

How to Cite:

Patitungkho, S., Patitungkho, K., & Laeid-on, K. (2022). Chemical compositions and antioxidant activities of the native rice in Thailand. *International Journal of Health Sciences*, 6(S1), 9819–9829. <https://doi.org/10.53730/ijhs.v6nS1.7292>

Chemical compositions and antioxidant activities of the native rice in Thailand

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Abstract---Many kinds of rice are processed in the processing of rice landraces. The farmers can earn more money by milling rice for milled rice, brown rice, and germinated brown rice. The aims of this study were to 1) investigate the chemical compositions, nutritional properties, and biological activities of antioxidants, and 2) to develop health supplements for the elderly together with village community. The native rice selected by the committee was categorized into three types: the Jib rice, the Black Fragrant rice (*Oryza sativa*), and the Dok-makam rice for analysis in this study. The results showed that the Dok-makam rice had the greatest protein, calcium, fiber, vitamins B1, sodium, amylose, and niacin. The most total fat, calcium, iron, zinc, and copper energy is provided by the Black Fragrant rice (*Oryza sativa*). The Jib rice contains the most carbohydrate, potassium, and magnesium. In terms of antioxidant capacity, it was found that the three native rice cultivars had enough antioxidant capacity. However, the Black Fragrant rice (*Oryza sativa*) had the highest antioxidant capacity followed by the Jib rice, and the Dok-makam rice. Three formulas were then developed to create germinated brown rice water: 1) Germinated brown rice water and salt, 2) Germinated brown rice water, fifth wild honey, and black sesame, and 3) Germinated brown

rice water mixed with grains. The results of product testing, the Black Fragrant rice (*Oryza sativa*) had a significantly higher acceptance score for each product quality than the Dok-makam rice, and the Jib rice at the .05 level.

Keywords---Antioxidant activities, Chemical composition, Functional food, Native rice

Introduction

Rice is one of the most important foods for humans, particularly Asian people who prefer rice as a staple food more than people from other continents. As a consequence, Asia produces the majority of rice, accounting for more than 90% of total output. Many Thailand's native rice varieties are available in a variety of colors, ranging from light pink to deep red and black. Rice is an excellent source of carbohydrates, proteins, fats, fiber, vitamins, and minerals, as well as an energy source. It is high in protein, particularly in brown rice grain, and contains eight essential amino acids such as lysine and tryptophan. There are also other bioactive substances such as phenolic compounds, the major flavonoid group is anthocyanins. It also contains folate, tocopherols, tocotrienols, folic acid, phytosterols, and gamma-oryzanol, among others. These substances serve an important in the physiological system, maintaining body balance, promoting health, and preventing diseases by functioning as antioxidants and lowering the risk of cancer and coronary heart disease. Certain types of rice including some the *Luem-Pua* rice contain fatty acids that nourish the brain while also preventing dementia and improving memory. The Black Fragrant rice (*Oryza sativa*) is a pigmented, purple-black rice with a unique aroma and high fiber content. GABA levels are generally high in solid rice such as the *Jib* rice, the *Rouge Champi* rice, and the *Nang Roi* rice. When heated, the *Lao Tak* rice and the White Glutinous rice (*Poaceae*) swell, making them suitable for processing into puffed rice and other products.

People are becoming more health-conscious which is a growing trend. Healthy food is thus an alternative that plays a significant role in providing more options for the new generation, particularly those with high purchasing power. Despite the higher price, we will find colorful rice on sale everywhere, and it is becoming more popular nowadays. It is obvious that promoting rice varieties like the Jasmine Rice 105 has a very depressing price. Once compared to the production volume, the price per ton is less than ten thousand Baht which is lower than the price of other products. As either a result, many people are looking for ways to add value to rice, and developing rice as healthy food is one way to provide it (Moongngarm & Saetung, 2006). Rice varieties differ in terms of physical properties, chemical compositions, and nutritional values.

