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Instant organic rice bran milk: A nutritional quality aspect

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Abstract

The nutritional value of rice bran (RB) is interesting for using as food ingredients in any healthy beverages. Functional drink is one of in fashion products cause of its health concern. This study aimed to produce instant organic rice bran milk (IRBM) with nutritional properties determinations. IRBM was prepared by using spray drying technique of pasteurized organic rice bran milk (ratio of RB to water 1:15 (w/v), xanthan gum (0.1%, w/v), sugar (5%, w/v), and vanilla flavor (5%, v/v)). Yield of IRBM was 52.42% based on the initial RB weight. Palmitic acid (C16:0) was the major free fatty acid (FFA) (124g/100g). The FFA (ω-3, ω-6 and ω-9) was observed, while *trans fat* was not illustrated in the IRBM. In terms of amino acid (AA), IRBM is rich of lysine, phenylalanine, and leucine (624.23, 566.64 and 552.79 mg/100g). Phosphorus, potassium, and magnesium were abundant in IRBM (7911.50, 5687.50, and 3311.50 mg/kg), meanwhile iron (15.25 mg/kg) was the lowest. Vitamin B and vitamin E can be found in IRBM. Nevertheless, nutrition value of IRBM was adequate as recommended for consumption per day. According to the results, IRBM could be an alternative healthy beverage and value-added products from rice bran.

Introduction

Utilization of cereal grain by-product as an alternative in dairy cattle has been pervasively investigated since they are lack of lactose which is major cause of lactose intolerance (Mäkinen *et al*., 2015). Rice bran (RB) is the one of material that obtained from rice milling process, its defined as a by-product. There are several reports noted that RB is a rich source of important nutrients such as vitamins, minerals, dietary fibre, essential fatty acids as well as amino acids composition. Moreover, RB is composing various biological active compounds (including; γ-oryzanol, tocopherols, tocotrienols, sterols, and others) which have potent antioxidant and free radical scavenging properties (Liu *et al*., 2017). Even though it promoted in high nutritional value and health benefit, annually around 90% RB is produced in the world which is underutilized as animal feeds or fertilizer or starting material for oil extraction (Schramm *et al*., 2007; Zullaikah *et al*., 2009). However, the completely utilize of the whole RB in food industries have not report yet. The chemical compositions of full-fat rice bran and defatted rice bran (% dry basis) composed of carbohydrate (43.5-54.3%), protein (14.1-18.2%), fat (1.6-20.9%), ash (12.8-15.3%), and fibre (8.4-10.5%) (Prakash, 1996; Moongngarm *et al*., 2012; Friedman, 2013). Issara and Rawdkuen (2016a) reviewed the currently main ingredient in healthy beverage and concluded that RB has potential to be used as ingredient or starting material for functional drink.

According to the nutritional values of RB and consumer trends, stimulate the researchers to develop the product that can utilize the whole RB. In the last decade, RB has been used as a valuable food material for production of various food products such as bakery product (Tuncel *et al*., 2014), snack food (Shih, 2003), and high protein powder supplement food etc. There are some reports on the whole RB utilization as healthy beverage and characterization (Faccin *et al*., 2009; Issara and Rawdkuen, 2014, 2015, 2016b, 2017). Nevertheless, a significant part in particularly nutritional value of the related product has no defined yet. As a consequence, the aimed of this study was to produce the IRBM together with examine its nutritional value.

Materials and Methods

Sample preparation

Stabilized organic rice bran (Hom mali 105) was received from Urmatt Co. Ltd., Chiang Rai province, Thailand. The rice bran was dried in the oven at 60°C for 8 h to prevent lipase enzymatic activity, ground, and passed through sieving machine (Retsch, AS200

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Digit) with 500 µM. Then packed in vacuum plastic bag and stored at -18°C. This sample was used as a starting material for instant organic rice bran milk (IRBM) production.

