

Specialty Rice (*Oryza sativa* L.) for Health in Indonesia

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Abstract.

Rice (*Oryza sativa* L.) is the most nutritious staple food for most Indonesian people. The Ministry of Agriculture through the Agricultural Research and Development Agency has released about 300 rice varieties. Some of these varieties have advantages that are beneficial for health. The purpose of this article was to review literature describing the specialty rice varieties from Indonesia, with a particular focus on low Glycemic Index, high antioxidant and high mineral content. Low GI rice is one way of coping with diabetes mellitus (DM). Hyperlipidemia, diabetic syndrome, and cancer diseases could be prevented by consuming pigmented rice which is rich in antioxidants. Fortified rice could be used to overcome iron nutritional anemia and stunting problems. In order to overcome nutritional and health problems in Indonesia, it is hoped that specialty rice could be used as a complementary program in the food diversification program that has been developed by the government. Specialty rice available in the market still has to pay attention to the quality class of the rice. Socialization about specialty rice needs to be conducted, and the availability of specialty rice opens up export opportunities.

Keywords: Specialty rice, health status, Indonesia

Introduction

Rice (*Oryza sativa* L.) is the most nutritious staple food for most Indonesian people. Based on (Food Security Agency, 2021) the level of rice consumption is 94.0 kg per capita per year (Food Security Agency, 2021), with a population growth rate which from 2010 - to 2020 was 1,25% (Central Bureau of Statistic, 2021). Rice in Indonesia is an essential and strategic commodity with increasing demand. Aside from carbohydrates sources, rice also contains a moderate source of protein, fat, fiber, vitamin and mineral and phenolic compound as an antioxidant. However, some rice cultivars are low in nutrients while others are rich in valuable nutrients (Verma et al., 2019).

The Ministry of Agriculture through the Agricultural Research and Development Agency has released about 300 rice varieties. Some of these varieties have advantages that are beneficial for health. Along with the development of science and technology, nowadays functional rice has shifted to food with special functions, especially for health. In 2019 Ministry of Agriculture has released four varieties of specialty rice (BBPADI Litbang Pertanian, 2019).

Generally, milled rice consists of several colors:

white, red, brown, purple and black. Colored or pigmented rice contains nutritional and functional properties that are beneficial for health. Several local rice germplasms from West Kalimantan are unique in terms of rice color, aroma, and texture, including Balik black rice cultivar, Beliah variety purple cultivar, and Sanik red rice cultivar (Indrasari et al., 2016). (Devi et al., 2015) mentioned that consumers prefer to consume polished white rice, even though that brown rice contains valuable nutrient. Whereas the milled or polished white rice has lower nutrient content than unpolished rice that contain rice bran. According to (Verma et al., 2019) and (Rathna Priya et al., 2019) the analysis of the nutrient content of rice varies depending on several factors such as the strain or variety (i.e., white, brown, red, and black/purple), nutrient quality of the soil in which rice is cultivated, the degree of milling and the method of preparation before consumption.

One factor that influence the health status of the general population is nutrition.(World Health Organization, 2003) strongly emphasized the role of unhealthy eating habits, along with sedentary lifestyle and cigarette smoking as a risk factor for the onset of chronic diseases such as cardiovascular disease, cancer, respiratory and metabolic disorders.

In Indonesia, the results of basic health research in 2018 showed that the average prevalence of diabetes mellitus (DM) based on a doctor's diagnosis in a population aged more than or equal to 15 years, was 2%. DKI Jakarta province had the highest prevalence of DM (3.4%), and the lowest was NTT (0.9%). The average prevalence of cardiovascular disease in Indonesia based on a doctor's diagnosis in a population of all ages is 1.5%, the province of North Kalimantan has the highest prevalence of heart disease (2.2%), and the lowest is NTT (0.7%). Based on a doctor's diagnosis, the average prevalence of cancer in Indonesia is 1.8 per mile. The DIY province has the highest cancer prevalence (4.9 per mile), and the lowest is NTB (0.9 per mile). The average prevalence of stroke in Indonesia based on doctor's diagnosis in the population aged more than or equal to 15 years, is 10.9 per mile. East Kalimantan province has the highest prevalence of stroke (14.7 per mile), and the lowest is Papua (4.1 per mile) (Agency for Health Research and Development, 2018). The purpose of this article was to review literature describing the specialty rice varieties from Indonesia, with a particular focus on low Glycemic Index, high antioxidant and high mineral content.

Methods

This research method is a literature study of various scientific papers related to functional rice. Table groups according to the required parameters is made, based on the primary data information collected.

Results and Discussion

Requirements For Specialty Rice

There are several types of specialty rice, and their requirements which are regulated in the Regulation of Ministry of Agriculture No. 31 of 2017 (Appendix II), namely healthy rice, organic rice, geographically indicated rice, and certain rice that cannot be produced domestically. Rice quality class requirements

for specialty rice can be seen in Table 1.