According to the 2018 report, the number of elderly people in Thailand would rise by up to 11.6 million, accounting for 17.5 % of 69.3 million people (TGRI, 2018). The elderly are particularly concerned about their health, as a popular blessing is, "Wishing you good health and a long life." Due to the obvious dread of aging and being unhealthy, everyone strives to retain health and stay youthful, as well as to

avoid mortality from heart disease, cancer, and obesity. These people became interested in vitamin supplements and food. As a result, increasing the consumption of coarse rice can help to improve the efficacy of nutritious foods and medicinal uses such as homeopathic diets (Supsaman, 2005: 50-55). The native rice in Thailand is suitable for the elderly as it contains carbohydrates, proteins, fats, fibers, vitamins, and minerals, especially in the kernels of coarse rice. It is high in protein and contains essential amino acids: the *Jib* rice, the Black Fragrant rice (*Oryza sativa*), etc.

The research team was interested in researching with the native rice community for the reasons and needs stated above. The farmers have the ability to work in a strong group and are passionate about preserving local rice types. Hence the farmers contains numerous varieties of native rice in Thailand.

Research Methodology

Physical Properties

Stage 1: A study of size and shape according to IRRI standard principles (IRRI, 1996).

The width (*b*, breadth), length (*l*, length), and thickness (*t*, thickness) of 1,000 grains of three types of brown rice were measured along the axis with digital vernier calipers to determine the width (*b*, breadth), length (*l*, length), and thickness (*t*, thickness). The derived mean was then used to determine the equivalent diameter (*D*, Equivalent diameter). The following details were gleaned from the research of physical property.

Step 1: Grain Weight Study

The study of the thousand-grain weight of all three cultivars of brown rice was sampled for 1,000 grains each and weighed.

Step 2: Process and Extraction of Flavonoid Phenolic Compounds

1) Brown Rice Sampling

Three types of brown rice samples used in the extraction were from Nangrong District, Phlapplachai District, and Mueang District, Buriram Province. During November - December 2017.

2) Preparation of Samples of three Varieties of Brown Rice

All three types of high-quality brown rice were chosen, and each variety's rice was crushed into a fine powder and weighed 500 g. Rice was evaluated for antioxidant activity in four replications with 95% ethanol. DPPH and FRAP are two independent approaches.

Chemical Properties Study and Nutritional Value of Rice

The chemical properties and nutritional values of three native rice types namely the Black Fragrant rice (*Oryza sativa*), the *Jib* rice, and the *Dok-makam* rice were determined using the AOAC technique (Association of Official Analytical Chemists, 2005).

Biological Activities Test

1. The antioxidant biological activities of three brown rice extracts were analyzed and compared using the same method for the DPPH experiment (Sharma et al., 2007: 91-98).
2. The antioxidant biological activities of three brown rice extracts were analyzed and compared using the same method for the FRAP experiment (Sharma et al., 2007: 91-98).

Product development of health food supplements from native brown rice varieties

1. Organize a meeting of researchers and farmer groups to analyze the data gathered from the physical properties, chemical compositions, nutritional values, and biological compounds studies. Then, collaboratively, create and prepare a formulation of health food supplements for the elderly.
2. Develop health food supplement products from native brown rice in order to achieve at least three health food supplement formulae produced collaboratively by researchers and farmers.
3. Deliver the developed supplement formula to customers to eat in order to assess acceptability and satisfaction with each formula, such as smell and color preference, taste preference, texture preference, soft flavor preference, and overall preferences.

Research Results

The following are the physical properties of the three native rice varieties:

Table 1
The characteristics of rice types along with the width, length, and color of milled rice

Rice types	The characteristics of rice cultivars	The width-length of paddy (mm.)	Rice kernel color	The indigenous knowledge of planting and caring
<i>Jib</i>	The stalks are light brown in color, good tillered, and have a long tillering period well.	2.55-9.90 Straw without tail	medium brown	It is simple to cultivate in shale fields where Jib rice is planted before May 15, and harvested between late November and early December.
<i>Dok-makam</i>	The stalks are upright and well-branched.	2.54-10.39 Brown, Straw without tail	light yellow	Easy to grow, good tillering, early harvest,

Oryza sativa L.
(RD15)
slightly.

Black Fragrant rice (<i>Oryza sativa</i>)	Purple stalks, short plants, aromatic when cooked in a pot	2.84-9.78 Black-brown, Straw without tail	long-seed purple	good tiller
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The results of the study on the size, shape, and weight of the three rice cultivars.