IRBM preparation

IRBM was prepared according to the method of Issara and Rawdkuen (2014) with some modification. In brief, the ratio of RB to water 1:15 (w/v) was used. Then, the mixture was blended using colloids mill (at 3000 rpm. for 15 min, ASAKO, YJTM85D-2P Model, China). The obtained suspension was filtered by using sheet cloth for 3 times. After that, the filtrate was added with 0.1% (w/v) xanthan gum to increase its stability, 5% (w/v) sugar, and 5% (v/v) vanilla flavour, then mix well before subjected to pasteurize at 72°C, for 15 sec, cooling down. The product obtained was referred as "pasteurized organic rice bran milk: RBM"

The JCM/SDE-10 Minilab Model (Switzerland) with lab scale was used for spray-drying of RBM based on the previous methods of Jinapong *et al*. (2008) and Aalaei *et al.* (2016) with some modification. The nozzle probe was used to create small droplets with a rotational speed of 3,000 rpm. (0.04 bar air pressure) in a co-current air flow system. The inlet and outlet temperature were set at 180±2°C and 80±2°C, respectively by varying the feed rate in the range of 26-33 ml/min. Finally, the IRBM was collected from a cyclone and kept without the moisture for further analysis.

Yield

The yield of IRBM was determined gravimetrically by using the weight of IRBM (X) and starting RB used (Y) as the following equation (1):

$$\text{Yield (\%)} = (X / Y)^{*}\ 100 \qquad (1)$$

Proximate analysis

IRBM was determined for moisture content, total ash, total lipid content, and crude fiber which carried out according to the method of AOAC (2000). For total nitrogen content was determined by Kjeldahl method (conversion factor of 5.95). Total carbohydrate (CHO) content was calculated by the percentage of difference (%CHO = 100- [% moisture + % ash + % lipid + % protein]).

Free fatty acids determination

Free fatty acid (FFA) compositions of IRBM was performed by using gas chromatography Agilent GC 6890N (Agilent Co. Ltd, USA) system coupled to a FID according to an in house method of AOAC (2012) 996.06 and Korean Food and Drug Administration (2015). IRBM (approximately 10 mg) was carried out to methylation of the extracted fat, using methanol-BF3 for fatty acid methyl esters (FAMEs) preparation. A capillary column (100 m x 0.25 mm i.d., 0.2 µm (Supelco), Agilent Co. Ltd, USA) was used to separate the 37 FAMEs. The injection volume was 1 µL in 1:20 split mode with the helium (carried gas) at 40 mL/min. Inlet temperature was 250°C. The GC oven was programmed as follows: 50°C for 1 min, 200°C (25°C min^{-1}) for 5 min, and 230°C (3°C min^{-1}) for 20 min. The temperature of the FID was set to 280°C. The amount of FFA was calculated and identified by comparing a certified of component FAME Mix (SupelcoTM 37).

Amino acids determination

Amino acids profile was determined followed by the method of Rawdkuen *et al.* (2016) based on AOAC method number 994.12 (AOAC, 2000). In brief, amino acids were liberated from IRBM by hydrolysis with 6 M HCl. Then hydrolysates were diluted with a sodium citrate buffer, and the pH was adjusted to 2.2. Amino acid profiles were separated, identified, and qualified by GC-MS technique. The content of each amino acid was reported as mg per 100 g sample.

Micronutrients analysis

Vitamin B_1, B_2, B_3 (Niacin), and vitamin E, were determined by in house method TE-CH-057 AOAC (2012) 942.23. Meanwhile minerals (Calcium, iron, magnesium, phosphorus, potassium, and zinc) of IRBM were analysed according to an in house method TE-CH-170 based on AOAC (2005) Ch.9 (984.27 and 990.10) (The laboratory of Central Laboratory (Thailand), Co., Ltd (Chiang Mai)) by ICP-OES technique.

Statistical analysis

All experiments were performed in triplicate and presented as Mean ± standard deviation (SD). The data was performed by T-test analysis at 95% of significant level using SPSS software (SPSS 16.0 for window, SPSS Inc., Chicago, IL).

