Biological Forum – An International Journal 15(8): 557-560(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Exploring the Potential of Novel Plant based Beverage Developed using a Traditional Brown Rice variety by Nutritional Assessment

R. Radha Maheswari[1], Ayyavoo Preamnath Manoharan[1], B. Murugan[2], P.S.L. Sesh[3] and V. Perasiriyan[3]*

[1]Department of Food Process Engineering, College of Food and Dairy Technology, (TANUVAS), Koduvalli, Chennai (Tamil Nadu), India.
[2]Department of Food Safety and Quality Assurance, College of Food and Dairy Technology (TANUVAS), Koduvalli, Chennai (Tamil Nadu), India.
[3]Department of Veterinary Biochemistry, Madras Veterinary College (TANUVAS), Vepery, Chennai (Tamil Nadu), India.
[4]Department of Food Business Management, College of Food and Dairy Technology (TANUVAS), Koduvalli, Chennai (Tamil Nadu), India.

(Corresponding author: Ayyavoo Preamnath Manoharan)*
(Received: 07 June 2023; Revised: 24 June 2023; Accepted: 23 July 2023; Published: 15 August 2023)
(Published by Research Trend)

ABSTRACT: Consumer's awareness towards the link between the diet and health increases the consumption of plant based products as they are packed with many bioactive phytochemicals. The increased demand for plant based products in turn increases the demand for various plant materials that are ecologically sustainable. Soy, oats, almond, coconut based beverages are the few popular raw materials used in the plant based beverage preparation. Oat beverage is the only well-known product under cereal based beverage category. None of the market samples available are prepared from any indigenous raw materials. Thus, there is an urge for the novel locally available raw materials for the sustainable production of plant beverages. In this context, this study aims to explore the utilization potential of traditional brown rice variety as a novel raw material to prepare plant based beverage by assessing its nutritional value. The brown rice extract was prepared and its phyisco-chemical composition was determined with standard analytical procedures. The moisture, total solids, ash, protein, fat, carbohydrate content, energy and pH of the brown rice based beverage was found to be 91.89 ± 0.04 %, 8.11 ± 0.04 %, 0.07 ± 0.03 %, 0.81 ± 0.03 %, 0.13 ± 0.06 %, 7.10 ± 0.08 %, 32.72 ± 0.63 Kcal and 6.83 ± 0.03 respectively. The developed product is compared with oat beverages in market for energy value and macronutrient content. It was found to have moderate calories with lower fat content and similar carbohydrate content. Thus, this native variety of brown rice can be used as an alternative and healthier cereal for the plant based beverage preparation in order to promote the utilization and consumption of indigenous raw materials in product formulation.

Keywords: Plant based beverage, Vegan, Brown rice, Mapillai samba, nutritional composition.

INTRODUCTION

The consumption of plant based foods increases owing to the increasing awareness of consumers about global food security (Hemamalini *et al.*, 2023). The demand for plant foods is further increased by increase in number of vegan population and consumers with lactose intolerance and milk protein allergy (Hassan *et al.*, 2012). Plant based beverages are aqueous extracts obtained by soaking and processing plant materials with water and filtered to remove the insoluble materials. The nutritional value of these beverages depends mainly on the plant materials used for the production and the processing methods. These beverages is reported to have an economic potential in market and also helps in alleviating hidden hunger (Rincon *et al.*, 2020). Soy based beverage is the most successful product in the plant beverage market. Recently, other beverages prepared from oats, coconut, almond are also gaining popularity among the consumer groups (Le and Le 2021).

Rice stands out as a staple food for almost half of the world population (Patra *et al.*, 2023). China and India are the leading rice producers in the globe (Padma *et al.*, 2018). Rice has high carbohydrate content and thus serves as an energy source for people who consume rice as the major part of diet (Saleh *et al.*, 2019). Rice is highly digestible and have high biological value and protein efficiency ratio as it has high lysine concentration in comparison with other cereal foods (Lin *et al.*, 2019; Padma *et al.*, 2018). Additionally, Rice protein is hypoallergenic and hence it can be the best alternative for people suffering from milk protein and other plant protein allergy (Atwaa *et al.*, 2019).