Low Glycemic Index (GI) Rice

Diabetes mellitus (DM) is a metabolic disease characterized by an increased of blood glucose level on the body. This disease is caused by impaired glucose metabolism due to both absolute and relative insulin deficiency. There are two types of DM, namely type 1 diabetes (juvenile diabetes) which is generally acquired since childhood, and type 2 diabetes acquired as an adult (Agency for Health Research and Development, 2018).

The glycemic index (GI) is a food grade according to its effect on blood glucose. Foods that slowly raise blood glucose levels have a low GI. Based on this definition, glucose (as a standard) has a GI value of 100. Food GI values are grouped into low GI (<55), medium (55-70) and high (>70) (Kusmiyati et al., 2019). Meanwhile, the International Rice Research Institute (IRRI) classifies rice into three categories based on its amylose content, namely glutinous rice (0-2%), low (10-20%), medium (20-25%), and high (> 25%) (Juliano, 1993). Consumption of rice with low GI is one way to regulate diet patterns for type 2 diabetes. Rice as a staple food with low GI, rice plays an essential role in regulating diet to control sugar levels in people with diabetes.

Several studies reported the association of rice consumption with an increased risk of developing type 2 diabetes ((Nanri et al., 2010);(Villegas et al., 2007)). The study was conducted in Japan and Shanghai, respectively, and in both places the rice consumed was high in GI because it came from low amylose rice (Fitzgerald et al., 2011).(Indrasari, 2019) has also identified rice varieties with low GI values. Several rice varieties with low GI with high and medium amylose content can be seen in Table 2.

Rice with low GI, which has functional properties that are good for health can be obtained naturally or processed by specific processing methods. Factors that affect rice GI include rice variety and amylose amylopectin ratio, protein and fat, dietary fiber content, starch digestibility, and processing methods (Indrasari, 2019).

No	Quality Component	Unit	Quality Class	
			Medium	Premium
1	Milling degree (minimum)	%	95	95
2	Moisture content (maximum)	%	14	14
3	Head rice (minimum)	%	75	85
4	Broken rice (maximum)	%	25	15
5	Total other rice grains (maximum)	%	5	0
6	Paddy grain (maximum)	(grain/100 g)	1	0
7	Others (maximum)	%	0.05	0

Table 1: Rice Quality Class Classification (Ministry of Agriculture RI, 2017)

Variety	Amylose (%)	GI Value	GI Classification	Reference
High Amylose Content Group				
IR36	27.3	45	Low	(Purwani et al., 2007)
Logawa	25.5	49	Low	(Widowati et al., 2008)
Batang Lembang	25.56	54	Low	(Widowati et al., 2008)
Cisokan	26.68	34	Low	(Indrasari et al., 2010)
Margasari	25.04	39	Low	(Indrasari et al., 2010)
Martapura	26.41	50	Low	(Indrasari et al., 2010)
Air Tenggulang	28.62	50	Low	(Indrasari et al., 2010)
Inpari 12	26.8	53	Low	(Wibowo et al., 2010)
Inpara 4	25.73	51	Low	(Indrasari et al., 2017)
Medium Amylose Content Group				
Ciherang	22.92	54	Low	(Widowati et al., 2009)
Hipa 7	22.7	49	Low	(Wibowo et al., 2010)
Inpari 1	22.0	50	Low	(Wahab et al., 2017)
Inpari 13	22.6	45	Low	(Wibowo et al., 2010)
Situ Patenggang	20.63	54	Low	(Indrasari et al., 2017)

Table 2: Rice with low glycemic index with medium and high amylose content from several rice varieties

Pigmented Rice

There are many kinds of local black rice varieties planted across the country of Indonesia, such as from West Java, Central Java, Yogyakarta, NTT, Sulawesi and Kalimantan (Pratiwi & Purwestri, 2017). Black rice cultivars are significantly variable in their secondary metabolite composition, especially anthocyanin (Zhang et al., 2010). Some rice varieties are better candidates as a source of antioxidants than others (Moko et al., 2014). (Kim et al., 2014) reported that anthocyanin compounds in black rice include cyanidin 3-O-glucoside, peonidin 3-O-glucoside, mal-

vidin 3-O-glucoside, pelargonidin 3-O-glucoside, and delphinidin 3-O-glucoside. The content of Cyanidin 3-glucosidase (C3G) of Beliah purple rice cultivar from West Kalimantan is higher than that of Balik black cultivar in brown rice and milled rice (Indrasari et al., 2016). The total anthocyanin contents among 11 black rice cultivars (mostly from Java) ranged from 53.22 to 650.37 mg/100g of black rice bran (Kristantini et al., 2012).

