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Antioxidant, Nutrition, and Crystallinity Properties From Three Kind of Glutinous Rice of Enrekang Regency, South Sulawesi Indonesia

Nancy Kiay[#1*], Abubakar Tawali[#2], Mulyati M. Tahir[#], Mariyati Bilang[#], Novizar N[+]

[#] *Department of Food Science and Technology, Hasanuddin University, Makassar, South Sulawesi Indonesia*
E-mail: [1]nancykiay@yahoo.co.id; [2]abubakar_tawali@yahoo.com

* *Faculty of Agriculture, Gorontalo University, Gorontalo, Indonesia*

[+] *Faculty of Agricultural Technology, Andalas University, Indonesia*

Abstract*— This research was carried out using a laboratory experiment method, which analyzed the total phenolic content (TPC), antioxidant activity, total anthocyanin, vitamins and the degree of crystallinity with XRD (X-ray Diffractometer), as additional data, analyzed all the elements contained in rice using the X-ray Fluorescence method. The research results showed that the total of Mandoti Kendenan glutinous rice phenol is higher than the other two glutinous rice, respectively 6.88 mg / g (MKR) and 6.74 mg / g (MSR) and 6.24 mg / g (BGR). Glutinous rice from Mandoti Salunkanan and Kendenan has an anthocyanin total of 5.03 mg / g sample and 3.96 mg / g sample is lower than black glutinous rice ie (119.42 mg / g sample). Evaluation of physicochemical properties obtained 11.6-15.01% moisture content, average protein content of 7.98-8.36%, fat content of 1.74-2.25%, total carbohydrates of 88.07-88.49%, and ash content of 0.86-1.15%. Vitamins obtained in all three types of rice showed vitamin B1 in black glutinous rice, namely (0.22) and Mandoti Salunkananglutinous rice of 0.45 but were not detected in the type of Mandoti Kendenan glutinous rice, vitamin B3 was found in all three types of black glutinous rice with values (2.15, 1.63, and 2.76) average total minerals of Cu (0.11), Fe (0.26) and Zn (0.86) ($P \leq 0.05$). The conclusion of this research is that the three types of glutinous rice has antioxidant activity and important components of vitamins and minerals.

***Keywords*— glutinous rice; Mandoti; DPPH; spectrophotometri; XRD; crystanillity; UPLC; XRF.**

I. INTRODUCTION

Rice is the main food widely consumed in South America, Sub-Saharan Africa, and countries in the Asian Region. As the global main food, rice is the important source of carbohydrate, and has the high calorie value. According to the 2014 Report of FAO, the global production of rice in 2014 was more than 738 million metric ton (MMT), providing around 70 MMT of bran [1]. Several factors which can improve the quality of rice, are: providing superior rice seeds; grain processing methods, before and after harvest; and the packaging and storage process in the warehouse.Consumer preference and urge to buy rice depend on the appearance in the form of rice color, as well as the organoleptic quality [2-3]. The rice quality influences the consumers acceptance and the market value. Characteristics of quality cover the physical appearance, food characteristics, and nutrition value [4]. Consumers choose the rice which has the good physical quality and chemistry characteristic; the physical characteristics are the rice form and the grain size, clean rice without polluter, translucent, high nutrition content; the rice with high percentage, slim form, and the texture of "medium to soft" is more preferable [5-6].

The importance of the nutritional quality is related to the lifestyle and the development of various diseases such as hypertension, diabetes, major chronic diseases in several countries in Asia, and obesity, which has increasingly become a major concern in decades in developed countries. [7]. The deficiency of micronutrients can be overcome by adding nutrients to food, and also by biofortification of food that is expected to complement efforts to meet the needs of micronutrients [8-9]. Various diseases appear and cause awareness increase in the adoption of phytochemical-diets. Many research reports that phytochemical, such as phenolic and flavonoid, has the potential to prevent various diseases such as diabetes, cancer, or cardiovascular disease [10-12]. Fruits, vegetables, and rice, are one main source of phytochemical consumed everyday, especially in the Asian countries. Phenolic, flavonoid, and anthocyanin, have been found in the glutinous rice with different colors, such as red rice, black rice, and brown rice. The higher contents of

phenolic, flavonoid, and especially anthocyanin, is inside the black rice, either the sticky rice or non-sticky rice, other than any rice [13-15].