Brown rice varieties viz. purple, red, black-brown are commonly used in Asian countries (Le and Le 2021). The traditional colored rice varieties are grown in southern part of India. Black kavuni, Poongar, Mappillai Samba, Karunguruvai are some of the known traditional brown rice varieties which are commonly used to prepare idli, dosa, appam, porridge (Devraj *et al.*, 2019). They are known to have more nutritional value and low calories than milled rice because of the intact bran layer (Le and Le 2021; Amini *et al.*, 2019). They are also reported to be rich in antioxidants, phytochemicals, phytonutrients, protein, and vitamin E. Particularly, phenolic compounds are known to be the natural antioxidants in grains that can help to reduce the risk of certain diseases (Subu Thavamurugan *et al.*, 2022). Oat beverage is the widely available cereal based beverage in the market. Therefore, this research focuses on utilizing Mappillai samba, one of the traditional brown rice variety of Tamil Nadu as an alternative raw material to prepare plant based beverage and its nutritional quality is being assessed to reveal its market potential.

MATERIALS AND METHODS

Raw materials. Mapillai samba rice was procured from local grocery store in Chennai, Tamil Nadu. The defected ones if any were removed manually.

Preparationof Brown rice based plant beverage. Brown rice extract was prepared by following Belew *et al.* (2013) with minor modifications. Mappillai Samba, the traditional brown variety procured from local market was washed thoroughly in tap water. Brown rice extract was made by soaking (1:3 v/v) for about 6 hours, followed by cooking (1:5 v/v) for about 15 minutes, grinding with sterile water 1:3 (v/v) and finally filtering the extract through the filter. The flow chart for the preparation of Brown rice based plant beverage (BRPB) was given in Fig. 1.

Collection of raw material and Washing in tap water
⇩
Soaking for 6 hours at room temperature (1:3 v/v water)
⇩
Pressure cooking for 15 minutes till it becomes soft (1:5 v/v water)
⇩
Blending in mixer with sterile water (1:3 water)
⇩
Filtration or clarification
⇩
Store at 4°C until further analysis

Fig. 1. Flow chart for the preparation of Brown rice based plant beverage.

Nutritional composition of Brown rice based plant beverage. The moisture, total solids, protein and ash content of the brown rice based plant beverage was determined by means of standard procedures of AOAC (2019). The average nutritional value of the oat beverages in market is kept as control.

The moisture content is determined by hot air oven method. The initial sample weight (W_1) was noted and the sample was dried in hot air oven at 105°C till constant weight is obtained between two consecutive measurements. The dried sample weight (W_2) is noted. The moisture content in the sample was calculated from the following formula. The total solids was found by subtracting the moisture from 100 and was expressed in percentage. The ash content was analyzed by ashing the sample in muffle furnace.

The protein content was analyzed by Kjeldahl method. The sample was initially digested by catalyst mixture and concentrated sulphuric acid. The digested sample was distilled with steam and the boric acid in the receiving flask receives the ammonia vapor. This was finally titrated against 0.1N hydrochloric acid till end point. The nitrogen content in the sample was calculated and multiplied by conversion factor of 6.25 to get the crude protein content.

The fat content was found by using Gerber method BIS (1977).The total carbohydrate content was determined by difference method. Energy value was finally found by using formulae given by El-Sayed and Ramadan (2020). The pH was determined with the help of portable type digital pH meter. Distilled water was used for calibrating the instrument.

Statistical analysis. The observations were done in triplicate and the values are expressed as Mean ± S.D. The data of the BRPB and control sample represented in Table 2 was statistically analyzed for significance by means of one sample t –test using IBM® SPSS® Statistics Version 26.0 software for windows. Means were considered significant if $p<0.001$.

RESULTS AND DISCUSSION

A. Nutritional composition of Brown rice based plant beverage

The nutritional composition of BRPB was presented in Table 1 and the composition of macronutrients and energy content of BRPB was statistically compared with average nutritional value of the oat beverages in the market. These values were shown with significance in Table 2.

BRPB has 91.89 ± 0.04 % of moisture content and is closer to the value (89.28%) reported by Chalupa-Krebzdak *et al.* (2018). The moisture content of the sample depends on the water added during preparation of beverage. It determines the concentration of other nutrients in the product (Yetunde and Ukpong 2015).

