Pak. j. sci. ind. res. Ser. B: biol. sci. 2025 **68B** (1) 78-83

Nutritional Analysis of Bakery Products Made From Broken Rice (*Oryza sativa* L.)

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(received November 2, 2022; revised September 8, 2023; accepted September 22, 2023)

Abstract. The study aimed at examining the nutritional analysis of broken rice (*Oryza sativa* L.) and bakery products made from it. In current project basmati broken rice was used. Some of the broken rice was used for the nutritional analysis, while rest was ground in the fine rice flour for making biscuits and pancakes. Nutritional analysis showed that the biscuits made with rice flour were rich in protein, fat, fibre and total carbohydrates content, while pancakes made with rice flour was rich in moisture, fat and energy in calorie content. Therefore, we can use broken rice with a mixture of other flours for making bakery products because of their fine taste and gluten free properties.

Keywords: rice, broken rice flour, nutritional/proximate analysis, biscuits, pancakes

Introduction

Rice belongs to grass family Poaceae (*Oryza sativa* L.) which include important staple crops such as rice, wheat, maize, sorghum and millet of a large population of the world (Sikdar *et al*., 2017). *Oryza sativa* is the most widely grown, about 3.5 million people use rice as a staple food for more people than wheat. Rice is the 2nd largest produce cereal in the world (Cannas *et al*., 2020). Rice production and usage is highest in Asian countries. Rice contributes upto 50% of daily calorie intake and a significant portion of protein (Muthayya *et al*., 2014).

Rice is the primary source of nutrition for half of the world's population particularly in the East and as a result, extensive rice cultivations are common around the world (Wasim, 2002). Approximately 600 million tons rice is harvested worldwide annually (Esa *et al*., 2013).

Rice cultivation extends from humid tropics to temperate regions of the world. Asia is considered as the hub of majority of the rice production also rice cultivation is done at extensive areas in Oceania and Europe. Hence, rice can be grown in a variety of climates, on different soil types and characteristics with wide geographic distribution (Chandio *et al*., 2016).

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In Asia, Pakistan is among the top 10 rice exporting countries. World Trade Development Authority stated Pakistan as world 12th biggest rice producer and 3rd rice exporter. Mainly Pakistani rice is exported to UAE, Iran, Saudi Arabia, Kenya and Afghanistan (Jafar *et al*., 2015).

Rice is the most easily digestible of all staple diets. Wheat, barley, corn and other staple diets may not be digested by children, elders, ill or the weak. As a result, rice is the most suitable diet for them (Gui *et al*., 2022). Gluten is a unique protein present in wheat which give viscoelasticity to bakery products. This is in turn a disadvantage of wheat because gluten can cause allergy in many people (Ma *et al*., 2021). To avoid such conditions other cereals such as rice should be used as alternative source (Wanyo *et al*., 2009). Rice has the properties such as lack of gluten, low protein, fat, fibre, sodium and high amount of easily digestible carbohydrates (Sivaramakrishnan *et al*., 2004).

Rice grain peeling, honing and polishing are the main steps of rice processing (Zhai *et al*., 2001). After the milling process inedible or undesirable parts are removed and edible part of rice particularly broken rice could be processed into a variety of value added products such as rice flour, rice milk, rice puddings, rice starch, rice glue, rice cake etc. Broken rice is the main product of

rice industry. They are equally important and beneficial (Padma *et al*., 2018).

Broken rice is a high-quality product with protein and metabolizable energy levels similar to maize and a good proportion of starch both of them are nutritionally and technologically important. As a result, broken rice has a high starch content and might be used as flour in the production of processed meals such as breads, cookies, simple extracts and compounds with fruit pulp, fermented drinks, sweets, and so on. Rice flour manufacturing is one of the solutions for adding value to broken rice while minimizing economic losses to the rice sector (Carvalho *et al*., 2012). Rice flour is a perfect ingredient to prepare gluten free products, because of its taste, white color and hypoallergic activities (Haleem and Amal, 2016). The purposed study was carried out to assess the nutritional composition of broken rice, to develop value added bakery products from broken rice and their nutritional estimation. The study further helped in creating awareness among public for beneficial uses and consumption of broken rice in daily life routine.