Glutinous rice (Oryza sativa var. Glutinosa) is found in Indonesia with a total production of around 42000 tons per year [16]. Even though white rice is consumed the most, pigmented rice is an alternative food known for its effects that improve health [17]. Colored rice such as red glutinous rice and black glutinous rice have pigments or dyes included in the flavonoid group called anthocyanins. Anthocyanin is an antioxidant which has a positive effect on health. Antioxidants are compounds that have a molecular structure that gives their electrons free of charge to free radical molecules without their functions being disturbed and can break free radical chain reactions. The advantages of red rice and black glutinous rice lie in the anthocyanin content which is located in the aleurone layer [18]. Anthocyanin is a compound that is good for health because it has antioxidant activity [19]. Antioxidants can prevent health problems by reducing free radicals that cause damage to cell components which results in the emergence of various degenerative chronic diseases such as cancer, atherosclerosis, and cataracts [20]. Based on the previous research by Sompong, *et. al.* (2011), the red rice has the content of anthocyanin around 0.33 to 1.39 mg per 100 g; meanwhile, the black sticky rice has the content of anthocyanin around 109.52 to 256.61 mg per 100 g. Goffman and Bergman (2004) also report that the color of the bran is one main factor that influences the concentrate of phenolic inside the rice core. Colored rice is analyzed in big amounts to find out the total content of the phenolic inside the whole grains. The total phenolic from colored rice is around 0.69 to 2.74 mg GAR g-1 grain[21-22].

Previously, a test of Vitamin B had been conducted on the rice bran in the condition of infrared stabilization, to find out the contents of composition of proximate, phenolic compound, and antioxidant component, phytate, dietary fiber, and Vitamin B. the phytate content in the stabilized rice brain reduced, however the contents of crude fat, ash, dietary fiber, and protein, did not change significantly [23].

Based on previous research, a research was conducted to characterize phenolic in glutinous rice with Folin Ciocalteu colorimetric, antioxidants specifically the ability to capture free radicals 2.2-diphenyl-1-picrylhydride (DPPH), and anthocyanin by spectrophotometric methods, vitamin chromatograms using Ultra Performance Liquid Chromatografy (UPLC), the degree of crystallinity with XRD (X-ray Difraction) with other additional data, namely XRF (X-ray Fluorescence) in three types of glutinous rice to determine the content therein in the form of elements.

The aim of this research was to determine antioxidant activity of Mandoti glutinous rice, Analysis of vitamins with and the degree of crystallinity from three kind of glutinous rice of Enrekang Regency, South Sulawesi Indonesia, as additional data, analyzed all the elements contained in rice using the XRF method.

II. Material and Method

Three types of glutinous rice were used in this research. SalunkananMandoti Rice (MRS), KendenanMandotiRice (MRK) and Black Glutinous Rice (BR) obtained from Enrekang Regency, South Sulawesi Indonesia. Rice samples in this research were taken from two locations, Salunkanan Village and Kendenan Village in EnrekangRegency, South Sulawesi.

A. Determination of Phenolic Content

The method of extracting the glutinous rice sample is carried out by putting 50 grams of crushed glutinous rice in a container that has been given a layer of aluminum foil. The glutinous rice sample is extracted. The extraction is done by adding 80% ethanol as much as 250 ml for 1 day, and then centrifuged for 20 minutes at 3000 rpm. Supernatants are collected for the phenolic phytochemical analysis, as well as determination of free-radical antidote activity in the DPPH free-radical system.

The analysis of phenolic content in the *mandoti* glutinous rice of Salunkanan, *kendenan*, and black glutinous rice, by extracting 1 mL of rice each, and put in a test tube by adding 1 mL of Folin-Ciocalteu reagent (50%), a mixture of rice extract, and reagents, vortexed for 3-4 minutes perpendicularly. Then 1 mL of Na2CO3 solution is added. The mixed rice extract samples are stored for 30 minutes. After 30 minutes, the absorbance of glutinous rice extract is read using a spectrophotometer at a wavelength of 750 nm [24].

B. Determination of free radical scavenger ability

The determination of the activity of free-radical scavenger from the glutinous rice extract is evaluated using the method of *Gaulejac, et al,* (1998). In 0.5-ml sample of the glutinous rice extract, 2.5 ml of 1.1-difenil-2-picrylhydrazyl (DDPH) 0.2 mM solution is added into the ethanol inside the test tube, and then perpendicularly vortexed. The efficiency of the free-radical scavenger can be found out by the decrease of the color level from the solution. The absorbance is measured by spectrophotometer at a wavelength of 517 nm, used to measure the deterrence effect from the extract for the DPPH radical. If the 517-nm wavelength absorbance decreases, as a reaction between the scavenger molecule of free-radical and DPPH radical, is by this following equation [25]:

$$FreeRadicalScavenger = 1 - \frac{AbsorbanceSample}{AbsorbanceControl} \times 100\% \quad (1)$$

C. Testing of Total Anthocyanins with a Spectrophotometer.

Reference method: AOAC Official Method 967.17 Chapter 37 p19 (AOAC 2006) The levels of anthocyanins in the sample are calculated as cyanidin-3-glucoside, which can be calculated [26]:

$$Anthocyanin = \frac{A}{\varepsilon x L} \times MW \times DF \times \frac{V}{Wt} \times 100\% \quad (2)$$

Description: A = (A520nm - A700nm) pH 1.0 - (A520nm - A700nm) pH 4.5, MW = = 449.2 g / mol (molecular weight cyanidin-3- glucoside), DF = Dilution Factor = extinction coefficient of cyanidin-3-glucoside 26900 L / mol / cm 1= pathlength (1 cm), 10^3= Conversion from gram to mg.

