compounds, pasting properties, and organoleptic tests (hedonic and ranking tests). Furthermore, 3 selected formulas based on the previous test were then evaluated for GI, and Glycemic Load (GL) was calculated. The results showed that adding black-eyed peas and mung beans (F9 and F10) increased the protein content of mixed rice while higher proportion of black or brown rice (F3 and F4) enhanced the fat content. The amylose content was decreased due to higher proportion of sticky rice (F6 and F8). Based on the hedonic test, the F1-F6 formula had a favorable rating. The ranking results indicated that F9 was better than F10, while F1 and F6 was the best among F1 to F4, as well as F5 to F8. Considering the constituent materials, F1, F6, F9 and commercial low GI rice were selected and tested for GI, and the test results showed 48.2, 54.7, 78.0, and 60.3, respectively. As a result, F1 and F6 have the potential to be developed as mixed rice because they have good nutritional value, physicochemical and organoleptic properties, as well as low GI.

Keywords: Mixed rice; nutritional value; physicochemical; glycemic index

INTRODUCTION

Packaged rice circulating in the community are generally classified into pure (one variety) and mixed rice. Pure rice is a product consisting of only one variety, with the authenticity being stated on the label. Furthermore, it has the same/uniform quality as grains of rice, and is usually location-specific, aligning with local rice varieties that possess distinctive quality, such as Pandan Wangi and Mentik Wangi rice from Cianjur and Klaten, respectively. Mixed rice consists of several varieties, serving diverse purposes. Rice mixing is conducted to lower the price or to create formulations with specific traits that appeal to consumers preference (Zhu et al., 2013) (Handoko et al., 2018).

Rice mixing to reduce selling prices is usually conducted between different varieties, as well as aromatic and non-aromatic rice, which have similar

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grain sizes and shapes, resulting in a uniform physical appearance. In modern times, there is a growing trend of mixed rice to meet specific consumers preference. The mixture might involve combining a few portions of white rice with different textures to obtain the desired outcime. It could also encompass a blend of various kinds of rice such as white (polished) rice, brown (husked) rice, colored rice, sticky rice, pigmented sticky rice, and even some variations incorporating other cereals (such as corn and sorghum) and legumes (mung beans and kidney beans).

Combining white (polished) and pigmented rice (or husked rice) can increase nutritional value. Pigmented rice is considered good for the body because it contains relatively high levels of protein, fat, fiber, minerals and vitamins compared to its white rice counterpart (Saleh et al., 2019). Furthermore, it is rich in anthocyanins, which are antioxidants discovered in its bran layers (Goufo & Trindade, 2014).

In addition to increasing its nutritional value, the mixing of white and pigmented rice is also improve or enhance organoleptic properties (texture). It is worth noting that the public interest in consuming pigmented rice is not as pronounced as their preference for white rice. This is because the texture of brown (husked) rice tends to be less fluffy and less absorbent of gravy or seasonings, resulting in a relatively subdued taste when eaten with vegetables and side dishes. To address this, efforts have been made to increase the acceptability of brown rice. Mardiah et al. (2017) suggested a method which involved partial polishing or mixing it with white rice.

The concept of mixed rice can also encompass the blending of rice with other cereals and legumes. Jung et al. (2009) stated that when white rice was combined with other cereals and legumes (GI=58), the outcome had a lower GI value (GI=86). Consuming low-GI mixed rice (white rice mixed with whole grains) is strategy in weight management, as individuals will consume less energy while still maintaining a sense of satiety. Whole grains (such as pigmented rice) and legumes have potential advantages in glycemic control, attributed to their composition of slow-digesting carbohydrates and high fiber content. Furthermore, the consumption of a diverse range of whole grains and legumes has been substantiated as an effective means to prevent and manage diabetes (Jenkins et al., 2012; Mohan et al., 2014).