The total solid content represents the quantity of other nutrients. The total solid content of BRPB was 8.11 ± 0.04 % and is in agreement with the dry matter content (8.37%) of tiger nut beverage reported by Belewu and Belewu (2007). It is found to be contradictory to the results reported by Thirumoorthy *et al.* (2023) in which the total solid content of peanut milk was found to be 14.76%. Total solids mainly depends on the water used for the preparation of the beverage.

Ash content generally represents the mineral content of the food products (Balogun *et al.*, 2016). Here, the ash content was determined to be 0.07 ± 0.03%. The lower ash content may be due to the fact that the insoluble residues are removed by filtration during preparation. The ash content of BRPB and the red rice beverage (0.08%) reported in Sulistyaningtyas *et al.* (2019) are almost similar.

Protein content of the BRPB is found to be 0.81 ± 0.03 % and is statistically significant from the average protein content of the oat beverages in the market. Higher protein content of the control is due to the fact that oats have higher protein content that rice. Protein content of BRPB was higher than the rice extract (0.00% and 0.31%) reported by Rincon *et al.* (2020); Scholz-Ahrens *et al.* (2020) respectively. This could be due to the fact that brown rice has superior nutrient quality than the milled rice. The values were in line with protein content of brown rice based beverage (0.86%) reported by Carvalho *et al.* (2011) and higher than protein content of fermented millet sprout beverage reported by Sudha *et al.* (2016).

BRPB has 0.13± 0.06 % of fat content and is found to be significantly lower than the average fat content of the oat beverages in the market. Addition of sunflower or rapeseed oil in the formulation of market beverages contribute to the fat content of the final product. This finding is in agreement with the fat content of rice beverage (0.04%) reported by Storck and Montagner (2020) and slightly higher than brown rice and red rice beverage (0.00%) reported by Abrão (2019). It is contradictory to the fat content of the rice extract (1.04%) quoted by Rincon *et al.*, (2020). The lower fat content in the formulation can help in the storage stability of the product.

Carbohydrate content of the BRPB is determined to be 7.10 ± 0.08 %. There is no significant difference between the BRPB and the control sample. Carbohydrate content of the beverage mainly depends on the water and raw material ratio used for the preparation of beverage. Higher water content will dilute the concentration of the nutrients in the final product (Yetunde and Ukpong 2015). Ravindran and Radhai Sri (2020) also reported comparable carbohydrate content (7.30%) for the beverage prepared using oats.

Table 1: Nutritional composition of the Brown rice based plant beverage (BRPB).

Moisture (%)	91.89 ± 0.04
Total solids (%)	8.11 ± 0.04
Ash (%)	0.07 ± 0.03
Protein (%)	0.81 ± 0.03
Fat (%)	0.13 ± 0.06
Carbohydrate (%)	7.10 ± 0.08
Energy (Kcal)	32.72 ± 0.63
pH	6.83 ± 0.03

Data are mean values of triplicates and are represented as mean + S.D.

Energy value of BRPB is 32.72 ± 0.63 Kcal and is found to be significantly lower than the average energy value of the oat beverages. The energy value of the product mainly depends on its fat content. Since the market samples had higher fat content than BRPB, energy value of control is found to be higher than BRPB. The energy content of BRPB was in similar range to the energy content of oats (33 Kcal) and rice beverage (35 Kcal) reported by Ravindran and Radhai Sri (2020); Karimidastjerd and Kilic-Akyilmaz (2021) respectively and is higher than brown rice beverage (20 Kcal) reported by Abrão (2019).

The pH of BRPB was found to be 6.83 ± 0.03. Since the beverage is majorly made of water, the pH of the beverage is almost neutral. El-Sayed and Ramadan (2020) reported similar pH value for the rice extract used in its study.

Table 2: Macronutrients and Energy content of Control Vs BRPB.

	Control	BRPB
Protein (%)	1.20± 0.00[a]	0.81 ± 0.03[b]
Fat (%)	1.25 ± 0.21[a]	0.13±0.06[b]
Carbohydrate (%)	7.60 ± 0.57[a]	7.10± 0.08[a]
Energy value (Kcal)	45.70 ± 3.82[a]	32.72± 0.63[b]

Data are represented as mean + S.D except energy value. Means along the same rows with different letters in superscripts are significantly different ($p<0.001$).