D. Proximate Composition Analysis (AOAC, 2005)

The proximate composition was determined according to AOAC (2005) methods. Crude protein content analyzed using the Kjeldahl method; crude lipid content referred to the Soxhlet method; while ash content through ash samples over-night at 550°C. Moisture content was by drying samples overnight at 105°C until constant weight was achieved,as well as carbohydrate content was calculated by differences.

E. Vitamin

The Sample Preparation of the glutinous rice extract is Weighed as much as 3 grams of sample, measured with pH 6.30, and Dissolved with 0.05-M sodium dihydrogen phosphate, the sample of rice extract is sonified for 10-15 minutes. The sample of rice extract is homogenized and put into a 2-mL tube, and 14000-rpm centrifuged for 25 minutes, the sample of rice extract is filtered with a 0.20-um RC minisart and then analyzed with the UPLC method.

UPLC PDA method: mobile phase = A: H_3PO_4 0.1%, B: Acetonitrile puree. System: Gradient Flow: 0.2ml / minute, Detector column = Acquity BEH C18 1.7 um (2.1 x 50 mm), column temperature: PDA, Sampling rate: 40^0C, inject volume 20 points / sec = 5 uL

F. X-ray Diffraction

The sample of glutinous rice is put into a sample bottle using X-ray Diffraction XRD 7000 maxima X (Shimadju Ltd., Tokyo, Japan). The target is Cu, at the Laboratory of Science Tech and Building, UniversitasHasanuddin, Makassar. The scanning reflection angle is 10° (2θ) to 80° (2θ). The result of the ratio of peak area to the total area of diffractogram is the relative degree of crystallinity (%).

G. X-Ray Fluorescence

The power chord stabilizer is connected to a power source, and turned on. The delay LED will light until the voltage meter shows 220VAC, and the UPS is turned on. The instrument fan will immediately be turned on when the UPS is on,by pressing the instrument on the instrument's back panel, and turning the X-ray key to the direction of *enable*, and waiting for 2 hours to cool down the detector. On the front panel, there will be a power indicator that will light up, the detector will blink as long as the temperature has not been reached, and will be extinguished when the detector temperature has been reached, and the sample of the glutinous rice is analyzed by inserting into the aluminum container of the XRF which is operated at $Eff._{Silent}$ = 13.0 mm, Viewed Mass = 300,000 mg, Sample Height = 2.26 mm, $Eff._{Area}$ = 132.7 mm^2.

III. Result and Discussion

A. Antioxidant Properties

The results showed that Glutinous Rice Mandoti Salunkanan, Mandoti Kendenan and Black Glutinuous rice extract possess to total phenolic content 6,74 mg/kg gallic acid, free radical scavenging activity 52,03%, anthocianin 5,03 ppm (p>0,05) (table 1). Mandoti Kendenan possess to total phenolic content 6,88 mg/kg gallic acid, free radical scavenging activity 54,78%, and Anthocianin 3,96 mg/100 g sample, Black Glutinous rice possess to total phenolic content7,48 mg/kg gallic acid free radical scavenging activity 59,07%, and Anthocianin 119,42 mg/100gsample. An antioxidant activity test has been carried out on black rice and red rice with several varieties from Sri Lanka, and China, and Thailand, reported that the largest antioxidant activity is owned by the Bahng Gawk (BG) red rice, with a FRAP value of 8.08 mmol Fe (II) per 100 g. Whereas the black rice variety of Niaw Dam PleuakKhao is only slightly different with a FRAP value of 7.58 mmol Fe (II) per 100 g [21].

TABLE I
PHENOLIC CONTENT, ANTIOXIDANT, AND ANTOCHYANIN PROFIL

No	Component	Sample		
		MSR	MKR	BGR
1.	Phenolic Content	6.74 ±0.05	6.88 ± 0.07	7.48 ± 0.07
2.	Antioxidant	52.03 ±0.35	54.78 ± 0.08	85.54 ± 0.3
2.	Anthochyanin	5.03 ± 0.01	3.96± 0.6	119.42 ± 0.5

Mandoti salunkanan rice (a) Mandoti kendenan rice (b) and Black glutinous rice (c)