Mixed rice products hold great potential for development in Indonesia due to their limited availability in the market. There is a growing trend among consumer to seek rice option that offers both nutritional and functional characteristics as well as good and specific rice texture. However, varieties in Indonesia, specifically those developed by the Indonesian Center for Rice Research (ICRR), have diverse characteristics and the potential to be developed as mixed rice. The purpose of this study was to characterize nutritional value (proximate), physicochemical properties, organoleptic properties, and Glycemic Index (GI) of several mixed rice. The information obtained can be used to map the potential use of various superior rice varieties as food products. Furthermore, mixed rice can be further developed into instant seasoned products in packaging.

METHODS

The raw materials used were Dried Rough Rices (DRR) obtained from the Sukamandi Research Station of ICRR. The DRR consists of four varieties which are white, red, black, aromatic, and sticky rice variety. The dual purpose of brown (husked) and black rice lay in their capacity to serve as sources of antioxidants, while sticky rice was harnessed to soften the cooked rice texture, rendering it delightfully fluffy. Additionally, the aromatic rice variety contributed a fragrant bouquet to the ensemble. Further augmenting the composition were black-eyed peas and mung beans, meticulously procured from markets in the Subang vicinity. These leguminous components fulfilled a dual role as repositories of dietary fiber and protein. Proximate analysis, amylose content, amylography, total phenolics and organoleptic test analysis were conducted at the ICRR's testing laboratory, while GI testing was performed at the UGM Food Technology Laboratory.

Experiment Design

This study used the Completely Randomized Design (CRD) method with one factor, namely mixed rice composition consisting of nine formulas. Analysis was conducted with SPSS software.

Sample Preparation and Formulation

The rice samples were de-husked into husked (brown) rice. In subsequent, the husked rice of white and stiky rice varieties were polished into white rice, while the husked rice of red, black, and aromatic rice varieties were retained in the husked rice form. Table 1 shows the formulations which ranged from F1 to F10. The formulations can be grouped into three based on their ingredients, namely: (1) combination of white, red and black rice (F1- F4), (2) white, red, black, fragrant (cracked), and sticky rice (F5- F8), and (3) a combination of white, red, black, aromatic (husked), sticky rice, as well as black-eyed peas and mung beans (F9 and F10). They were then packed in plastic bags of 1 kg each and stored in cold storage while waiting to be tested.

Table 1. Mixed rice formula

Material	F1 (%)	F2 (%)	F3 (%)	F4 (%)	F5 (%)	F6 (%)	F7 (%)	F8 (%)	F9 (%)	F10 (%)
White rice	50	33	25	25	25	25	20	20	20	20
Red rice	25	33	50	25	25	25	25	20	20	20
Black rice	25	33	25	50	25	25	25	20	20	20
Aromatic rice	0	0	0	0	25	0	20	20	20	10
Sticky rice	0	0	0	0	0	25	10	20	10	10
Black-eyed beans	0	0	0	0	0	0	0	0	5	10
Green beans	0	0	0	0	0	0	0	0	5	10

Analysis Method

The mix rice samples were subjected to proximate analysis (moisture content, protein content, fat content, fiber content and ash content) (AOAC International, 2019), amylose content (Badan Standardisasi Nasional, 2015), Pasta Properties (Zhu et al., 2013), Total Phenol Compound (TPC) Analysis (Mardiah et al., 2017), and organoleptic analysis (hedonic test and ranking test). The test data was analyzed, taking into account the representativeness of the formula group. Based on this analysis, three mixed rice formulations were chosen, alongside a commercial low GI rice (for comparison purposes). These selections will be subjected to testing to determine their Glycemic Index (GI) and calculate the Glycemic Load (GL).