Results and discussion

Yield and chemical compositions of IRBM

Yield and chemical compositions of IRBM was compared with starting RB and presented in Table 1. Carbohydrate was the major constituent in both IRBM (86.43%) and RB (48.44%). Comparative to other nutritive beverages such as milk, soybean milk

Table 1. Chemical compositions of IRBM compared with RB

Compositions	Amount (%, wet basis)*	
	IRBM	RB
Moisture	1.51 ± 0.06**	4.21 ± 0.02
Ash	3.55 ± 0.01	9.18 ± 0.02
Protein	4.84 ± 0.48	12.75 ± 0.02
Fat	1.05 ± 0.41	21.48 ± 0.02
Fiber	2.62 ± 0.24	8.14 ± 0.03
Carbohydrate	86.43 ± 0.50	48.44 ± 0.44
Yield	52.42 ± 0.00	-

IRBM: instant organic rice bran milk; RB: rice bran
* Exception for moisture and yield
** The values are expressed as Mean ± SD (n=3), significantly different at p<0.05

as well as cereal grain extract, it is possible to note that the presence of carbohydrate is the main significant different in RB and its related products (Faccin *et al.,* 2009). Moreover, IRBM contains xanthan gum as a stabilizer and sugar for improve tasting; therefore, the high percentage of carbohydrate could be due to those saccharides as well as starch and others. Nevertheless, all compositions in the IRBM was clearly different when compared with initial RB ($p<0.05$). According to Fabian and Ju (2011) noted that the extraction medium and extraction condition play an important role in RB protein and other components, and also influence the recovery of those compounds. As a consequence, low compositions was presented in IRBM may cause by extractability or dilution effect as well as proportion of RB to water for IRBM production.

Fatty acids profile of IRBM

In general, the lipid compositions were expressed by percentage of interested peak area from all peaks. Both saturated fat and unsaturated fat were observed in the IRBM (1.63 and 3.94 g/100g, respectively) and presented in Table 2. Palmitic acid (C16:0) was found and seem as a major FFA (124.00 g/100g) in IRBM when compared with other FFAs. *Trans fat* (bad fat) was not illustrated in the IRBM, meanwhile essential FFA (omega-3, 6 and 9) that promoted in health benefit was observed in this product. However, about 18-times and 22-times lower of ω-3 was observed when compared with ω-6 and ω-9, respectively. Previous comparative studies with similarity product categories were performed. According to Faccin *et al.* (2009) who pasteurized organic rice bran beverage (PRB) reported that the percentage of fat was saturated fat (23.8%), monounsaturated fat: MUFA (43.9%) and polyunsaturated fat: PUFA (32.3%). However,

Table 2. Free fatty acids composition of IRBM

Type of fatty acids	Amount* (g/100g)	Type of fatty acids	Amount* (g/100g)
Butyric acid(C4:0)	ND	Palmitoleic acid(C16:1n7)	ND
Caproicacid (C6:0)	ND	Cis-9-Oleic acid (C18:1n9t)	2.11 ± 0.01
Caprylicacid (C8:0)	ND	Cis-9,12-Linoleic acid(C18:2n9)	1.74 ± 0.00
Capric acid (C10:0)	ND	Alpha-Linolenic acid(C18:3n3)	0.10 ± 0.01
Lauric acid(C12:0)	ND	Monounsaturated fatty acid	2.11 ± 0.01
Tridecanoic acid(C13:0)	0.12 ± 0.01	Polyunsaturated fatty acid	1.84 ± 0.01
Myristic acid(C14:0)	0.03 ± 0.00	Saturated fat	1.63 ± 0.01
Palmitic acid (C16:0)	124.00 ± 1.41	Unsaturated fat	3.94 ± 0.00
Heptadecanoic acid (C17:0)	0.01 0.00	Trans fat	ND
Stearic acid (C16:0)	0.13 ± 0.00	Omega 3**	95.02 ± 0.28
Arachidic acid(C20:0)	0.04 ± 0.00	Omega 6**	1744.28 ± 2.21
Behenic acid(C22:0)	0.02 ± 0.00	Omega 9**	2103.51 ± 10.12
Lignoceric acid (C24:0)	0.04 ± 0.00		