In this research, the determination of the total phenolic levels to determine the potential of the free-radical scavenger in the mandoti salunkanan of the glutinous rice, kendenan, and the black glutinous rice. The activity of free radicals scavenger is directly related to the content of the total phenolic contained in each glutinous rice. The total phenolic of the extract was measured by the standard gallic acid (mg / g). The use of gallic acid as a standard is because this compound has a hydroxy group and double bond which is conjugated on each benzene ring which causes this compound to be very effective in forming complex compounds with Folin-Ciocalteu reagents, so that the reaction occurs is more sensitive and intensive [27]. The higher the absorbance, indicates the more content of phenolic compounds. The total phenolic content of glutinous rice extracts were 6.74, 6.88, and 7.48 mg / kg gallic acid (Figure 1). The higher concentration of glutinous rice extract shows the more total phenolic contained in the extract, it is assumed that the higher the concentration of glutinous rice extract, the more phenolic or polyphenols components in the extract react, so that the greater total phenolic compounds obtained. The total phenolic content in glutinous rice extract was determined based on the ability of phenolic compounds in glutinous rice extract which react with phosphomolibdat-phosphotungstate acid in the Folin-Ciocalteu (yellow) reagent which changes color to blue because of the reaction with the extract. The older the color intensity of the solution shows the greater the number of phenolic compounds in the extract [27].

The DPPH radical is an unstable free-radical, and if it accepts one electron or hydrogen, it will become a stable molecule. The free-radical antidote activity of glutinous rice, with the DPPH radical test, is used as a substrate to analyze the 1.1-diphenyl-2-picrylhydrazyl (DPPH). [28]. The activity of free radical scavenging in black glutinous rice showed a higher free radical scavenger activity (85.54%) compared to mandoti salunkanan glutinous rice (52.03%) and kendenan glutinous rice (54.78%) (Figure 1). High free radical

scavenging activity in black glutinous rice extract is due to the clearer solution compared to glutinous rice extract solution of mandoti Salunkanan and kendenan glutinous rice, so that the absorbance number that appears on the spectrophotometer is lower than black glutinous rice extract. Poumorad et al. (2006) reported that extracts with the highest content of phenolic compounds showed the highest antioxidant activity. This antioxidant activity is involved by hydroxyl groups in phenolic compounds which act as free radical scavenger. Determination of a solution of free radical scavengerof black rice can be used by testing 1.1-diphenyl-2-pikrillhidrazil (DPPH) radicals. The resolution color reduction level adds to the efficiency of radical antidotes. Testing of DPPH free radical prevention activities using a spectrophotometer was carried out by only looking at the extract with the DPPH solution. Sorbance is needed at λ 517 nm [29].

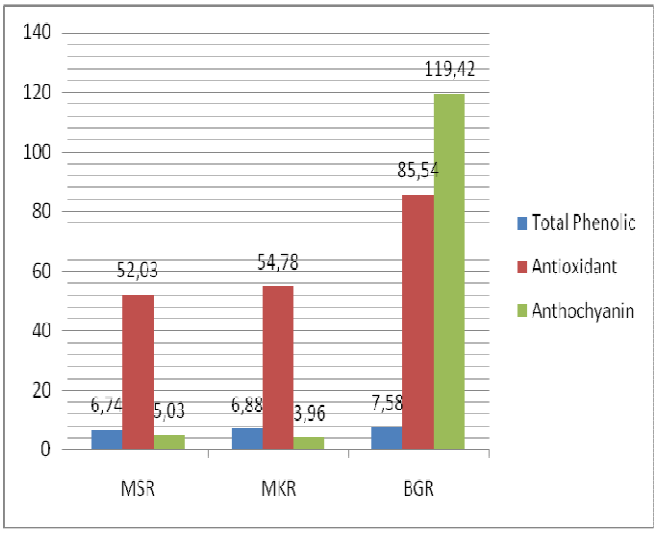

Fig. 1 Histogram Total Phenolic Content, Antioxidant, and Antochyanin Mandoti Salunkanan rice (MSR) Mandoti Kendenan rice (MKR) and Black Glutinous rice (BGR)

The results of the research on the antioxidant activity of glutinous rice extract of mandoti Salunkanan, and black glutinous rice. The antioxidant activity of glutinous rice extracts extracted on average with ethanol had antioxidant activity, respectively 52.03, 54.78 and 85.54%, the total phenol obtained had a positive relationship with antioxidant activity. This has been supported by Walter and Marchesan (2011) reporting that the higher the total phenol, the higher the antioxidant activity [30]. Muntana and Prasong (2010) also reported that antioxidant activity of black rice ishigher than brown rice and brown rice. The total phenol concentration in paddy seeds has a positive contribution to antioxidant activity and is important in antioxidant activity in rice grains. Apart from a large amount of antioxidants, concentrated in greater amounts, the more the composition, the more antioxidant content increases [31]. The antioxidant activity of glutinous rice of mandoti salunkanan, kendenanand black glutinous rice is caused by phenolic compounds that act as antioxidants. Vichapong et al. (2010) stated that the phenol compounds found in pigmented rice were far greater than those without pigments [32]. Khalekuzzaman et al. (2006) informed that pigment compounds in rice samples were bound to the aleurone layer [33]. Sutharut and Sudarat (2012) stated that colored rice (red and black) contained more phenolic content and anthocyanins. Black rice extract has high antioxidant activity. It is important for the body because of maintaining healthy skin, proper functioning of the nervous system and bile and gastric secretions [34-35].