Table 2
The study of the size, shape, and weight of the rice kernels

Name of the cultivars	Properties Analyzed						
	The seed husk's color	Coat of seeds	Paddy's average weight (mg)	Length of paddy grain (mm)	Breadth of paddy grain (mm)	Brown rice color	Brown rice shape
<i>Jib</i>	Brown	Long	2.62	9.56	2.48	Red	Tapered
Black Fragrant (<i>Oryza sativa</i>)	Brown	Short	2.39	10.43	2.69	Black purple	Tapered
<i>Dok-makam</i>	Dark yellow	Long	2.56	10.39	2.54	White yellow	Tapered

Chemical Properties and Nutritional Values of Rice

The result of antioxidant biological activities of three brown rice extracts were as in Table 3

Table 3
The comparison of chemical composition and nutritional value of rice

Nutrients	Nutritional value per 100 grams of raw rice		
	<i>Jib</i>	Black Fragrant rice (<i>Oryza sativa</i>)	<i>Dok-makam</i>
Energy (kcal)	352.98	366.18	365.28
Moisture (g)	10.93	11.61	11.35
Protein (g)	7.19	7.68	8.36
Total Fat (g)	0.34	3.26	1.44
Total Carbohydrate (g)	80.29	76.53	77.47
Dietary fiber (g)	3.36	3.06	4.67
Ash (g)	1.25	0.92	1.38
Vitamin B1 (mg)	0.36	0.39	0.48
Vitamin B2 (mg)	0.03	0.03	0.03

Calcium (mg)	9.54	11.29	8.72
Phosphorus (mg)	322.35	270.69	371.98
Sodium (mg)	16.58	8.67	60.74
Potassium (mg)	240.94	203.24	221.80
Magnesium (mg)	130.32	75.68	100.66
Iron (mg)	1.01	3.89	1.26
Zinc (mg)	1.68	2.15	1.77
Copper (mg)	0.03	0.21	0.04
Amylose (g)	14.74	14.00	16.32
Niacin (mg)	3.67	3.70	4.75

The *Dok-makam* rice has the largest quantity of protein, phosphorus, fiber, vitamin B1, sodium, amylose, and niacin among the three forms of rice. The Black Fragrant (*Oryza sativa*) rice has the most total fatty acids, calcium, iron, zinc, and copper energy. The *Jib* rice has the greatest concentrations of carbohydrates, potassium, and magnesium.

Antioxidant biological activities test results

The findings of the DPPH method investigation of antioxidant capability

Table 4
The results of the DPPH method research of each compound's antioxidant activities

Substances	Concentration (ppm)	Absorbance at wavelength 520 (nm)			$\bar{x} \pm SD$	Free radical Scavenging Activity (%)
		Round 1	Round 2	Round 3		
Trolox	20	0.48	0.39	0.41	0.428±0.05	27.00
	40	0.38	0.42	0.40	0.402±0.02	31.50
	60	0.33	0.34	0.33	0.331±0.01	43.60
	80	0.13	0.32	0.30	0.247±0.10	57.90
	100	0.10	0.21	0.13	0.147±0.06	75.00
<i>Jib</i> Rice Extract	20	0.71	0.63	0.63	0.656±0.05	3.90
	40	0.61	0.62	0.61	0.613±0.00	9.90
	60	0.56	0.60	0.56	0.575±0.02	15.40
	80	0.39	0.48	0.45	0.440±0.04	35.20
	100	0.14	0.05	0.19	0.129±0.07	81.10
Black Fragrant (<i>Oryza sativa</i>) Extract	20	0.47	0.49	0.47	0.474±0.01	2.30
	40	0.32	0.35	0.37	0.346±0.03	28.70
	60	0.29	0.29	0.22	0.268±0.04	44.90
	80	0.20	0.25	0.24	0.225±0.03	53.60
	100	0.15	0.15	0.10	0.132±0.03	72.80
<i>Dok-makam</i> Extract	20	0.467	0.47	0.37	0.437±0.06	25.60
	40	0.22	0.38	0.38	0.323±0.09	45.00
	60	0.05	0.05	0.04	0.045±0.00	92.30

80	0.05	0.04	0.04	0.042±0.01	92.80
100	0.02	0.03	0.03	0.027±0.01	95.30

Table 5
IC₅₀ Values of Antioxidant Samples

Substances	IC ₅₀ (Inhibitory Concentration 50%)
Trolox	4.30
<i>Jib</i> Rice Extract	83.20
Black Fragrant (<i>Oryza sativa</i>) Extract	71.50
<i>Dok-makam</i> Extract	146.0

The antioxidant ability of the Black Fragrant (*Oryza sativa*) rice is the highest followed by the *Jib* rice and the *Dok-makam* rice.