IRBM: instant organic rice bran milk; RB: rice bran
* In-house method TE-CH-208 based on AOAC (2012) 996.06.
** The value are expressed as mg/100g sample
ND = Not detect

the different result was observed when compared with this study, in particularly different major FFA of that product. Oleic acid (C18:1) was the highest (43.7%) and linoleic acid (C18:2) as a second FFA (30.9%), while palmitic acid was the third major FFA (20.3%) in PRB. The comparative studied about fatty acid composition in conventional and organic milk (a case study in Korea) was investigated by Chung *et al.* (2016). They concluded that conventional milk is richer in total FA than organic milk. Compared with conventional milk, about 45% of PUFA including essential FA are higher in organic milk and the PUFA/MUFA and ω-3/ω-6 FA ratios are also respectively 40% and 26% higher. Although cereal grain have been used as a potential for producing an alternative food and beverage products due to the absence of cholesterol and lactose, in part of nutritional aspect especially FFA when compared with plain milk still need to improve.

Amino acids composition of IRBM

Rice bran has abundance source of protein which known in terms of amino acid (AA) (Sereewatthanawut *et al.,* 2008). Amino acids are essential to the body, especially in the part of muscle building and maintenance (Han *et al.,* 2014). They had divided to two types; essential and non-essential AA. However, both of them are significant to human digestibility and absorbability. The AA composition of IRBM was expressed as mg/100g of IRBM and shown in Table 3. The essential AA was observed in IRBM and it rich of lysine, phenylalanine, and leucine which indicated by the highest level when

Table 3. Comparative of amino acids composition of IRBM, pasteurized rice bran beverage, and RB

Type of Amino acids	Amount (mg/100g)		
	IRBM*	Pasteurized rice bran beverage***	RB****
Histidine**	252.23 ± 0.62	92.3	271 - 523.15
Isoleucine**	221.80 ± 11.46	285.2	300 - 698.85
Leucine**	552.79 ± 72.10	648.4	691 - 1473.22
Lysine**	624.23 ± 28.93	184.4	470 - 1010.49
Methionine**	59.20 ± 4.67	91.0	143.64 - 232
Phenylalanine**	566.64 ± 31.11	364.8	443 - 954.22
Threonine**	37.89 ± 1.31	480.7	370 - 646.57
Tryptophan**	20.48 ± 0.99	ND	ND
Valine**	224.95 ± 4.16	435.9	570 - 894.22
Alanine	143.84 ± 2.05	853.8	610 - 1233.66
Arginine	< 5.00	227.4	828 - 1242.70
Aspartic acid	161.79 ± 4.35	983.3	800 - 1419.28
Cystine	70.91 ± 5.01	27.6	123.86 - 232
Glutamic acid	400.42 ± 1.94	1487.7	1250 - 2258.78
Glycine	89.92 ± 5.01	631.4	540 - 946.99
Hydroxylysine	< 5.00	ND	ND
Hydroxyproline	< 5.00	ND	ND
Proline	106.74 ± 1.79	749.7	423 - 651.26
Serine	47.61 ± 035	553.0	410 - 789.89
Tyrosine	428.05 ± 40.21	297.3	313 - 596.83

IRBM: instant organic rice bran milk; RB: rice bran
[*] In-house method based on AOAC (2000) 994.12, 988.15 Detected by GC-MS.
[**] Essential amino acids
[***] Reported as mg/L by Faccin *et al.* (2009)
[****] Reported by Juliano (1985); Wang *et al.* (1999); da-Silva *et al.* (2006); and Faccin *et al.* (2009)
ND = Not detect