B. Proximat Composition

Table 2 shows the proximate composition of glutinous rice Mandoti Salunkanan, Mandoti Kendenan and Black Glutinous Rice. There was no significant difference (P>0.05) in protein, lipid, moisture content and ash content of black rice. Water is an important component in foods that can affect the appearance, texture, and flavor of food. The water content in foodstuffs in determine acceptability, freshness and durability of food [35]. The analysis results, water content of Mandori Rice Salunkanan, Kendenan and black Glutinous rice ranges from 11,06-15,91%.

TABLE II
PROXIMAT COMPOSITION ANALYSIS THREE KINDS GLUTINOUS RICE

No	Component	Sample		
		MSR	MKR	BGR
1.	Moisture content	11.39 ± 0.53	11.06 ± 0.08	15.91 ± 0.20
2.	Protein	7.98 ± 0.64	8.40 ± 0.11	8.36 ± 0.39
3.	Fat	1.97 ± 0.12	2.25 ± 0.34	1.74 ± 0.27
4.	Carbohydrate	88.49 ± 0.19	88.07 ± 0.26	88.21 ± 0.36
5.	Ash Content	0.90 ± 0.09	0.86 ± 0.06	1.15 ± 0.06

Mandoti salunkanan rice (a) Mandoti kendenan rice (b) and Black glutinous rice (c)

The calculation results of the protein content from the analyzed *MandotiSalunkanan* glutinous rice, *Kendenan*, and black sticky rice, ranged from 7.98% - 8.36%. The average protein content is quite high. This means the *Mandoti* sticky rice and black sticky rice are fluffier. Several research on rice reported that the red rice protein content in North America varied from 9.9% to 14.0%. in Brazil,skin-broken rice contains 7.42% protein, and white rice only contains about 5.71% protein. While skin-broken rice in Thailand contains protein at 7.92%. In Thailand, Sri Lanka, and China, brown rice contains proteins varying from 7.16% to 10.36%. The protein content in brown rice is relatively higher than in ordinary white rice, although the rice undergoes a minimal milling process (brown rice) [35].

The carbohydrate main source of Mandoti glutinous rice carbohydrate content. Determination of carbohydrates contents calculated by difference, by calculating the difference between 100% total moisture, ash, protein, and fat. Analysis result shown black rice carbohydrate content ranged from 88,07-88,49%. Research results of Masniawati et al. 2013 proximate analysis of white glutinous rice (oryza sativa glutinosa) the percent of water content ranged from 16.24%, protein content of 6.81%, fat content of 0.19%, ash content ranged from 0.24%, fiber content of 0.28% , and Carbohydrate levels ranged from 76.24%, in mandoti glutinous rice the protein content is 8.89% [36].

C. Nutrition (Vitamin and Mineral)

Vitamins are organic nutrients that are closely related to the enzyme function. In addition, vitamins perform specific and vital functions in various human body systems, and are very important for maintaining the optimal health. Vitamins are also a catalyst in the body's biochemical reactions. Vitamin B complex is one ofthe water-soluble vitamins. Vitamin B complex is also called nicotinic acid, and niacinamide (nicotinamide) [37].

TABLE III
VITAMIN AND MINERAL PROFILE

No	Component	Sample		
		MSR	MKR	BGR
1.	Vitamin :			
	Thiamin (B1)	0.22	nd	0.45
	Niacin	2.15	1.63	1.76
2.	Mineral :			
	Cu (ppm)	1.02	1.01	1.29
	Fe (ppm)	2.88	2.89	2.64
	Zn (ppm)	0.68	0.69	1.15

Mandoti salunkanan rice (a) Mandoti kendenan rice (b) and Black glutinous rice (c)

Vitamins function in the metabolism of carbohydrates, proteins, and fats. In addition, the vitamin B complex functions in the nervous system and –mostimportantly—for the maintenance of healthy skin. The Vitamin B1 level in mashed rice is not different from the level in ground rice. In general, the vitamin B1 level in husks is the same as in ground rice; while in rice bran, about 2-3 times the content of rice. The vitamin content in rice, especially vitamin B1, depends on the rice variety, and is influenced by the way it is processed [37].

