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Research paper

Physio-chemical and Functional Properties of Rice Bran

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ABSTRACT

The aim of the present study was to determine physico-chemical and functional properties of Rice bran the proximate composition analysis showed higher protein and fat content in rice bran. Rice bran is a rich source of vitamins, minerals, essential fatty acids, dietary fiber and other sterols. Proximate composition of rice bran (moisture, ash, crude protein, crude fat and crude fiber) were determined. Moisture content of 8.21 to 8.24% was observed, while average percent ash, fiber, fat and protein contents were 9 to 9.1%, 7.14 to 7.15%, and 17.21 to 17.23 and 12.55 to 12.58% respectively.

Keyword: Rice bran, proximate composition, Physico-chemical properties

Rice is a staple food for more than half of humanity According to the Association of Japanese Agricultural Scientific Societies (1975), every continent on the planet produces rice except, Antarctica. The major rice growing countries are China, India, Indonesia, Bangladesh, Thailand, Burma, Vietnam, Japan and the Philippines. Frequently, rice is eaten in cooked form by humans to obtain various nutrients as well as to supplement their caloric intake (Kim *et al., 2011).* The milling of paddy rice has nearly a 70% yield of rice (endosperm) as its major product, although there are some unconsumed portions of the rice produced such as rice husk 20%, rice bran 8% ,and rice germ 2% (van *et al. 2006)*. India is the second largest producer of rice in the world next to China. In India paddy occupies the first place both in area and production. Apart from rice milling, processing of rice bran for oil extraction is also an important agro processing activity for value addition, income and employment generation (Qureshi *et al.* 2000). Rice bran - both full fat and defatted is a rich source of nutrients and can serve as a source of nutrient supplement. Both the bran and oil from rice bran have a range of bioactive phytochemicals with potential for reducing the risk of chronic degenerative diseases. There is a need to utilize the full potential of the available rice bran in the country, both as a source of healthy edible oil and as a food supplement for promoting our population's nutrition and health. The yield of husk, bran and milled rice from 100 kg paddy are 22.8 kg and 73 kg, respectively. The yield of bran depends upon the degree of milling of the brown rice, it may vary from 5 to 10 per cent. In India, polishing is restricted to 5 per cent by Government regulation (Rao, 1988).

Rice bran constitutes 8 per cent of the weight of the whole grain and contains most of the nutrients (65 per cent), such as vitamins, minerals, oils, trace elements, antioxidants, phytosterols and phytochemicals. It contains 12-22 per cent oil, 11-17 percent protein, 6-14

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per cent Fiber, 10-15 per cent moisture and 8-17 per cent ash. It is rich in vitamins including vitamin E, thiamin, niacin and minerals like aluminum, calcium, chlorine, iron, magnesium, manganese, phosphorus, potassium, sodium and zinc (Qureshi *et al*. 2000).

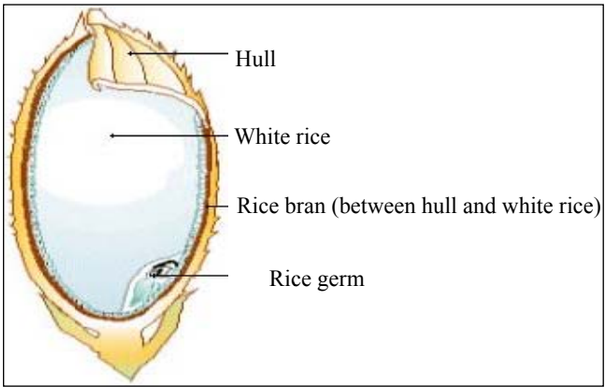

Fig. 1: Structure of mature rice grain

Rice processing or milling produces several streams of material, including husks, milled rice, and bran. Rice bran, a byproduct of rice milling industry is an indispensable, less expensive abundantly available as soft and fluffy off-white powdery material, during the milling period. It constitutes 8% of the weight of the whole grain that contains most of the nutrients (65%). During milling process rice containing nutrients is completely removed with bran (Saunders, 1990).