compared with others (624.23, 566.64 and 552.79 mg/100g, respectively). The lowest essential AA was tryptophan (20.48 mg/100g). Meanwhile, tyrosine and glutamic acids were the highest amount of non-essential AA (428.05 and 400.42 mg/100g, respectively). Interestingly in AA composition of IRBM was clearly different from previous studies reported for similarity among product as well as original rice bran (starting material). Faccin *et al.* (2009) reported for AA profile in pasteurized rice bran beverage that tryptophan, hydroxylysine and hydroxyproline were not found, while can be obtained some in IRBM (20.48, and less than 5.00 mg/100g, respectively). When compared the range of AA content in rice bran from previous reports (Table 3) by Juliano (1985); Wang *et al.* (1999); da-Silva *et al.* (2006); and Faccin *et al.* (2009), found out that the AA composition of both IRBM and pasteurized rice bran beverage were in contrast. It is possible to be explained that the different contents of rice bran composition (AA) caused by different sources and cultivars (da-Silva *et al.*, 2006) as well as may cause by processing steps since obtaining the final product. Garde-Cerdán *et al.* (2007) reported about comparison between Conventional thermal process and pulsed electric field (PEF) on fatty acids and free amino acids of grape juice, significantly different reduction was found in both thermal and PEF treatments modified the total content of fatty acids and free amino acids. Nevertheless, the essential AA content in IRBM was sufficient as recommended by the FAO/WHO for consumption per day except methionine and threonine. The regulation recommended the amount of histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine should be 34, 119, 229, 103, 45, 90, 87, 22, and 105 mg/kg/day, respectively (FAO, 1981).

Table 4. Micronutrients content of IRBM

Micronutrients	Type	Amount*
Vitamins (mg/100g sample)	B1	0.218 ± 0.00
	B2	0.230 ± 0.00
	B3(Niacin)	0.10 ± 0.00
	E	0.42 ± 0.00
Minerals (mg/kg sample)	Calcium (Ca)	442 ± 4.24
	Iron (Fe)	15.25 ± 0.07
	Magnesium (Mg)	3311.50 ± 34.65
	Phosphorus (P)	7911.50 ± 71.42
	Potassium (K)	5687.50 ± 102.53
	Zinc (Zn)	25.62 ± 1.64

IRBM: instant organic rice bran milk
[*]In-house method TE-CH-057 and TE-CH-170 based on AOAC (2005) Ch.9 (984.27 and 999.10), by ICP-OES technique

Micronutrients content of IRBM

Normally, rice bran has a long history for animal feed such as livestock, but is gaining importance commercially due to their promoted in beneficial nutritive and biological aspect (Gul *et al*., 2015). After polishing process, it remains some micronutrients (vitamins and minerals) which is critical to body function, resulting as it had a potential for food ingredient along with healthy beverages (Friedman *et al.*, 2013; Gul *et al.*, 2015). The vitamin and mineral profiles content in IRBM are shown in Table 4. It is known that the cereals are rich in mineral on its shell fraction. IRBM was abundant in phosphorus, potassium, and magnesium (7911.50, 5687.50 and 3311.50 mg/kg, respectively), while the lowest amount element was iron (15.25 mg/kg). However, all minerals content was adequate as recommended for consumption per day except calcium (Institute of Medicine: US, 1997). The USDA (2012) noted that phosphorus should be intake at least 800 mg, potassium (800 mg), magnesium (350 mg), calcium (800 mg), iron (15 mg), zinc (14 mg), and iodine (150 µg) per day. Vitamin especially a group of vitamin B (B_1, B_2, and B_3: Niacin) was the main vitamin in IRBM. Furthermore, it was also composed of vitamin E (0.42 mg/100g) that plays role an important to antioxidant capacities for oxidative mechanisms inhibition (Wang *et al.*, 2002). Although IRBM provided in significant nutritive values, a comparative studies with commercial plain milk powder and/or same categories product should be more investigated. In addition, a part of product development also need to be concerned for improving its quality to be good for plant-based milk product.

Conclusion

Instant healthy beverage is one of an alternative to added-value of rice bran. Nutritional quality of IRBM in terms of essential amino acids, fatty acids, dietary fiber, vitamins, and minerals content suggested that the IRBM provided an acceptable for human consumption. Further research related to product development and consumers testing are required. As the presented results, IRBM can be a new alternative plant-based functional drink for health concern consumer.

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