Material and Methods

Sample collection. Basmati broken rice was obtained from local market. Some of the sample was taken as such for proximate analysis while rest of the sample was ground into fine rice flour for making value-added products such as Pancake and Biscuits. The work was done at Food and Biotechnology Research Center, PCSIR Laboratories Complex, Lahore.

Development of biscuits and pan cakes. For biscuits finely ground rice flour, all-purpose flour, baking powder, salt, brown sugar, vanilla essence, egg and butter were mixed together to make a dough. Cookie cutters were used to give different shapes and after that, biscuits were baked in pre-heated oven (Fig.1a). For making pancakes finely ground broken rice flour, all-purpose flour, sugar, milk, egg and baking powder were mixed. The mixture was poured into pan and cooked till the reddish-brown

Nutritional analysis. Proximate analysis of broken rice was performed for following parameters;

***Moisture estimation*.** Moisture determination was done in electric oven (AOAC, 2016). Crucibles were taken, washed and dried in electric oven for half an hour at 130ºC. After drying the crucibles were placed in desiccator for cooling. Empty crucibles were weighed

Fig. 1. Biscuits and pancakes made from broken rice flour.

by using electric balance. Two to three grams of sample were taken in crucibles. The crucibles then placed in oven for 1 h for moisture drying. Cooling was done in desiccator and the weigh was noted for moisture estimation.

weight of sample = weight of crucible and sample – weight of crucible

loss in weight = weight of crucible and sample – weight of dried sample

$$\text{moisture \%} = \frac{\text{Loss in weight (g)} \times 100}{\text{weight of sample}}$$

Ash estimation. Ash determination was done by Muffle furnace (AOAC, 2016). The crucibles having dried sample (from moisture estimation after taking readings, previously used sample was further processed for ash estimation) were placed on the burner for cheering about 10-15 min. Then crucibles were directly transferred into the muffle furnace at 500-550 °C for 5-6 h. When ash formed, crucibles were shifted into oven for 1 h and then into desiccator for cooling. The weigh was noted for ash estimation.

weight of sample = weight of crucible and sample – weight of crucible

weight of ash = weight of crucible and ash - weight of crucible

$$\text{Ash \%} = \frac{\text{weight of ash (g)} \times 100}{\text{weight of sample}}$$

Fat estimation. Determination of fat was done by Soxhlet apparatus (AOAC, 2016). Thimbles were place in the oven for dehydration for about 1 h after that thimble were placed in the desiccator for 10-15 min. Thimbles were weighted and 2-5 g of sample was added. Thimbles were placed in the Soxhlet apparatus having N-hexane for about 5-6 h. Later on, the thimbles were air dried for evaporation of N-hexane. After drying, thimbles were placed in oven for 1 h. Weight of the thimbles and samples were calculated to obtain crude fat.

weight of defatted sample = wt. of thimble and sample (before) – wt. of thimble and sample (after)

weight of sample = wt. of thimble and sample – wt. of empty thimble

$$\text{fat \%} = \frac{\text{weight of defatted sample (g)} \times 100}{\text{weight of sample}}$$

Fiber estimation. Following AOAC (2016) protocol, fiber content was estimated by Electro-mantle a product of PCSIR. The defatted sample was taken in digestion/ round bottom flask. Concentrated 1.25% H_2SO_4 was added and attached to the condenser of Electro mental for 30 min. Washing of residue was done and 1.25% NaOH was added. The process was repeated. Filtration of the filtrate was done and filter paper was air dried. Cheering of residue left in the filter paper was performed after that crucible was shifted in the muffle furnace for 5-6 h at 500-550 °C. When ash was formed crucible was placed in the oven, then was transferred into desiccator and the obtained ash was weighed.

weight of ash = wt. of crucible and filter paper ash – wt. of crucible and filter paper

loss in weight = wt. of oven dried sample – wt. of ash

Percentage fibre was calculated as. weight of oven dried sample = wt. of crucible and demoistured filter paper – wt. of crucible + filter paper and ash)

Protein estimation. Protein content was estimated by using Kjeldhal method (AOAC, 2016). Sample was poured with catalyst and concentrated H_2SO_4 into digestion bulb which was placed in digestion chamber. When the colour of the digestion solution changed some distilled water was added. Dilution of solution was done in volumetric flask.