The FRAP method yielded antioxidant test findings.

The FRAP method of free radical scavenging is an antioxidant method for measuring the effectiveness of reducing Ferric ions to Ferrous compounds. The FRAP reagents which are the precursors of this reaction, combine to form a complex with FeCl₃ to create Fe³⁺. When an antioxidant reduces this complex, a ferrous complex is formed. The absorbance was measured at a wavelength of 593 nm, and the absorbance was obtained, as given in Table 6.

Table 6
The quantity of Fe²⁺ obtained by Ferric Reducing Antioxidant Power Assay

Substances	Concentration (ppm)	Absorbance at wavelength 593 (nm)			$\bar{x} \pm SD$	The amount of Fe ²⁺ (ppm)
		Round 1	Round 2	Round 3		
<i>Jib</i> Rice Extract	20	0.31	0.32	0.30	0.309±0.01	8.30
	40	0.32	0.33	0.34	0.330±0.01	8.90
	60	0.33	0.34	0.34	0.339±0.01	9.10
	80	0.36	0.37	0.37	0.369±0.01	9.90
	100	0.49	0.50	0.49	0.491±0.01	13.30
Black Fragrant (<i>Oryza sativa</i>) Extract	20	0.81	0.77	0.80	0.791±0.02	21.30
	40	0.86	0.87	0.86	0.864±0.00	23.50
	60	0.93	1.01	1.01	0.982±0.04	26.70
	80	1.53	1.49	1.56	1.522±0.03	41.50
	100	2.27	2.26	2.29	2.276±0.02	62.20
<i>Dok-makam</i> Extract	20	0.10	0.09	0.09	0.092±0.01	2.30
	40	0.12	0.12	0.13	0.124±0.00	3.20
	60	0.16	0.14	0.15	0.149±0.01	3.90
	80	0.18	0.18	0.17	0.175±0.01	4.60
	100	0.18	0.20	0.20	0.195±0.01	5.20

The extracts from the Black Fragrant (*Oryza sativa*) rice had the greatest Fe²⁺ content, followed by the *Jib* rice and the *Dok-makam* rice. It was found that the three indigenous rice cultivars had significant antioxidant-containing compounds. Those with black kernels, such as the Black Fragrant (*Oryza sativa*) rice were especially high in anthocyanin.

Health food supplement product development based on native brown rice varieties

The elderly group and the research team researched and debated the techniques of processing the three indigenous rice types. As a result, the board agreed to co-process rice into three food supplement formulae for a total of nine formulas: 1) Germinated brown the *Jib* rice can be divided into three sub-formulas, namely (1) (the *Jib* rice water formula with sugar, and salt, (2) the *Jib* rice water formula with fifth wild honey, pandan leaves, and salt, and (3) the *Jib* rice water formula with grains (sesame, millet), sugar, and salt, 2) the Black Fragrant (*Oryza sativa*) GABA rice into formula three subsidiaries: (1) the Black Fragrant (*Oryza sativa*) rice water formula with sugar, and salt, (2) the Black Fragrant (*Oryza sativa*) rice water formula with fifth wild honey, pandan leaves, and salt, and (3) the Black Fragrant (*Oryza sativa*) rice water formula with cereal grains, (black sesame, millet), sugar, and salt, and 3) the *Dok-makam* GABA rice is divided into three different sub-formulas: (1) the *Dok-makam* rice water formula with sugar, and salt, (2) the *Dok-makam* rice water formula with fifth wild honey, pandan leaves, and salt, and (3) the *Dok-makam* rice water formula with cereals (black sesame, millet), sugar, and salt.

The findings of a survey of senior people's pleasure with healthful beverages

The results of the satisfaction survey of beverages from three native rice varieties with 90 elderly people were as follows:

The color of the beverages would have been 1) the drink made from the Black Fragrant (*Oryza sativa*) rice, and the most popular formula was the second list of ingredients (fifth wild honey with pandan), 2) The drink made from the *Dok-makam* rice which was the most widely recognized formula such is formulas two, and 3) Formula two is the most universally acknowledged formula. Each side was seen as follows:

The olfactory features were as follows: 1) the most popular menu from is the Black Fragrant (*Oryza sativa*) rice was formula one, 2) the most popular menu from the *Dok-makam* rice was formula one, and 3) Formula two was the most widely accepted the *Jib* rice drink ingredients.