CONCLUSION AND FUTURE SCOPE

The carbohydrate content of the developed product is found to be similar to the control and the fat content is found to be significantly lower than control. This helps to promote the product as low fat with moderate calories of about 32.72 Kcal of energy (1.64 % RDA per 100 ml). None of the market samples available are prepared from any indigenous raw materials. Thus, this study utilizes the locally available as well as nutritionally rich cereal based raw material alternative to oats in order to develop a healthy plant based beverage. This will reduce its cost and also encourages the consumption of indigenous rice variety. This product can also be marketed as a ready to drink plant beverage after adopting proper processing and packaging methods. To produce a nutritionally balanced product, this beverage can also be combined with other plant beverages. Since brown rice varieties possess various bioactive phytochemicals, the future study may focus on the profiling of these compounds and assessing its activity which will further enhance the market potential of this beverage.

Acknowledgement. The author(s) would like to thank College of Food and Dairy Technology, TANUVAS for providing support and all the facilities to carry out this research work. The authors also acknowledge UGC for providing funds for this work.
Conflict of Interest. None.

REFERENCES

Abrão, Y. B. (2019). Avaliação Físico-química de extratos de arroz polido, parboilizado, integral e vermelho.

Alozie Yetunde, E. and Udofia, U. S. (2015). Nutritional and sensory properties of almond (*Prunus amygdalu* Var. Dulcis) seed milk. *World Journal of Dairy & Food Sciences*, *10*(2), 117-121.

Amini, R. K., Islam, M. Z., Kitamura, Y. and Kokawa, M. (2019). Utilization of Fermented Rice Milk as a Novel Coagulant for Development of Paneer (Soft Cheese). *Foods*, *8*(8), 339.

AOAC (2019). Official Methods of Analysis of the Association of Official Analytical Chemists: Official Methods of Analysis of AOAC International. 21st Edition, Washington DC.

Atwaa, E. S. H., Elmaadawy, A. A. and Awaad, E. A. (2019). Production of Fruit Flavored Probiotic Rice Milk