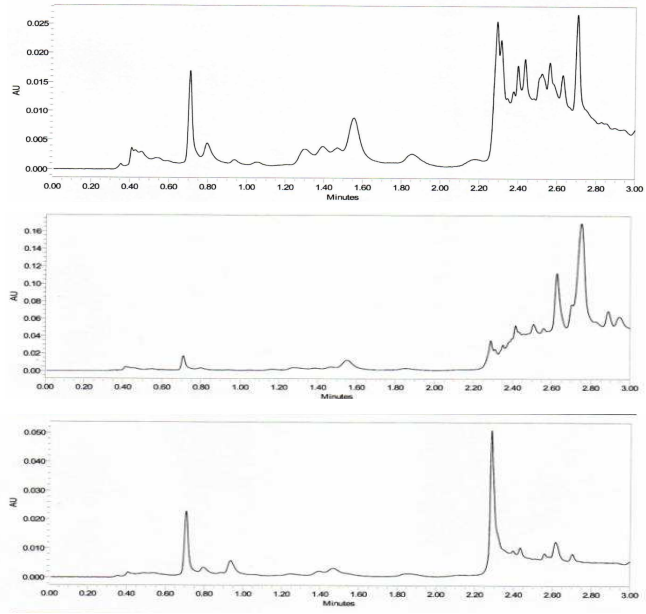

Fig. 2 UPLC Chromatograms of Vitamins B1 detected at the wavelenght of 245 nm.

The nutritional properties of Mandoti Salunkanan Glutinous Rice, Kendenan and Black Glutinous Rice are provided in Table 3. Thiamin (B1) content of Salunkanan Mandoti rice is 0.22, black glutinous rice is 0.45 while the content of vitamin B1 is not detected in Mandoti Kendenan rice. Furthermore, the analysis results with HPLC for niacin (vitamin B3) of the three types of glutinous rice contain niacin with an average value of 1.63, 1.76 and 2.15 with the chromatogram as figure 2 and figure 3.

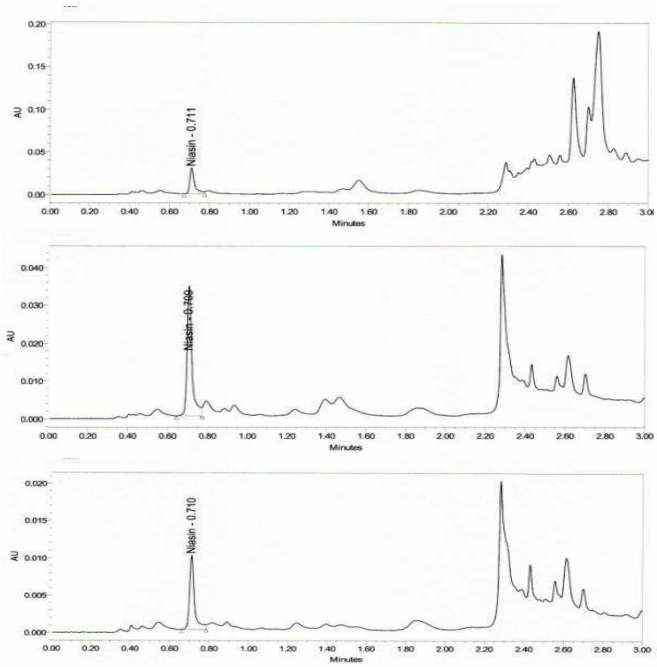

Fig 3. UPLC Chromatograms of Vitamins B3 detected at the wavelenght of 245 nm.

Besides vitamins, rice also contains macro minerals and micro minerals. Analysis of the mineral content of 51 milled rice varieties was carried out using Inductively Coupled Plasma (ICP) tool in 2007, where there were sixteen minerals in rice, namely Cu, Fe, Zn, Mn, Ca, Na, P S, K, B, Mo, Co, Ni, Al, Cd. The mineral content in rice depends on the variety. For example, Indonesian rice of dodokan variety (source of Ca, Mg, K, Zn, Mn, Cu), Indragiri (source of Mg, Na, P, S, Mn), and Batutegi (source of Ca and K) [38].

D. Crystallinity

The crystallinity of *mandotisalankan*glutinous rice starch, *kendenan*, and black sticky rice, can be calculated by the equation, and using the XRD curve image. The ratio result of the peak area to the diffractogram total area is the relative degree of crystallinity (%). Starch molecules are interconnected to form a regular structure, and starch granules are recrystallized during the retrograde period. XRD diffractogram showed a similar crystallinity behavior between the three types of glutinous rice. Compared to the crystallinity degree of black glutinous rice, mandoti salunkanan glutinous rice has a smallercrystallinity and decreased crystallinity in glutinous rice ofmandotikendenan. The XRD diffractogram of the three glutinous rice showed the same crystallinity behavior (Figure 4) about 11.47-14.65% of normal crystals 24%, it was estimated that the degree of crystallinity of the three types of glutinous rice was the main crystal amylose peak. However, the Bragg parameter is slightly different which might be caused by starch crystal polymorphisms (39).