After cooling of flask digested/diluted sample was taken in the distillation flask with the help of pipette. 40% NaOH solution was added in the upper portion of the tube and distillation was started. Methyl red and 2% boric acid was taken as an indicator. Content passed through heated stream. All the nitrogen in the form of ammonia was captured at the receiving end of the flask containing boric acid and methyl red as an indicator. As a result of distillation, the pink colour of boric acid changes to yellow coloration. Titration of the solution was done against N/70 HCL. Percentage of nitrogen was calculated to figure out protein in sample.

titration reading/ factor 5/ factor 10x100x100

% age nitrogen = titration reading after diving and multiplying weight of sample (mg)

% age protein = %age N x factor 6.25

Results and Discussion

The work was done at Food and Biotechnology Research Center, PCSIR. Nutritional analysis showed that the biscuits made with rice flour were rich in protein, fat, fibre and total carbohydrates content, while pancakes made with rice flour was rich in moisture, fat and energy in calorie content. The results obtained for each sample were mentioned below in Table1 and their graphical representation as shown in Fig. 2 and Fig. 3 respectively.

In current project basmati broken rice was used. First of all, the proximate analysis of broken rice was done by using AOAC (2016) methods. Followed by develop-

Table 1. Nutrition values of broken rice purchased from local market and products made from broken rice flour

Contents	Percentage of broken rice	Percentage of biscuits made from rice flour	Percentage of pan cakes made from rice flour
Moisture %	5.90 ± 0.362	1.519 ± 0.134	20.715 ± 0.686
Ash %	0.96 ± 0.048	1.293 ± 0.008	0.595 ± 0.094
Fat %	1.18 ± 0.069	13.57 ± 0.102	31.206 ± 0.105
Fiber %	0.6 ± 0.201	7.15 ± 0.081	1.75 ± 0.124
Protein %	12.25 ± 0.082	21.041 ± 0.770	5.940 ± 0.346
Carbohydrates %	79.11 ± 0.382	55.427 ± 0.510	40.294 ± 0.134
Energy (calorie)	376.06	428.002	465.79

*All the values are mean ± standard deviation. All readings are taken in triplicates. Values in the same column having super script letter are not significantly different (P > 0.05); protein was calculated by multiplying % N by the conversion factor of 6.25; Total carbohydrate was calculated as 100% - % of (protein + fat + moisture + ash); Energy (calories) were calculated using 4 kcal/g for protein and carbohydrate and 9 kcal/g for fat.

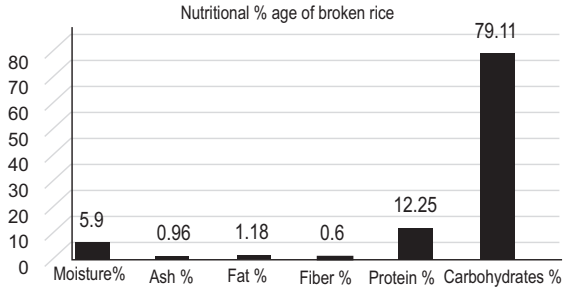

Fig. 2. Nutritional representation of broken rice in bar chart.

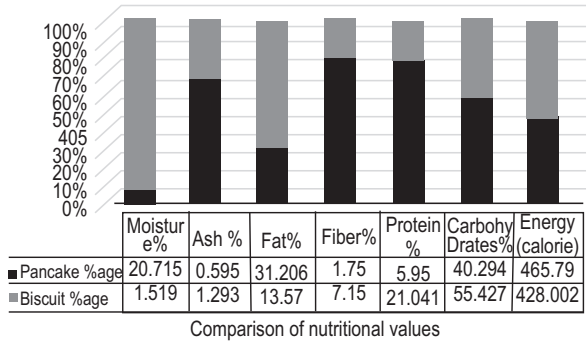

Fig. 3. Graphical representation of comparison of nutritional values of biscuits and pancakes.

ment of biscuits, pancakes and their proximate analysis.

Results showed presence of moisture in basmati broken rice was 5.90% ± 0.362. It correspondingly compared with the work of Jamal *et al.* (2016). They studied proximate compositions and functional properties of selected Pakistani rice and determined 5.46% moisture content while on the other hand in the work of Ahmed *et al*. (2016) the moisture content obtained was 4.47%. Total ash content present in broken rice was 0.96% ± 0.048. The current study was in line with El-Hadidy *et al.* (2022) work they stated that rice contain 0.846% ash. Cannas *et al.* (2020) obtain 0.5% ash in their rice sample. In the study of Corado *et al*. (2017) total ash obtained was 0.52% and Jamal *et al*. *(*2016) reported 0.78% ash in Pakistani rice respectively.