The cyanidin 3-glucoside is the most abundant anthocyanin in black rice bran extract, which has hypolipidemia effects via regulating hepatic lipogenic

enzyme activities (Um et al., 2013) and prevents hyperlipidemia and diabetic syndromes in fructose-fed rats (Guo et al., 2007). (Xia et al., 2003) reported that black rice pigment is responsible for inhibiting atherosclerotic lesions via a reduction in oxidative stress and inflammation. Dietary supplements containing black rice extract could normalize serum lipid profiles and induce the expression of genes involved in fatty acid metabolism (Jang et al., 2012). In Indonesia, a diet supplemented with a black rice cultivar from Indonesia improved the serum lipid profiles within hyperlipidemia rats better than red or white rice supplementation (Pratiwi et al., 2014). (Wahyuni et al., 2016) suggested that the ethanolic extract of Indonesian cultivar black rice bran inhibited α -glucosidase activity and induced regeneration of pancreatic beta cells, thereby causing an increase in blood insulin level in alloxan-induced diabetic rats. Several studies reported that flavonoids and phenols are the major compounds in colored rice bran that have been suggested to have anti-cancer properties for several types of cancer cells ((Banjerdpongchai et al., 2013); (Takashima et al., 2013)).

Up to now, specialty rice in Indonesia is still limited, and on the other hand, the public need for pigmented rice to be consumed because it is believed for an antioxidant function for health. Therefore, the Ministry of Agriculture, through the Indonesian Center for Rice Research (ICRR) continues to make breakthroughs by assembling and producing varieties that are beneficial to health. Jeliteng, a black rice with a fluffy rice texture has the highest phenolic content (Table 3).

Fortified Rice

Iron Deficiency Anemia (IDA) and Stunting are nutritional problems in Indonesia. The impact of this nutritional problem will inhibit growth from childhood,

adolescence to adulthood. In general, these two nutritional problems are predictions of the low quality of human resources, which in turn will reduce the productivity of a nation in the future. One of the causes of the high prevalence of IDA and Stunting in countries that consume rice as a staple food is the low content of Fe and Zn minerals in milled rice and the low ability of the community to consume foods rich in Fe and other minerals as side dishes ((Indrasari & Kristantini, 2018) ; (Indrasari & Susanto, 2018)).

The government's efforts to overcome the problem of Fe and Zn deficiency are diversification, supplementation, and fortification, but they have a limited reach due to recurring costs and ineffective delivery systems. Biofortification of rice with increased levels of Fe and Zn in milled rice can be a cost-effective and sustainable solution to help combat Fe and Zn deficiency. Biofortification is a process by which the nutritional quality of food crops is improved by means through agronomy, conventional plant breeding, or modern biotechnology. Biofortification of staple food crops which are commonly consumed in large quantities with Fe and Zn has been suggested to be an alternative, complementary, and sustainable approach to overcome Zn deficiency (Bouis et al., 2013).

The Ministry of Agriculture through the Agricultural Research and Development Agency, has released the Inpari 5 Merawu rice variety with a higher Fe content in brown rice (18.3 ppm), in 2008 with the conventional breeding program. While the popular Ciherang variety has an iron content of 11.4 ppm in brown rice (Indrasari et al., 2009). In addition to having high micronutrients, the Inpari 5 Merawu rice variety also has a reasonably high yield, an average of 5.74 t/ha (Suprihatno et al., 2010). Meanwhile, the Inpari IR Nutri Zinc variety released in 2019 contained 29,54 ppm Zn, while Inpari 5 Merawu contained 23,63 ppm Zn (Indrasari & Susanto, 2018).

Variety	Phenolic total	Characteristic
Arumba	5742.35 ± 124.1	Aromatic red rice , fluffy rice texture High Zn content (23.66 ± 0.25ppm)
Pamelen	6929.8 ± 482.3	Red rice rice, fluffy rice texture
Pamera	5384.1 ± 345.8	Aromatic red rice
Jeliteng	7104.3 ± 417.9	Black rice, fluffy rice texture

Table 3: Specialty Rice Varieties released by the Ministry of Agriculture in 2019 (?)

Conclusions

Indonesia is rich in specialty rice such as low GI rice, pigmented rice and fortified rice. Low GI rice is one way of coping with Diabetes mellitus. Pigmented rice is rich in antioxidant that has a hypolipidemia effect and prevents hyperlipidemia and diabetic syndrome, and an anticancer for several types of cancer cells. Fortified rice is to overcome iron nutritional anemia and stunting problems. Therefore, specialty rice could be used as a complementary program from the food diversification program that has been developed by the government in order to overcome nutritional and health problems in the community.

Specialty rice originating from local rice or new superior varieties needs to be developed immediately after going through releasing varieties process. These varieties also need to be registered with competent parties, including the researcher's Intellectual Property Rights (IPR) of researchers. In addition, it is also necessary to certify Rice with Varieties Assurance Label (RVAB) from specialty rice varieties produced through plant breeding in order to increase economic added value and protect consumer rights. It is hoped that specialty rice can meet the food needs of the community in the provision of healthy food. Specialty rice available in the market still has to pay attention to the quality class of the rice Socialization about specialty rice needs to be conducted and the availability of specialty rice opens up export opportunities.

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