Rice bran is used for the enrichment of foods, due to its high dietary Fiber content. Since the middle of the 1970s, the role of dietary fiber in health and nutrition has stimulated a wide range of research activities which caught public attention. Accumulating evidence favours the view that increased intake of dietary Fiber can have beneficial effects against diseases, such as cardiovascular diseases, gastrointestinal disease, decreasing blood cholesterol, diverticulosis, and diabetes and colon cancer. In view of the therapeutic potential of dietary fiber, more fiber incorporated food products are being developed. Addition of dietary fiber to a wide range of products will contribute to the development of value-added foods or functional foods that currently are in high demand (Hu *et al.* 2009).

Many studies reported that rice bran has cholesterol lowering properties, cardiovascular health benefits and anti-tumor activity (Qureshi *et al.* 2000). Rice bran is good source of protein (16.5 g/100 g), fat (21.3g/100g), carbohydrate (49.4g/100g), mineral (8.3g/100g), crude fiber (11.4g/100g), starch (24.2g/100g), total sugar (5.0g/100g), thiamin (3.0mg/100g), riboflavin (0.4mg/100g), niacin (43mg/100g) (Rao 1988). Rice bran is the best source of total lipids and phytosterols based on raw material. Furthermore, presence of antioxidants like tocopherols, tocotrienols and γ-oryzanol also brighten prospects of rice bran utilization for humans as functional ingredient to reduce the life threatening disorders. To improve quality and nutrition of food product, rice bran can be evaluated as a potential food ingredient. It has been used in food as full-fat, defatted bran, bran oil, and protein concentrates. Rice bran is used by the food industry in the production of baked foods, snacks, crackers, breads, cereals, pastries, pancakes, noodles, muffins, biscuits (Ozgul *et al.* 2014) The protein of rice bran has relatively high nutritional value. The interesting characteristic of rice bran protein is that it is composed of high amount of lysine, an essential amino acid (Sudarat *et al*. 2005). From fatty acid containing about 12-18% palmitic acid, 40-50%, oleic acid and 30-35% linoleic acid which makes them represent about 90% of fatty acid. (Malekian *et al.* 2000). Producing food with high content of fibers and with considerable level of calories and also good physical and organoleptic characteristics acceptable for consumers is big challenge for producers (Gajula, 2007).

In the present study the functional and nutritional properties of rice bran is determined. The rice bran could be used for the development various value added foods like bread, cookies, muffins etc.

MATERIALS AND METHODS

Collection of rice bran

The sample namely full fatted raw rice bran was procured from the Gulaba Rice Mill, Roha.

Proximate analysis of rice bran

1. Moisture Content

The moisture content of the rice bran determined was by AOAC (2010). 10-15 g of the rice bran samples was taken for in to each three different moisture boxes. The initial weight of moisture box was recorded. The samples were exposed to 105°C ± 1°C for 24 hr. in a hot air oven (Make M/s: Aditi Associate, Mumbai. Model: ALO-136). The final weight was recorded. The moisture content of the sample were determined by equation (1);

$$\text{Moisture content (\% db)} = \frac{W_2 - W_1}{W_3 - W_1} \times 100 \qquad \ldots(1)$$

Where,

W_1 = Weight of moisture box, g

W_2 = Weight of moisture box + sample g

W_3 = Weight of moisture box + oven dried sample, g

2. Protein

Protein in the rice bran was determined by a micro-Kjeldahl distillation method (AOAC 1990). The rice bran 1-2 g was digested by heating with concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture, potassium sulphate (K_2SO_4) and copper sulphate ($CuSO_4$). The mixture was then made alkaline with 40% NaOH. Ammonium sulphate thus formed. Released ammonia which was collected in 4% boric acid solution and titrated again standard HCL. The percent nitrogen content of the sample was calculated the formula given below. Eq (2) Total protein was calculated by multiplying the amount of percent nitrogen with appropriate factor (6.25).

$$\%\ N = \frac{\left(\text{Sample titre} - \text{Blank titre}\right) \times N\ HCL \times 1.4 \times 100}{\text{Weight of sample}} \times 100 \qquad \ldots(2)$$

% Protein = % N × Factor (6.25).