Fat content in broken rice was determined by using Soxhlet apparatus. The results showed that rice contain 1.18% ± 0.069 crude fat. The fat content found in the study of (Corado *et al.,* 2017; Ahmed *et al*., 2016; Jamal *et al*., 2016) was 1.12%, 1.41% and 1.5% respectively.

Percentage of crude fibre in broken rice was 0.6 ± 0.201. It is correspondingly related to the results of (Corado *et al.,* 2017; Haleem and Amal, 2016) were 0.6% and 0.73% respectively.

Protein found in sample was 12.25% ± 0.082 which is equivalent to Ahmed *et al.* (2016) work they reported 8.93% protein, while in the study of Jamal *et al.* (2016) protein obtained was 9.50%.

Percentage of carbohydrates present in broken rice was 79.11% ± 0.382. Whereas in previous study of Corado *et al.* (2017) showed that the carbohydrates content in broken rice was 78%.

In present study after complete analysis of broken rice, the rest of sample was ground into fine rice flour to

make biscuits and pancake. After development of biscuits their proximate analysis as mentioned above were performed for nutritional estimation.

The moisture content of biscuits obtained in the current study was 1.519% ± 0.134. Jothi *et al.* (2014) worked on cracker biscuits and reported 3.31% moisture in their results.

Ash content present in biscuits was 1.293% ± 0.008 which was in accordance with the studies of (Jothi *et al*., 2014); More *et al.*, 2013); Islam *et al.*, 2012). The ash content obtained in the study by Jothi *et al*. (2014) was 1.2%. More *et al.* (2013) reported 1.08% ash in their results, while working on gluten free rice flour biscuits. Islam *et al.* (2012) found 1.64% ash content respectively. In the current study, fat content present in biscuits found was 13.57% ± 0.102 that was in line with the Ziena *et al.* (2019) study they stated 12.99% fat in biscuits made from rice flour. The results are supported by the study of Jothi *et al.* (2014) work on gluten free cracker biscuits and reported 14.03% fat content present in biscuits. Okpala and Egwu (2015) utilized broken rice flour blend for production of biscuits and obtained 18.37% fat. In another study done by More *et al.* (2013) they obtained 10.13% fat in rice flour biscuits respectively.

The fibre content present in biscuits was 7.15% ± 0.081. A study conducted by Wanyo *et al.* (2009) on using rice flour as a substitute of wheat flour for making different gluten free products they obtained 7.13% total fiber in their results.

During present study total protein obtained from biscuit was 21.041% ± 0.770. The results were higher than Jothi *et al.* (2014) study they reported 9.73% protein in cracker biscuits. In another study conducted by More *et al.* (2013), they found 10.13% protein in gluten free rice flour biscuits.

Total digestible carbohydrate present in biscuits was 55.427 ± 0.510 which was in accordance with (Okpala and Egwu, 2015); More *et al*., 2013) studies they obtained 63.67% and 52.32% total carbohydrates content in biscuits made from broken rice flour respectively.

Rakmai *et al.* (2021) developed pancakes from rice and done their proximate analysis. The results showed that pancakes made from rice had 34% moisture, 1.89% ash, 11.78% fat, 0.93% fibre, 5.75% protein and 46.59% digestible carbohydrates. Whereas, during current study proximal analysis of rice flour pancakes exhibited 20.715% ± 0.686 moisture, 0.595% ± 0.094 ash, 31.206% ± 0.105 fat, 1.75% ± 0.124 fibre, 5.940% ± 0.346 protein and 40.294% ± 0.134 total carbohydrates. Shih *et al.* (2006) reported 1.13% fibre, 7.06% proteins and 40.26% total carbohydrates in rice flour pancakes.

Conclusion

From the present study, we can conclude that broken rice is nutritionally rich in all aspects. The use of broken rice flour in bakery products can provide all important nutrients with the benefit of being cheap in price and having gluten free/non-allergic properties.

Conflict of Interest. The authors declare that they have no conflict of interest.

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