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Research Article

Exploring the functionality of ethnic fermented sour beverages and their standardization with improved shelf stability for industrial use

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Abstract
The nutritional and functional characteristics of cereal and millets have been enhanced by fermentation technology and have proven to be a viable option for the cereal industry. The fermentation technique aids in increasing the nutrient content, *viz.,* minerals, vitamins, proteins, phenolics and antinutritional compounds, as phytic acid degrades. The study aimed to investigate the appropriate fermentation technique for developing ethnic fermented sour beverages and standardize the product with improved shelf stability for industrial use. Neeragarams (an indigenous fermented rice product from the southern part of India) were prepared using Mapillai samba, and a notable and nutritious traditional rice variety of Tamil Nadu was taken (T_1 - raw - unpolished, T_2 - raw - polished, T_3 - parboiled - unpolished and T_4 - parboiled - polished) with added species such as onions, green chillies and curry leaves. The study observed that among four different treatments of neeragaram, T_1 (raw rice - unpolished) was highly acceptable based on consumer acceptability with the sensory value of 9.0 higher nutritional characteristics *viz.,* energy 68.29 Kcal, carbohydrates 11.15 %, protein 4.21 %, fiber 2.59 %, fat 0.93 %, iron 4.21 mg, potassium 181.7 mg, sodium 61.23 mg and zinc 2.32 mg per 100 ml of neeragaram. The developed product will be highly suitable for commercialization with improved shelf stability. Among the four treatments, raw (unpolished) neeragaram was highly acceptable with maximum retention of nutritional characteristics. The developed fermented sour beverages do not involve a high cost of production and earn good returns to entrepreneurs. The development of these fermented sour beverages using rice will increase the suitability for consumers and, in turn, improve persons with nutritional and functional status.

Keywords: Fermentation, Nutritional characteristics, Shelf stability, Traditional rice, Human health

INTRODUCTION

The most common cereal consumed by people is rice, and it is a staple food for approximately half of the world population. Approximately 50,000 varieties of rice existed before 400 BC, but now only a few varieties are cultivated by the human population. Worldwide, India places 2nd in rice cultivation, with a total area of approximately 59.6 million hectares and a production yield of 4.6 tons per hectare (Oko *et al.,* 2019). After the Green

Revolution, the net availability of food grains per capita was amplified to 71.9 kg/year in 2020 from 62.5 kg/year in 1951. The primary food for the Indian population is rice, and 90% of the people consume rice as their staple food. Compared to polished white rice, traditional brown rice varieties are higher in nutrients and hold major health benefits (Rayaguru *et al.,* 2011). Many types of ethnic fermented cereal foods are widely consumed worldwide. In fermented food preparation, beneficial microbes have an essential role in improving the sensory quality, nutritional value, prevention of health-causing diseases and protection of foods. In Tamil Nadu, the traditional practice is the consumption of fermented rice by the majority of people. Fermented rice was traditionally prepared by allowing the excess cooked rice to ferment overnight and added curd at a small amount and then consuming the fermented rice the next day. This is one of the best techniques to conserve food resources without wastage. The leftover cooked rice allowed for fermentation was known as '*pazhaya sadham'* or '*palaya soru'*, and fermented rice water was known as *pazhaya sadham kanchi* or *neeragaram*. Extracts obtained from rice are an alternative beverage for consuming healthy products with desirable nutritional characteristics. Epidemiological studies consistently showed that the consumption of fermented cereal products drastically reduced the onset of type II diabetes, ulcers, and coronary heart diseases.

Haard *et al.* (2019) stated that the natural fermentation of cereals breaks down complex carbohydrates to simple sugars, synthesizes amino acids and increases the bioavailability of B vitamins and minerals. The most favourable pH condition leads to the degradation of antinutritional factors and increases the bioavailability of minerals, *viz.,* iron, zinc and calcium (Nout and Motarjemi, 2017).

Sour beverages fermented using traditional rice enhance the body with a high-energy rich rehydrating drink, refurbish health with beneficial intestinal flora, help to prevent the occurrence of gastrointestinal diseases and promote immune barriers, which are the most promising solutions to decrease the prevalence of health ailments. It acts as an emerging demand for market among non-dairy probiotic beverages. Short-chain fatty acid (SCFA) molecules present in torani (Neeragaram) in good proportion have anti-inflammatory properties. "Lactobacillus in 'torani' promotes secretory immunoglobulins that fight local infection, particularly in the lungs and intestines". SCFAs have multiple functions in our body. These are energy sources and have antiviral properties (Balamurugan, 2021). The study aimed to develop the ethnic fermented sour beverages using traditional rice variety and analyze their nutritional characteristics.