3. Ash Content

The ash content of rice bran was determined using the method of AOAC (1990) Porcelain crucible were dried and cooled in desiccators before weighing. Five grams of the rice bran were weighed into the crucible and the weight was taken. The crucible containing the samples were placed into the muffle furnace and muffle furnace was kept at 500°C. This temperature was maintained for three hours. The muffle furnace was then allowed to cool; the crucibles were then brought out, cooled and weighed. The ash content was calculated as follows:

$$\%Ash = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100 \qquad \ldots(3)$$

Where,

W_1 = weight of crucible + ash,

W_2 = weight of empty crucible.

4. Fat Content

The fat content of the rice bran determined using solvent extraction in a soxhlet apparatus as described by James, (1995) Two grams of each of the rice bran were wrapped in a filter paper and placed in a soxhlet reflux flask which is connected to a condenser on the upper side and to a weighed oil extraction flask full with two hundred mili petroleum ether. The ether was brought to its boiling point, the vapor condensed into the reflux flask immersing the samples completely for extraction to take place on filling up the reflux flask siphons over carrying the oil extract back to the boiling solvent in the flask. The process of boiling, condensation, and reflux was allowed to go on for four hours before the deffated samples were removed. The oil extract in the flux was dried in the oven at 60°C for thirty minutes and then weighed.

$$\%\ Fat = \frac{W_4 - W_3}{W_2 - W_1} \times 100 \qquad \ldots(4)$$

Where:

W_1 = weight of oven dried thimble,

W_2 = weight of sample used,

W_3 = weight of round bottom flask,

W_4 = weight of round bottom flask with fat residue.

5. Crude Fiber

About 2 g fat free residue of rice bran was taken and then transferred to the digestion flask. 200 ml boiling sulphuric acid was added and immediately the flask was connected to condenser. The flask was heated, boiled by frequently rotating for 30 min and the volume was maintained with hot water. Then filtered through filter cloth in a fluted funnel. The residue was washed on cloth with hot water or potassium sulphate solution. The residue was returned to digestion flask by washing with hot water. 200 ml boiling sodium hydroxide was added and boiled for 30 min. The volume was adjusted with boiling water, filtered it thorough the muslin cloth and the residue free of alkali was washed. The residue was transferred into crucible and washed with 15 ml alcohol and the crucible was dried at 110°C for 2 hrs. The crucible was cooled in desiccators and weighed the crucible was ignited in the furnace at 550 °C for 30 min then cooled and weighed. The loss in weight represented the crude fiber.

$$\text{Crude fiber (\%)} = \frac{(W_1 - W_2)}{\text{Weight of sample } (g)} \times 100 \quad \ldots(5)$$

Where,

W_1 = Weight of material before ashing (g)

W_2 = Weight of material after ashing (g)

6. Carbohydrate Content

Carbohydrate content rice bran was determined by subtracting the total sum of protein, fiber, ash and fat from the total dry matter 100 (James, 1995). The carbohydrate was calculated by using following equation (6)

$$\text{\% Carbohydrate} = 100 - (\text{\%protein} + \text{\% fat} + \text{\% fiber} + \text{\% ash} + \text{\% moisture content}) \quad \ldots (6)$$

7. Bulk density

The bulk density of rice bran was determined according to the method described by (Vengaiah *et al.* 2013). A graduated measuring cylinder of 10 ml was weighed the rice bran was filled in to it by constant tapping until there was no further change in volume. The cylinder with the sample was weighed and the difference in weight was determined. The experiment was replicated for 5 times the average value of bulk density was reported. The bulk density was calculated by using following equation (7);

$$\text{Bulk density (g/ml)} = \frac{(W_2 - W_1)}{\text{Volume of sample}} \times 100 \quad \ldots(7)$$