In terms of taste were 1) the most accepted formula of the Black Fragrant (*Oryza sativa*) rice drink was formula one, 2) The most accepted recipe was the *Dok-makam* rice drink formula three, and 3) Ingredient one was the most widely accepted the *Jib* rice drink formula.

In terms of texture were 1) the most acceptable formula of the Black Fragrant (*Oryza sativa*) rice drink was formula one, 2) the most accepted list of ingredients from the *Dok-makam* rice was formula three, and 3) the most accepted formula of the *Jib* rice beverage is formula two.

Overall acceptance was as follows: 1) the most accepted kind of the Black Fragrant (*Oryza sativa*) rice was formula three, 2) the most accepted type of

the *Dok-makam* rice was formula one, and 3) the most acceptable type of the *Jib* rice was formula one.

The findings of the variance analysis between variables

The following are the findings of the research on the correlation using rice type as the source variable and product features as the dependent variable.

1. On the color side, the most acceptable is the Black Fragrant (*Oryza sativa*) rice drink.
2. In terms of smell, the most accepted is the Black Fragrant (*Oryza sativa*) rice drink.
3. In terms of taste, the most acceptable is the Black Fragrant (*Oryza sativa*) rice drink.
4. Texture side, the most accepted is a drink from the *Jib* rice
5. Overall acceptance results, the most accepting tester was the *Jib* rice.

It was found that the participants who tasted the research can involve ranked the acceptability of each product feature with a statistically significant difference the level was .05. At a statistically significant level of .05, the acceptability score for each product quality of the Black Fragrant (*Oryza sativa*) rice was considerably greater than that of the *Dok-makam* rice and the *Jib* rice.

Discussion and Conclusion

Farmers have grouped together to cultivate and process native rice, earning more money by selling rice varieties, rice milling to brown rice, and germinated brown rice. In the perspective of industrialization, states were portrayed as little houses in a global village. Although qualitative causes for a shift in power are frequently articulated in the current situation, quantitative analysis backed by scientific facts remains particular (Jermsittiparsert et al., 2013). As a result, the research team collaborated with the community to identify ways to turn rice into germinated brown rice water products that would improve the health of the elderly. By collaborating to establish operational parameters and selecting three native rice types to examine and assess the nutritional value. The biological activities test of free radicals which cause sickness and aging are then analyzed. Subsequently, three formulae were developed to create germinated brown rice water: 1) Brown rice water that has been germinated and mixed with water, and salt, 2) germinated brown rice water with honey, sesame, and salt, along with the formula, and 3) a mixture of germinated brown rice water and grains.

All three types of rice are highly nutritious with the *Dok-makam* rice having the highest content of protein, phosphorus, fiber, vitamin B1, sodium, amylose, and niacin. The Black Fragrant (*Oryza sativa*) rice provides the highest energy, total fatty acids, calcium, iron, zinc, and copper. The *Jib* rice also has the largest levels of carbohydrate, potassium, and magnesium. In terms of antioxidant capacity, the three native rice cultivars were determined to have antioxidant capacity however the rice with the highest antioxidant capacity from both methodologies was the Black Fragrant (*Oryza sativa*) rice. This is due to the fact that the high anthocyanin content of this variety of rice has been found to be favorably connected with its antioxidant potential (Sutharut & Sudarat, 2012). As

a result, rice with a high anthocyanin concentration had a high antioxidant capacity (Lucioli, 2012). This was followed by the *Jib* rice and the *Dok-makam* rice, in that order. In considerations of the Black Fragrant (*Oryza sativa*) rice product results and findings. The acceptance score of each product quality was substantially greater than that of the *Dok-maam* rice and the *Jib* rice at a statistically significant level of .05.

Acknowledgements

The research team would like to thank the National Research Council of Thailand (NRCT Agreement No.3/2018), Buriram Rajabhat University, and Institute of Nutrition, Mahidol University. By enabling, supporting, advising, and double-checking the correctness of the study until it was completed successfully and the villages had additional avenues for earning a livelihood.

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