MATERIALS AND METHODS

The Mapillai samba paddy was procured from Tamil Nadu Rice Research Institute, Aduthurai, TamilNadu. This traditional rice variety was chosen based on consumer preference and is popularly cultivated in southern India. The different treatments, such as raw rice (unpolished, polished) and parboiled rice (unpolished, polished), were performed at the Department of Food Science and Nutrition, Community Science College and Research Institute, TamilNadu Agricultural University, Madurai. The paddy was hulled using a huller machine, milled rice using a polisher machine for one min/100 g of rice, and paddy parboiling was performed using the Central Food Technological Research Institute method. Then the rice samples were stored in an airtight container for further biochemical analysis. Mud pots were used for fermenting cooked rice.

Standardization of process parameters for the development of neeragaram

The rice variety utilized in the study is represented in (Fig. 1). The fermented sour beverages (neeragaram) were prepared using the traditional rice Mapillai samba

Fig. 1. *Traditional rice variety (Mapillai Samba)*

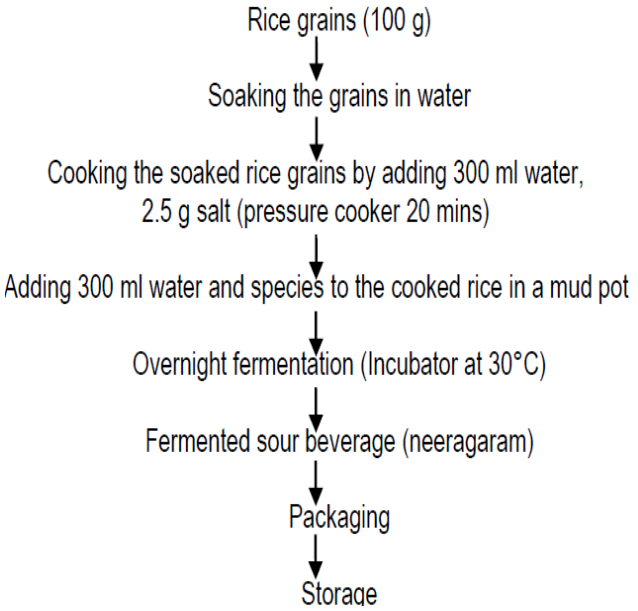


Fig. 2. *Preparation of fermented sour beverage (neeragaram)*

Table 1. Different treatments of Neeragaram (Mapillai Samba)

S.No	Treatments	Rice variations
1.	T_1	Raw rice (Unpolished)
2.	T_2	Raw rice (Polished)
3.	T_3	Parboiled rice (Unpolished)
4.	T_4	Parboiled rice (Polished)

(Fig. 2). The different treatments were raw rice (unpolished, polished) and parboiled rice (unpolished, polished) for the processing of neeragaram, as presented in Table 1. Fermentation was carried out in an incubator at 30°C overnight. The known weight of rice (100 g) was taken, and 300 ml of water was added and allowed to cook for approximately 20 mins. Then, cooked rice was added along with the required amount of water, and different spices, such as green chillies (5 g), small onions (20 g), curry leaves and coriander leaves (1 g), in a mud pot were allowed to ferment overnight in an incubator at 30°C. The hulling and milling characteristics were analyzed by the Association of Official Analytical Chemists method (AOAC 2000). Physical characteristics such as length, breadth, length/breadth ratio, thousand grain weight and gruel solid loss were analyzed using the AOAC method (2000). Nutritional characteristics such as energy, carbohydrates, protein, fat, fiber and minerals such as iron, potassium, sodium and zinc were analyzed using the AOAC method (2005). The developed fermented sour beverages are depicted in (Fig. 3).

Parboiling of paddy

The initial moisture content of paddy was 13±1% w.b. Paddy parboiling was conducted by the CFTRI method. A cleaned paddy sample (one kg) was soaked in 1250 ml of hot water at 70°C for three hours. Then, the water was drained off and allowed to steam for approximately 20 mins. Again, the steaming water was drained away, allowing steaming using a 1.05 kg/ cm^2 vertical autoclave (15 psi) for approximately 30 mins. After steaming, paddies were sun-dried for 4 hrs, and the optimum moisture content was approximately 13-14% (w.b.) which was appropriate for milling of the paddy.