Testing Procedure

Organoleptic analysis

Organoleptic assessment in the form of a hedonic and ranking test was conducted in three sessions based on mixed rice groups, namely F1-F4, F5-F8, as well as F9 and F10. The procedures involved washing mixed rice samples with clean water twice, and drain. Following this, cooking was performed using an electric rice cooker with rice and water ratio ranging from 1:1.5 to 1:2 until the indicator light switched to warm mode, signalling the completion of the cooking. The rice was left in the cooker for 15 minutes for it to be fully cooked. Subsequently, the cooked rice samples were served on smallcoded plates to 30 semi-trained panelists in organoleptic test room. Panelists were asked to rate rice on a computerized worksheet, covering the attributes of rice appearance, palatability, and general acceptability, as well as further rank rice. The rating scale for the hedonic test consisted of 1 (strongly like), 2 (like), 3 (moderate), 4 (dislike) and 5 (strongly dislike). After testing one sample and moving on to the next, water was provided to neutralize the tongue. Finally, the 3 selected formulas and a low-GI commercial rice were tested for GI.

GI testing

GI testing was conducted in vivo, employing the International Organization for Standardization method (ISO, 26642:2010) and the guidelines set forth by Joint FAO/WHO Expert Consultation on Carbohydrates in human nutritional (FAO/WHO 1998). This assignment was executed with the involvement of several pre-selected healthy volunteers which were given three types of mixed rice and three samples of pure glucose solution as reference foods (standards). The samples were cooked, and the amount of rice tested was equivalent to 50 g of available carbohydrates. The amount was calculated based on the total sugar and starch content in the samples. A total of 10 healthy (non-diabetic) volunteers who passed the selection were asked to fast for 12 hours (except water) at night. Their blood samples were collected at this period (0 minutes) as well as 30, 60, 90, and 120 minutes after the cooked rice was consumed. Blood glucose levels were analyzed by the GOD-PAP (Glucose Oxidase Phenol Amino Phenazone) method, while sugar levels obtained were plotted into a glucose response curve, with the area was calculated on a geometric basis (the area under fasting conditions was ignored). The GI value of the sample was determined by comparing the area under the glucose response curve of the sample with the corresponding area under the curve of the reference food (glucose solution), multiplied by a factor of 100. Food is classified to have a high, medium, and low GI when it has value of > 70, 55-70, and < 55, respectively (Atkinson et al., 2021).

$$GI = \frac{curve\ area\ of\ sample\ blood\ glucose\ level}{curve\ area\ of\ pure\ glucose\ blood\ level}\ x\ 100 \quad (1)$$

Glycemic Load (GL) calculation (Atkinson et al., 2021)

GL was calculated by multiplying the GI of the product by the available carbohydrate content in a serving size of the food, divided by 100. The calculation was conducted for a serving size of 150 g, as established in the Indonesian Food Consumption Survey 2014. Food is said to have a high, medium, and low GL when it has value of > 20; 10-19 and < 9, respectively.

$$GL = \frac{GI\ x\ starch\ content\ of\ sample\ per\ serving\ (150\ g)}{100} \quad (2)$$

RESULTS AND DISCUSSION

Nutritional Content and Total Phenolic Compounds (TPC)

Nutritional content of several mixed rice formulas was tested through proximate analysis. Table 2 showed that the moisture content of rice samples did not differ much except for the ash, fat, protein and fiber content. The moisture, ash, fat, protein, and fiber contents of mixed rice formulas ranged from 8.56 ± 0.13% - 9.67 ± 0.34%, 0.38 ± 0.05% - 1.47 ± 0.11%, 0.52 ±0.01% - 3.57 ±0.03%, 7.37 ±0.08% - 10.93 ±0.13%, and 5.62% - 7.00%, respectively. The adding of black-eyed peas and mung beans increased the protein content in the rice mix formulas of F 9 and F10. The fiber, fat and ash content of mixed rice were higher than the low-GI commercial rice. Finally, F9 showed higher nutrient content (ash, fat, protein and fiber) when compared to the commercial low GI rice.

Based on the analysis, it is observed that the total phenolic content of the 10 formulas ranged from 12.21 mg/100 g to 19.98 mg/100 g. The addition of pigmented rice to mixed rice formulas, is directly proportional to their total phenolic content.