Where

W_2 = wt. of measuring cylinder with sample

W_1 = wt. of measuring cylinder

8. Water absorption capacity

Water absorption of rice bran was determined using the method of Sosulski (1962) with slight modifications. The sample, 3g was dispersed in 25 ml of distilled water and placed in pre weighed centrifuge tubes. The dispersions were stirred occasionally. After a holding period of 30min, the dispersions were centrifuged at 5000 rpm for 25 min. The supernatant was removed and the pellet was dried at 50°C for 25min which was cooled and weighed. The water absorption capacity was expressed as grams of water retained in the material. The experiment was repeated for three times and average water absorption was reported;

$$WAC(g/ml) = \frac{(W_2 - W_1)}{W_0} \times 100 \quad \ldots(8)$$

Where,

W_0 = the weight of the sample, g;

W_1 = the weight of centrifuge tube plus sample, g and

W_2 = the weight of centrifuge tube plus the sediments.

9. Oil absorption capacity

Oil absorption capacity of rice bran was determined using the method of Sosulski (1962) with slight modifications. The sample, 3g was dispersed in 25 ml of oil and placed in pre-weighed centrifuge tubes. The dispersions were stirred occasionally. After a holding period of 30 min, the dispersions were centrifuged at

5000 rpm for 25 min. The supernatant was removed and the pellet was dried at 50 °C for 25 min which was cooled and weighed. The oil absorption capacity was expressed as grams of water retained in the material. The experiment was repeated for three times for replication.

$$OAC(g/ml) = \frac{(W_2 - W_1)}{W_0} \times 100 \quad \ldots(9)$$

Where,

W_0 = the weight of the sample, *g*;

W_1 = the weight of centrifuge tube plus sample, *g* and

W_2 = the weight of centrifuge tube plus the sediments

10. Colour Determination

Colour of rice bran measured by using Konica Minolta colour Reader. (Make: Minolta Camera Co. Ltd. Japan Model: (R-10). The colour of the rice bran was measured in dark room. Rice bran was placed on white surface and placing colour reader on the rice bran in a Petri dish and the colour was measured in L, a, b were reported. Where L value indicates degree of lightness or darkness, 'a' value indicates redness or greenness and 'b' value indicates the yellowness or blueness.

RESULTS AND DISCUSSION

Physico-chemical and functional properties of Rice bran

Table 1 shows the Physico-chemical properties of rice bran. Various Physico-chemical properties i.e. (a) Moisture content; (b) Protein; (c) Ash; (d) Fat; (e) Fiber; (f) Carbohydrate; (g) Water holding capacity; (h) Oil holding capacity; (i) Bulk density; (j) Colour in term as L, a, b for were reported and discussed.

1. Moisture content

Table 1 (a) shows the Moisture content of rice bran found to be in the range of 8.21 to 8.24% and average was 8.22%±0.015. Moisture content of rice bran was reported in literature are 6.45 9.48%,8.5%, 10-12% by Mohammad *et al. (*2014); Sudarat *et al.* 2005; Ozgul *et al.* (2014) and Qureshi *et al*. (2000) respectively.

2. Protein

Table 1 (b) shows the Protein of rice bran found to be in the range of 12.55-12.58% and average was 12.56%±0.015. Protein content for rice bran was reported by the various researchers Mohammed *et al.* (2014) Sudarat *et al*. (2005); Ozgul *et al.* (2014); Parkash (1996) and Qureshi *et al*. (2000) was 12.26-

Table 1: Physico-chemical and functional properties of Rice Bran

Sl. No.	Parameter	Range	Average	Standard deviation
(a)	Moisture content (%)	8.21-8.24	8.22	0.015
(b)	Protein (%)	12.55-12.58	12.563	0.015
(c)	Ash	9.0-9.10	9.10	0.10
(d)	Fat (%)	17.21-17.23	17.22	0.010
(e)	Fiber (%)	7.14-7.16	7.15	0.010
(f)	Carbohydrate (%)	45.63-45.85	45.74	0.11
(g)	Water holding capacity(g/ml)	2-2.2	2.10	0.005
(h)	Oil holding capacity(g/ml)	1.54-1.55	1.55	0.10
(i)	Bulk density (g/ml)	0.39-0.40	0.393	0.010
(j)	Colour "l"	79.33-79.83	79.503	0.28
	Colour "a"	4.66-4.68	4.676	0.015
	Colour "b"	26.43-26.46	26.74	0.017

14.01 %, 12.6%, 11-17%, 19.4-76.1%, 17.5-85% and 12-22 % respectively.