Hulling and Milling of paddy

A total of 500 g of all treatments (raw and parboiled paddy samples) was dehulled using Satake huller cum rubber roll sheller THU (No. 101527) (Satake Engineering Co. Ltd. Tokyo, Japan) in two passes and for polishing the raw and parboiled rice polished in a horizontal abrasive type polisher for one minute by using a Satake grain testing mill (No. 553228, Satake Engg Co Ltd, Tokyo, Japan).

Physico-chemical characteristics of selected rice variety

Length, breadth, length/breadth ratio

The length, breadth and L/B ratio were analyzed (Odenigbo *et al.,* 2014) for the rice samples. Ten rice kernels were taken, and the length and breadth were noted using a Vernier calliper for all the treatments and expressed in cm.

Thousand grains weight

An electronic weighing balance was used to determine thousand-grain weights (Odenigbo *et al.,* 2014).

Gruel solid loss

The gruel solid loss of the samples was analyzed according to the method (Ayamdoo *et al.,* 2014).

Gruel solid loss (%) = Increase in weight of dish × 100/ Weight of rice sample

Energy

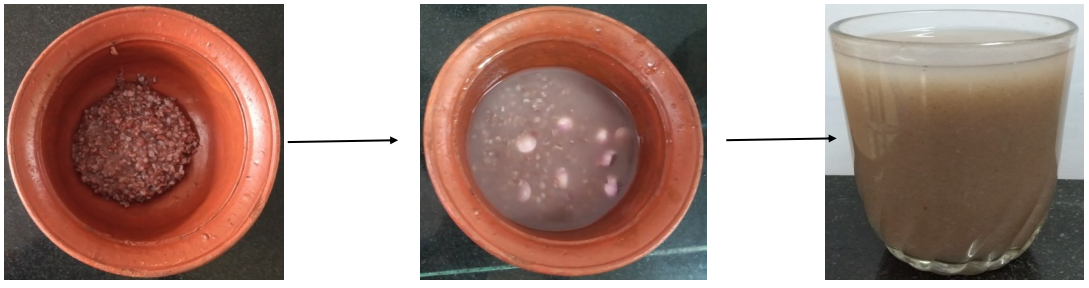
The energy values of the selected rice samples for all the treatments were determined using the bomb Calorimetric method (AOAC, 2000).

Total carbohydrates

The total carbohydrates were estimated using the phenol-sulfuric acid method (AOAC, 2000) for the selected ice samples.

Protein

The amount of crude protein was analyzed by the



Cooked Rice Fermentation Fermented Sour Beverage

Fig. 3. *Preparation of fermented sour beverage (Neeragaram)*

Kjeldahl (FOSS Tecator AB, 2100, Sweden) method for the selected ice samples using a digestion tube.

Fat

The amount of fat content in selected rice samples was analyzed using a Socs plus apparatus (Pelican Equipments, SCS-08, Chennai, India).

Fiber

The crude fiber content was determined by the method described by (Maynard, 1995) using fibra plus.

Total amylose

The amylose content present in the selected rice samples was analyzed using potato amylase as a standard (Bhattacharya and Sowbhagya, 1971).

Estimation of minerals

The mineral content present in the selected rice samples was estimated using atomic absorption spectrophotometry following the method of Lindsey and Norwell (1969).

Organoleptic evaluation

A panel of fiftten semitrained judges evaluated organoleptic evaluation for the developed sour beverages to assess the sensory properties using a score card with a nine-point hedonic scale. The panellists determined the quality of developed sour beverages in terms of appearance and color, flavor, consistency, taste and overall acceptability (Wichchukit and O'Mahony, 2015).

Statistical analysis

The data obtained from the studies were recorded and subjected to statistical analysis. The significance effect between different parameters for the selected rice variety and its treatments was analyzed by means of SPSS software (2017 version) and the completely randomized design (CRD) proposed by Gomez and Gomez (1984) using AGREE statistical software.

RESULTS AND DISCUSSION

The hulling and milling characteristics of the paddy are presented in Table 2. The hulling recovery was higher in parboiled rice (79.1%) than in raw rice (76.1%). The parboiling process obtained the maximum head rice yield compared to raw rice. Accordingly, the milling percentage of parboiled rice (68.6%) was higher than that of raw rice (67.6%). The maximum increase in length, breadth, L/B ratio and thickness was noted in the parboiling process (Saif *et al.,* 2019). Bhattacharya (2016) stated that raw rice leads to kernel integration, higher hulling and milling recovery and reduces cooking loss.