Amylose Content and Pasta Properties of Some Mixed Rice Formulas

Based on the analysis results, it is observed that there were 8 mixed rice formulas with low amylose content, namely F3, F4, F5, F6, F7, F8, F9, and F10. Table 3 showed that F1 and F2 had medium amylose content, while in the low-GI commercial rice control, it was high. The addition of sticky rice to the mixed rice formulas reduced the amylose content. This phenomenon can be attributed to the higher proportion of amylopectin relative to amylose in sticky rice (Setyawati et al., 2016). The compositional variation in turn influences the textural attributes of the cooked rice products.

Pasta properties is an important characteristic in determining cooked rice texture. Some pasta properties used to describe the cooking and eating quality include gelatinization temperature, peak viscosity, breakdown value, cold viscosity, and setback value. Gelatinization is the process of disruption of molecular arrangement in starch granules characterized by granule swelling, destruction of crystalline structure, loss of birefringence, increase in viscosity, and dissolution of starch components (Liu et al., 2009). The gelatinization temperature in Table

Table 2. TPC and proximate contents of some mixed rice formulas

Sample	Water content (%)	Ash content (%)	Fat content (%)	Protein content (%)	Fiber content (%)	TPC (mg/100 g)
F1	9.34 ± 0.06^{cd}	0.84 ± 0.02^{c}	1.10 ± 0.05^{b}	7.37 ± 0.08^{a}	6.64 ± 0.10^{cdef}	13.94
F2	8.93 ± 0.14^{abc}	0.94 ± 0.02^{d}	1.66 ± 0.07^{d}	7.60 ± 0.09^{ab}	6.30 ± 0.20^{bcd}	17.93
F3	9.28 ± 0.33^{bcd}	0.91 ± 0.03^{cd}	2.55 ± 0.04^{g}	7.61 ± 0.10^{ab}	6.73 ± 0.18^{def}	19.87
F4	9.44 ± 0.40^{d}	1.00 ± 0.04^{de}	3.57 ± 0,03^{i}	7.84 ± 0.05^{b}	6.06 ± 0.19^{b}	19.98
F5	9.42 ± 0.20^{d}	1.08 ± 0.02^{f}	2.50 ± 0.02^{f}	7.82 ± 0.08^{b}	6.43 ± 0.28^{bcde}	14.59
F6	9.67 ± 0.34^{d}	0.61 ± 0.05^{b}	2.19 ± 0.16^{e}	7.63 ± 0.36^{ab}	6.24 ± 0.18^{bc}	13.63
F7	8.87 ± 0.12^{ab}	0.86 ± 0.04^{c}	2.63 ± 0.05^{fg}	7.89 ± 0.02^{bc}	6.33 ± 0.08^{bcd}	12.21
F8	9.49 ± 0.29^{d}	0.87 ± 0.04^{c}	1.51 ± 0.15^{c}	8.21 ± 0.35^{cd}	7.00 ± 0.37^{f}	11.84
F9	9.32 ± 0.22^{cd}	1.08 ± 0.02^{f}	2.66 ± 0.06^{g}	8.92 ± 0.31^{e}	6.53 ± 0.16b^{cde}	13.32
F10	8.96 ± 0.06^{abc}	1.47 ± 0.11^{g}	3.15 ± 0.07^{h}	10.93 ± 0.13^{f}	6.88 ± 0.06^{ef}	14.64
Commercial Low GI rice	8.56 ± 0.13^{a}	0.38 ± 0.05^{a}	0.52 ± 0.01^{a}	8.42 ± 0.12^{d}	5.62 ± 0.16^{a}	-