3. Ash

Table 1 (c) shows the ash of rice bran found to be in the range of 9-9.1% and average was 9.1%±0.1. Ash content for rice bran was reported by various researcher Mohammed *et al.* (2014) Sudarat *et al*. (2005); Ozgul *et al.* (2014); Saunders (1985); Qureshi *et al*. (2000) was .7.24 -10.63%, 8.97 %, 8-17%, 8-22.2%, 8-14%. Carroll (1990) stated that 6.0-9.0 per cent ash was present in stabilized natural rice bran.

4. Fat

Table 1 (d) shows the Fat of rice bran found to be in the range of 17.21-17.23% and average was 17.22%±0.01. Fat content for rice bran was reported by various researcher Mohammed *et al.* (2014); Sudarat *et al*. (2005); Ozgul *et al.* (2014); Saunders (1985); Qureshi *et al*. (2000) was .23.53-27.8%, 8.97 %, 12-22%, 4.7-22.6%, 12-22.

5. Fiber

Table 1 (e) shows the Fiber of rice bran found to be in the range of 7.14-7.16% and average was 7.15%±0.015. Fiber content for rice bran was reported by various researcher Mohammed *et al*. (2014); Sudarat *et al.* (2005); Ozgul *et al*. (2014); Saunders (1985) and Qureshi *et al*. (2000) was .2.5 10.10%, 5.59 %, 6.-14 %, 6.2-26.9%, 6-14%..

6. Carbohydrate

Table 1 (f) shows the Carbohydrate of rice bran found to be in the range of 45.63-45.85% and average was 45.74%±0.11. Carbohydrate content for rice bran was reported by various researcher Mohammed *et al*. (2014); Sudarat *et al.* (2005); Ozgul *et al*. (2014) and Qureshi *et al*. (2000) are .42.19-45.74%, 43.12%, 53-65% and 53.68%.

7. Water holding capacity

Table 1 (g) shows the water holding capacity of rice bran was in the range of 2-2.2 ml/g and the average value was 2.1.ml/g±0.005. Water holding capacity of rice bran reported in literature was 2-3ml/g, and 1.74ml/g by Bhosle *et al (*2015) and Rafe *et al.* (2017) respectively.

8. Oil holding capacity

Table 1(h) shows the oil holding capacity was of rice bran in the range of 1.54-1.55 ml/g and the average value was.1.55ml/g±0.1. Oil holding capacity of rice bran reported in literature was 1.5-2.5ml/g, by Bhosle *et al.* (2015).

9. Bulk density

Table 1 (i) shows the bulk density of rice bran was in the range of 0.39-0.40g/ml and the average value was 0.393g/cc ± 0.01. Bulk density of rice bran reported in literature was 0.22g/ml, 0.41g/ml 0.39g/ml by Bhosle *et al. (*2015), Rafe *et al.* (2017) and Rao *et al.* (1998) respectively.

10. Colour

Table 1 (j) shows the colour for rice bran. 'L' value for rice bran was 79.33-79.83 and average value was 79.503±0.28, 'a' value for rice bran was 4.66-4.68 and average value was 4.67±0.015. 'b' value for rice bran was 26.43-26.46 and average value was .26.74±0.017. Similar result was reported in literature was that the colour of rice bran l, a, b value 69.13 3.29 21.38 respectively (Sangle *et al*. 2016).

CONCLUSION

Proximate composition of rice bran (moisture, ash, crude protein, and crude fat crude fiber) and functional properties (water holding capacity, oil holding capacity and bulk density) were determined. Moisture content of 8.21 to 8.24% (db) was observed, while average percent ash, fiber, fat and protein contents were 9 to 9.1%, 7.14 to 7.15%, and 17.21 to 17.23% and 12.55 to 12.58% and functional properties i.e. Water holding capacity and bulk density was 2.1ml/g, 1.55ml/g and 0.393g/cc respectively.

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