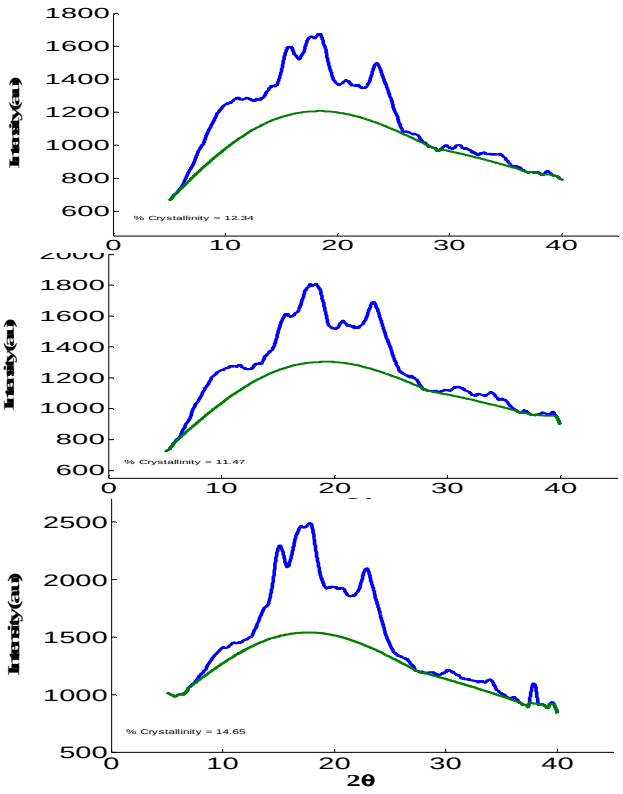

Fig. 4 X-ray diffraction (XRD) data in study diffraction peak assignment. Mandoti Salunkanan rice (a) Mandoti Kendenan rice (b) and Black Glutinous rice (c)

The value of d reflection and angle 2θ of mandoti glutinous rice with those in α-amylose dihydrate starch. Angles d and 2θ at (100) with 100% intensity and other reflections are slightly different. However, all the three show a typical type-A crystal structure, and have a diffraction with 2θ around 12.34, 11, and 14.65 [39].

TABLE IV
FONT SIZES FOR PAPERS

Rice Sample	Reflection/diffraction angles (d, $2\theta^0$,I%)
Glutinous Mandoti Salunkanan	1. (12.61783, 7.0000, 51), 2. (11.35446, 7.7800, 38), 3. (10.34563, 8.5400, 135), 4. (8.94528, 9.8800, 59), 5. (8.17016, 10.8200, 56), 6. (7.44345, 11.8800, 46), 7. (6.29387, 14.0600, 45), 8. (5.69034, 15.5600, 88), 9. (5.00688, 17.7000, 97), 10.(4.81795, 18.4000, 100), 11.(4.27527, 20.7600, 44), 12.(4.06623, 21.8400, 41), 13.(3.77155, 23.5700, 78), 14.(3.35833, 26.5200, 6), 15.(3.29252, 27.0600, 8), 16.(3.21032, 27.7666, 3), 17.(2.99794, 29.7775, 7), 18.(2.91363, 30.6600, 11), 19.(2.81346, 31.7800, 8), 20.(2.70421, 33.1000, 10), 21.(2.62507, 34.1280, 14), 22.(2.48673, 36.0900, 3),
	23.(2.32309, 38.7300,5)
Glutinous Mandoti Kendenan	1. (12.80047, 6.9000, 11), 2. (11.01521, 8.0200, 28), 3. (10.27358, 8.6000, 36), 4. (9.54277, 9.2600, 43), 5. (8.24615, 10.7200, 40), 6. (7.59638, 11.6400, 32), 7. (6.81502, 12.9800, 22), 8. (6.32070, 14.0000, 25), 9. (5.63991, 15.7000, 69), 10.(4.96239, 17.8600, 100), 11.(4.27120, 20.7800, 53), 12.(4.11463, 21.5800, 48), 13.(3.78262, 23.5000, 85), 14.(3.32387, 26.8000, 10), 15.(2.98985, 29.8600, 6), 16.(2.85942, 31.2560, 13), 17.(2.73312, 32.7400, 10), 18.(2.64675, 33.8400, 16), 19.(2.54754, 35.2000, 10) 20.(2.44293, 36.7600, 3), 21.(2.34155, 38.4125, 5),
Black Glutinous	1. (10.93355, 8.0800, 5), 2. (8.96338, 9.8600, 15), 3. (8.15514, 10.8400, 13), 4. (6.44906, 13.7200, 31), 5. (5.87812, 15.0600, 83), 6. (5.20536, 17.0200, 98), 7. (4.97344, 17.8200, 100), 8. (4.47586, 19.8200, 44), 9. (4.29574, 20.6600, 45), 10.(3.87702, 22.9200, 71), 11.(3.36081, 26.5000, 7), 12.(3.10095, 28.7660, 3), 13.(2.94363, 30.3400, 10), 14.(2.87882, 31.0400, 7), 15.(2.76434, 32.3600, 6), 16.(2.69946, 33.1600, 8), 17.(2.63767, 33.9600, 12), 18.(2.55739, 35.0600, 3), 19.(2.37541, 37.8440, 18)