Table 3. Amylose content and paste properties of some mixed rice formulas

Formula	Amylose content (%)	Gelatinization		Peak viscosity			Viscosity after 10 minutes at 94 °C	Breakdown	Viscosity (cP)	
		Time (Minute)	Temperature (°C)	Time (Minute)	Temperature (°C)	Viscosity (cP)			Cold 50 °C	Setback
F1	20.27 ± 0.17	16	87.5	19	93.8	2205	1670	535	3480	1810
F2	20.70 ± 0.12	17	89.0	20	94.0	1525	1215	310	3305	2090
F3	15.26 ± 0.16	17	89.9	19	93.7	1430	1350	80	2820	1470
F4	16.96 ± 0.21	17	89.7	20	94.1	1850	1285	565	4150	2865
F5	17.31 ± 0.24	17	88.1	20	93.8	1740	1210	530	4220	3010
F6	14.16 ± 0.12	18	92.9	-	-	-	180	-	1135	955
F7	16.23 ± 0.16	18	91.6	20	94.3	1185	1050	35	2725	1675
F8	12.97 ± 0.09	18	93.2	-	-	-	360	-	1175	815
F9	13.43 ± 0.29	17	91.5	-	-	-	380	-	1255	875
F10	17.25 ± 0.24	18	91.0	20	93.9	345	340	5	1085	745
Commercial Low GI Rice	25.32 ± 0.32	17	90.2	-	-	-	1590	-	3085	1495

3 was recorded when the pasta increased in viscosity. Some of the commonly used methods for its measurement include viscometry, optical microscopy, electron microscopy, Differential Scanning Calorimetry (DSC), X-ray Diffraction, Nuclear Magnetic Resonance (NMR) spectroscopy, Fourier Transform Infrared (FTIR) spectroscopy, and simultaneous X-ray scattering (Ai & Jane, 2015). These methods applied different principles in ascertaining gelatinization temperature. According to Jang et al. (2016), the temperature measured by the RVA tool tends to be higher than the melting onset temperature in DSC. This indicated that the melting of the crystalline structure occurs first when compared to the increase in pasta viscosity.

The gelatinization temperature of the samples ranged from 87.5 °C (F1) to 93.2 °C (F8). The 2 types of mixed rice with the highest gelatinization temperature, which were F8 (93.2 °C) and F6 (92.9 °C), had the highest sticky rice composition of 20% and 25%, respectively. Sticky rice tends to have a higher gelatinization temperature (Pang et al., 2016). As presented in Table 3, all mixed formula containing sticky rice have temperatures above 90 °C. Furthermore, the beans were added to samples F9 and F10, and the lipid content of beans is likely to inhibit granule swelling. This has an effect on the increasing gelatinization temperature, as reported by Devi et al. (2020). The gelatinization temperature serve as the minimum requirement for cooking a sample (Kaur et al., 2018). In addition to the fat content of the sample, this value can increase with storage (Falade & Christopher, 2015; Li et al., 2020).

As the temperature increases to 94 °C, the starch granules that absorb water expand until they reach peak viscosity. However, at stable high temperature for a while, they become damaged, resulting in decreased viscosity and detachment of starch molecules. The difference between peak viscosity and viscosity observed after 10 minutes at 94 °C (trough viscosity) is termed the breakdown value.

The peak viscosity of the samples ranged from 345 cP (F10) - 2205 cP (F1). Samples F6, F8, F9 and commercial low GI rice had no peak viscosity. They experienced an increase in viscosity when heated without breakdown. It is crucial to note that some rice, cereals or food products have no peak viscosity and breakdown viscosity due to starch type, composition, and processing. In samples F6, F8, F9 and commercial low GI rice, the absence of peak viscosity and breakdown viscosity was might cause starch type, composition, and processing.

The breakdown value of the samples ranged from 5 cP (F10) - 565 cP (F4). Sample F4 had 50% black rice composition and 25% white and red rice each. Additionally, F1 and F5 also had breakdown value above 500 cP, both had a composition of 50% white rice (one of which is fragrant rice) and 25% black and red rice, respectively. The breakdown value indicate the resistance of starch granules to stirring and heating (Liu et al., 2009).