Beverage. *Journal of Food and Dairy Sciences (Print)*, *10*(12), 453–458.
B.I.S. Part – II. (1977). Determination of fat by Gerbers method - Milk Products. New Delhi. IS: 1224.
Balogun, M. A., Kolawole, F. L., Joseph, J., Adebisi, T. T. and Ogunleye, O. T. (2016). Effect of fortification of fresh cow milk with coconut milk on the proximate composition and yield of warankashi, a traditional cheese. *Croatian Journal of Food Science and Technology*, *8*(1), 10–14.
Belewu, M. A., Abdulsalam, K., Belewu, K. Y. and Belewu, N. O. (2013b). Rice- Coconut Yoghurt: Preparation, Nutritional and Sensory Qualities. *Asian Journal of Agriculture and Rural Development*, *3*(12), 924–928.
Belewu, M. A. and Belewu, K. Y. (2007) Comparative Physicochemical Evaluation of Tiger Nut, Soy Bean and Coconut Milk Sources. *International Journal of Agriculture Biology, 9*, 785-787.
Chalupa-Krebzdak, S., Long, C. V. and Bohrer, B. M. (2018). Nutrient density and nutritional value of milk and plant-based milk alternatives. *International Dairy Journal*, *87*, 84–92.
de Carvalho, W. T., dos Reis, R. C., Velasco, P., Soares Júnior, M. S., Bassinello, P. Z. and Caliari, M. (2011). Physical and chemical characteristics of Whole Rice, Broken Rice, and Soybean Extracts. *Pesquisa Agropecuária Tropical*, *41*(3), 422–429.
Devraj, L., Panoth, A., Kashampur, K., Kumar, A. and Natarajan, V. (2019). Study on physicochemical, phytochemical, and antioxidant properties of selected traditional and white rice varieties. *Journal of Food Process Engineering*, 43(3).
El-Sayed, H. E. M. and Ramadan, M. F. (2020). Production of probiotic-fermented rice milk beverage fortified with cactus pear and physalis pulp. *Zagazig Journal of Agricultural Research*, *47*(1), 165–177.
Hassan, A. A., Aly, M. M. and El-Hadidie, S. T. (2012). Production of cereal-based probiotic beverages. *World Applied Sciences Journal*, *19*(10), 1367-1380.
Hemamalini S., Perasiriyan, V., Mathanghi, S.K., Ramani, R. and Sunil Raj S. (2023). Optimization of Young Jackfruit-Based Meat Analogue using Sensory Profile by D-Optimal Mixture Design. *Biological Forum – An International Journal*, *15*(1), 92-100.
Karimidastjerd, A. and Kilic-Akyilmaz, M. (2021). Formulation of a low-protein rice drink fortified with caseinomacropeptide concentrate. *Food and Bioproducts Processing*, *125*, 161–169.
Le, T. A. and Le, N. T. (2021). Effects of Microwave Roasting Time on Physico-Chemical Properties and Sensory Evaluation of Germinated Red Brown Rice Milk. *J Microbiol Biotech Food Sci*., (2), e1306.
Lin, Q., Zhang, H., Li, J., Zhu, D. and Liu, H. (2019, December). Optimization of Process Technique of Rice Milk Drinks via Response Surface Methodology (RSM). In *IOP Conference Series: Earth and Environmental Science*, *IOP Publishing*, *371* (5), p. 052024.
Padma, M., Jagannadarao, P., Edukondalu, L., Ravibabu, G. and Aparna, K. (2018). Physico-Chemical Analysis of Milk Prepared from Broken Rice. *International Journal of Current Microbiology and Applied Sciences*, *7*(2), 426–428.
Ravindran, S. and Radhaisri, S. (2020). Probiotic oats milk drink with microencapsulated *Lactobacillus plantarum* – an alternative to dairy products. *Nutrition & Food Science*, *51*(3), 471–482.
Rincon, L., Botelho, R. B. A. and De Alencar, E. R. (2020). Development of novel plant-based milk based on chickpea and coconut. *Lebensmittel-Wissenschaft and Technologie*, 128, 109479.
Sabyasachi Patra. (2023). Seed Multiplication of Traditional Varieties of Paddy (*Oryza sativa* L) for their Protection in Sustainable Agriculture. *Biological Forum – An International Journal, 15*(1), 592-600.
Saleh, A. I., Wang, P., Wang, N., Yang, L. and Xiao, Z. (2019). Brown rice versus white rice: nutritional quality, potential health benefits, development of food products, and preservation technologies. *Comprehensive Reviews in Food Science and Food Safety*, *18*(4), 1070–1096.
Scholz-Ahrens, K. E., Ahrens, F. and Barth, C. A. (2020). Nutritional and health attributes of milk and milk imitations. *European Journal of Nutrition*, *59*(1), 19–34.
Storck, C. R. and Montagner, G. E. (2020). Sorvete com extratohidrossolúvel de arroz: Análisefísico-química e sensorial. *DEMETRA: Alimentação, Nutrição & Saúde*, *15*, 45766.
Subbu Thavamurugan, N., Dhivyadharchini, M., Suresh, P., Manikandan, T., Vasuki, A., Nandhagopalan, V. and Prabha, A. M. L. (2022). Investigation on nutritional, phytochemical, and antioxidant abilities of various traditional rice varieties. *Applied Biochemistry and Biotechnology*, *195*(4), 2719–2742.
Sudha, A., Devi, K. S., Sangeetha, V. and Sangeetha, A. (2016). Development of fermented millet sprout milk beverage based on physicochemical property studies and consumer acceptability data. *Journal of Scientific and Industrial Research*, *75*, 239-243.
Sulistyaningtyas, A. R., Lunggani, A. T. and Kusdiyantini, E. (2019). Kefir Produced from Red Rice Milk by *Lactobacillus bulgaricus* and Candida kefir Starter. *IOP Conference Series*, *292*(1), 012038.
Thirumoorthy, S., Marx Nirmal, R., Perasiriyan, V. and Esther Magdalene Sharon, M. (2023). Development of Protein Enriched Peanut Milk based Misti Doi. *Biological Forum – An International Journal*, *15*(2), 137-143.

How to cite this article: R. Radha Maheswari, Ayyavoo Preamnath Manoharan, B. Murugan, P.S.L. Sesh and V. Perasiriyan (2023). Exploring the Potential of Novel Plant based Beverage Developed using a Traditional Brown Rice variety by Nutritional Assessment. *Biological Forum – An International Journal, 15*(8): 557-560.