E. Determination of Elements by XRF

According to Mulyaningsih (2009), rice contains sufficient amounts of Fe and Zn minerals [45]. The content of Fe and Zn in rice is <50 µg/g. Therefore, in addition to adequate calories, rice consumption has another important role in the form of adequate intake of Fe and Zn. Previously, the results of the Indrasari research showed that the average of Fe and Zn content in rice in Indonesia ranged from 9,4-16,2 and 18,4-35,0 ppm. Zn / Fe content in rice is also influenced by the degree of rice maize . Zn / Fe content in soil and soil types [46], differences in weather and climate when planting, fertilizing and irrigating, and plant age [47]. The Atomic Absorption Spectrometry, the inductively-added plasma atomic emission spectrometry (ICP-OES), the energy dispersive X-ray spectrometry and the X-ray fluorescence techniques are generally used to detect elements [48]. However, in this research 40 elements were observed in glutinous rice of mandotisalunkanan, kendenan and black glutinous rice (Figure 5) with the XRF technique. 26 important elements have been detected in rice with several techniques [49, 50].

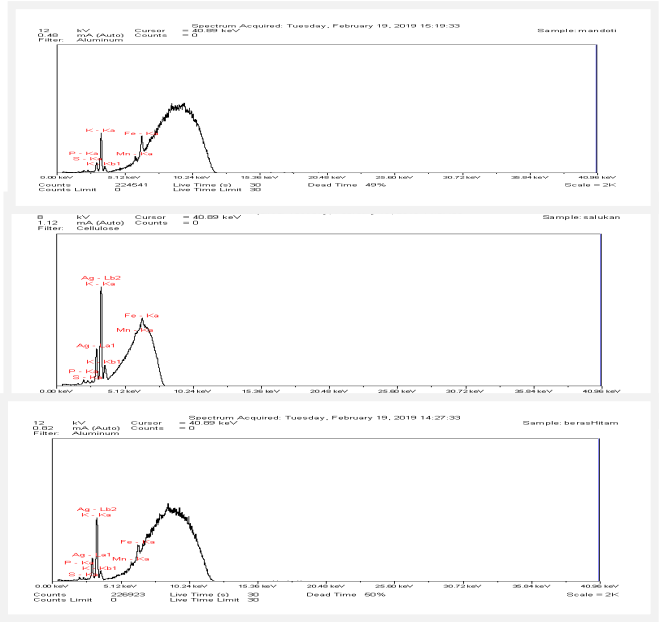

Fig 5. Flourescence spectra of Mandoti salunkanan rice (a) Mandoti kendenan rice (b) and Black glutinous rice (c)

From the research results, the determination of elements withfluorosence X-ray, 12 elements was detected, Fe and Cu is not found in all three types of glutinous rice. Zn is only found in black glutinous rice of 0.287 and not found in the type of glutinous rice of mandoti Salunkanan and Kendenan, but the element of Ca is only found in the type of glutinous rice mandoti salunkanan (1.68) and is not found in glutinous rice mandoti kendenan and black glutinous rice.

TABLE V
PERCENTAGE OF ELEMENTS PRESENCE IN THE RICE SAMPLES

No	Element	Sample		
		MSR	MKR	BGR
1.	P	18.87	19.33	18.47
2.	K	29.57	30.05	32.77
3.	S	6.98	7.38	6.91
4.	Ca	1.68	-	-
5.	Zn	-	-	0.287
6.	Ti	0.42	0.38	0.26
7.	Nb	0.134	0.115	0.051
8.	Sn	0.065	0.049	0.0333
9.	Ni	0.073	0.07	0.0305
10.	Sb	0.066	-	-
11.	Te	-	-	0.035
12.	Mo	-	0.069	-

The other elements detected are the most greatest elements of P and K followed by other elements in the form of elements S, Ti, Nb, Sn, Ni, Sb, Te, Mo. The knowledge of mineral delocalisation in grains is also important to understand their role in seed development. Detection of metals or elements in rice grains has also been investigated from the point of view of nutrition and security. The pattern of distribution of micronutrients or metals in whole wheat is very important because large amounts will be lost during the grinding process before consumed including X-ray flouresence and ICP. The experiment was repeated twice and analysis of elements in the spectrum consistently showed the presence of metals. The percentage of elements after normalization with the XRF technique for the three types of glutinous rice is given in Table 5.

IV. CONCLUSIONS

Antioxidant properties, nutrients and physical chemical properties and the crystallinity of rice have been studied and can be concluded from the three types of glutinous rice having antioxidant activity and important components of vitamins and minerals. This research is very useful as nutritional information, antioxidants and chemical physical properties of glutinous rice which can be developed and utilized as functional food.

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