During the cooling process, an evident increase in the viscosity of the starch pasta became apparent. This surge was primarily attributed to soluble starch molecules, specifically amylose, establishing bonds. The gradual process results in viscosity of the pasta incrementally rising and eventually culminating in the formation of a gel at around 50 °C (Liu et al., 2009). This phenomenon, known as retrogradation or setback aligned with the results by (Belitz et al., 2009). The setback value is the difference between the final and trough viscosity. The final viscosity of the samples ranged from 1085 cP (F10) - 4220 cP (F5), while the setback value spanned between 745 cP (F10) - 3010 cP (F5). Starch with high amylose content often has a higher readiness to retrogradate (Ashogbon et al., 2013), making the final viscosity value greater (Nikitha & Natarajan, 2020). However, in the mixed rice samples, which consisted of white rice, pigmented rice, and beans, other components such as fat play a role in determining the tendency of starch to retrogradate. Devi et al. (2020) reported that the addition of fat to wheat flour samples caused a decrease in the setback value.

Organoleptic Quality of Mixed Rice

Organoleptic test was conducted to gauge the acceptability of the mixed rice among consumers. Sensory or organoleptic attributes carry significant importance as they contribute to acceptance of a product, alongside nutritional and functional properties (David & David, 2020). The results of the organoleptic testing conducted through hedonic and ranking test are shown in Table 4 and 5. According to Table 4, all rice samples garnered moderate to favorable liking from panelists. For the ranking test, mixed rice was grouped into three, namely F1-4, F5-F8, and F9-F10. This division facilitate separate ranking evaluation within each group. Among mixed rice samples in their respective groups, F1, F6 and F10 ranked first, as shown in Table 5. They exhibited the best ranking because F1 had the highest percentage of white rice or white cooked rice, F6 has the appropriate composition of Sintanur or sticky rice, while F9 and F10 had the lesser content of black-eyed peas and mung beans. The addition of more mung beans and black-eyed peas was not much preferred by panelists, as it affects the taste and texture of the cooked rice.

Table 4. Hedonic test results of mixed rice samples

Formula	Total strongly like	Total like	Total moderate	Total dislike	Total strongly dislike	Modus
F1	4	12	11	3	0	Like
F2	2	21	7	0	0	Like
F3	1	18	9	2	0	Like
F4	5	10	7	6	2	Like
F5	2	13	12	3	0	Like
F6	5	19	6	0	0	Like
F7	2	9	13	5	1	Moderate
F8	2	9	12	6	1	Moderate
F9	1	14	14	1	0	Like and Moderate
F10	1	17	10	1	1	Like

Table 5. Ranking test results of mixed rice samples

Formula	Total rank 1	Total rank 2	Total rank 3	Total rank 4	Rank conclusion
F1	11	7	3	9	1
F2	8	12	9	1	2
F3	2	9	12	7	3
F4	9	2	6	13	4
F5	5	9	10	6	2
F6	14	6	9	1	1
F7	2	9	7	12	4
F8	9	6	4	11	3
F9	19	11	0	0	1
F10	11	19	0	0	2

GI and GL of Three Selected Mixed Rice

The results of the GI test showed that F0, F1, F6 and F9 rice had value of 60.3, 48.2, 54.7, and 78.0, respectively, as shown in Table 6. Among the three mixed rice, F1 and F6 had low GI, while value was high in F9. The F0 rice sample, namely Commercial Low GI rice, has a medium value similar to the results of the previous study (Purwani et al., 2007). The GI of mixed rice can be interpreted as the resultant or of each rice component. For instance, black rice had a low GI (63.60) (Dian Nurhayati et al., 2019), while partly polished Inpari 24 - was categorized in the medium class (64) (Rakhmi et al., 2014). White Sintanur and sticky rice, including Grendel sticky rice, exhibited higher GIs of 81.65 and 88.93, respectively (Dian Nurhayati et al., 2019).

Afandi et al. (2019) elucidated the intricate relationship between the composition of carbohydrates and their impact on GI value. Carbohydrates can be categorized as available or non-available, each distinctly influencing the GI. Available carbohydrates, those readily broken down by digestive enzymes, exert an elevating effect on this value. Foods rich in available carbohydrates, such as glucose, disaccharides, oligosaccharides, and digestible starches, are associated with higher GI value. Rice stands out as a prime example, boasting a substantial reservoir of available carbohydrates primarily in the form of starch. However, it is important to note that an elevated starch content doesn’t unilaterally translate to heightened sugar and insulin responses. Various factors come into play, including the structural attributes of the starch, the amylose-amylopectin ratio, and its interactions with other constituents. This insights was reinforced by studies conducted by (Septianingrum et al., 2015; Afandi et al., 2019; Indrasari, 2019). Amylose has an unbranched structure, hence the bonds or interactions formed are stronger and more compact, difficult to gelatinize, resulting in challenging digestion by digestive enzymes. Foods with high amylose content tend to be difficult to digest, which contributes to a decrease in sugar and insulin response. Types of non-available carbohydrates, such as resistant starch and dietary fiber in cereals, affects GI by producing a low value. In the context of rice, an increased dietary fiber content exerts a mitigating influence on glycemic responses, hence contributing to a propensity for lower GI value (Indrasari, 2019).

The GIL of rice was calculated by multiplying the GI with the available carbohydrate content in one serving of the food, divided by 100. GL focused more on how much carbohydrate the body absorbs from rice or food. This implied that it was directly proportional to the servings of carbohydrate foods consumed by the

Table 6. The area under the glucose response curve and GI value of rice mixed with 50 g glucose standard meal

No.	Sample (test food)	Total area under the curve	GI Value
1	Standard I (glucose)	178.8	100
2	Rice (F0)	107.9	60.3
3	Rice (F1)	86.1	48.2
4	Rice (F6)	97.8	54.7
5	Rice (F9)	139.45	78.0

Table 7. GL value of mixed rice

No.	Sample (test food)	GI Value	GL Value
1	Standard I (glukosa)	100	66.7
2	Rice F0	60.3	40.2
3	Rice F1	48.2	32.1
4	Rice F6	54.7	36.5
5	Rice F9	78.0	52.0

body. In this case, the calculation was conducted using a serving size of 150 g of product.

Food is said to have a high, medium and low GL when it has value of > 20, 10-19, and < 9, respectively. Based on these calculations, the 4 rice samples tested had a high GL. This outcome is unsurprising due to the inherently high content of total carbohydrates in rice. F1 (32.1) and F2 (36.5) had a GL below commercial low GI rice (F0) (40.2), while F9 had a greater value (52.0), as presented in Table 7.

The relationship between GI and GL was not always proportional. Foods with high GI will have different effects when consumed in large or small amounts (Permatasari et al., 2015). A high GL value can be lowered by reducing the portion of food eaten, which in turn, decrease the carbohydrates consumed. Achieving stability in blood glucose levels necessitates attention not only to carbohydrate type, but also to the aggregate amount ingested and the broader composition of the meal. It is crucial to recognize that personalized nutritional requirements dictate diverse food preferences. Optimal bodily impact is contingent upon the ability of a food to align with individualized needs for fat, protein, carbohydrates, and dietary fiber content.

CONCLUSION

In conclusion, the proximate analysis showed minimal variations in moisture and ash content among rice samples, while notable differences were observed in fat, protein, and amylose content. After organoleptic test, mixed rice samples F1, F6, and F9 were selected for subsequent evaluation of their GI and calculated GL. The results indicated that the GI value for Taj Mahal rice (a commercially available low-GI rice), F1, F6, and F9 were 60.3, 48.2, 54.7, and 78.0, respectively. Specifically, F1 (32.1) and F6 (36.5) showed lower GL value compared to the commercial low-GI rice (40.2), while F9 exhibited a higher value (52.0). Considering these results, F1 and F6 indicated promise as candidates for further development as mixed rice options due to their favorable nutritional and functional characteristics, low GI value, well-received by consumers. Furthermore, it is important to acknowledge that the nature of carbohydrates, namely available (amylose) or non-available (fiber), significantly influenced the GI value.

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CONFLICT OF INTEREST

There is no conflict of interest with any party in this study.

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