The physical characteristics estimated for the selected rice samples, *viz.,* length, breadth, L/B ratio, thousand grain weight and gruel solid loss, to check the significant effect ($p > 0.05$) among the rice varieties and are illustrated in Table 3. The data from the study revealed that the conventional rice variety Mapillai samba, parboiled - unpolished rice showed the highest length of 0.59 cm with a breadth of 1.92 cm followed by raw - unpolished rice. The thousand grain weight was higher for parboiled - unpolished plants (26.7 g), followed by other treatments. Raw polished rice has gained popularity for greater L/B ratios. However, it decreased from 3.23 for raw polished rice to 3.03 for sample parboiled - polished rice. The data obtained from the treatments were similar to the study conducted by Odenigbo *et al.,* (2014), who estimated the length, breadth and L/B ratios of parboiled and raw rice varieties of karungkuruvai milled rice. The length of local rice varieties was maximum compared to traditional rice varieties (Raghuvanshi *et al.,* 2017).

Parboiling reduced the amount of solid dissolution into the cooking water. The maximum gruel solid loss in the parboiled rice treatment was 2.59%, which significantly decreased ($p<0.05$) to 2.10% in the raw rice treatment, indicating that all rice treatments had a negative correlation with cooking time (R^2=0.90). Soponronnarit *et al.,* (2019) reported that minimum gruel solid loss would lead to a vigorous rice structure influenced by starch gelatinization.

The cooking and pasting characteristics were determined by the level of amylose content present in the rice varieties. The data revealed a significant ($p<0.05$) reduction in the parboiled polished rice sample from 25.9% to 23.4% in raw unpolished rice (Asghar *et al.,* 2020). Rice containing intermediate amylose content (20-25%) cooks moist and soft and is consumed more widely than rice with high (>25%) or low amylose content (10-20%) (International Rice Research Institute, 2017).

The nutritional characteristics of neeragaram are presented in (Table 4 and Fig. 4). Among all the treatments, the raw - unpolished rice variety neeragaram had higher nutritional characteristics. The maximum total energy was 68.29±0.25 kcal in raw unpolished rice and 51.29±0.49 kcal in parboiled polished rice. Raghuvanshi *et al.,* (2017) reported an energy value of 49.34 kcal in neeragaram prepared using local rice varieties. Treatment T_1 possessed a maximum carbohydrate content of 11.15±0.88 % and a minimum carbohydrate content in T_4 of 8.16±0.42 %. The total protein content was higher in T_1 (4.21±0.11 %) than in the other treatments T_3 (4.09±0.41 %), T_2 (3.80±0.26 %) and T_4 (3.72±0.30 %).

The maximum fiber content was observed in T_1 at

Table 2. Hulling and Milling characteristics of paddy

S.No.	Rice varieties	Hulled rice (g)	Husk (g)	Milled rice (g)	Bran (g)	Hulling Percentage (%)	Milling Percentage (%)
1.	Raw - Mapillai Samba	74.9	23.4	58.3	2.7	76.1	67.6
2.	Parboiled - Mapillai Samba	78.4	23.6	59.7	2.4	79.1	68.6

Table 3. Physico-chemical characteristics of selected rice variety (Mapillai Samba)

S.No.	Treatments	Length (mm)	Breadth (mm)	L/B ratio	1000 grain weight (g)	Gruel solid loss (%)	Amylose (%)	Amylopectin (%)
1.	Raw-Unpolished-Mapillai Samba	0.57	0.18	3.17	24.1	2.28	23.4	76.6
2.	Raw-Polished-Mapillai Samba	0.55	0.17	3.23	22.5	2.10	23.9	76.1
3.	Parboiled-Unpolished-Mapillai Samba	0.59	0.19	3.05	26.7	2.59	25.2	74.8
4.	Parboiled- Polished-Mapillai Samba	0.56	0.18	3.03	24.8	2.43	25.9	74.1
	CD (5%)	0.04	0.05	0.34	0.27	0.26	0.57	0.49

Table 4. Nutritional characteristics of neeragaram

S.No	Nutrients	T_1	T_2	T_3	T_4
1.	Energy (Kcal)	68.29 ± 0.25^a	59.02 ± 0.29^b	57.15 ± 0.31^c	51.29 ± 0.49^d
2.	Carbohydrates (%)	11.15 ± 0.88^a	9.03 ± 0.98^c	10.59 ± 0.86^b	8.16 ± 0.42^d
3.	Protein (%)	4.21 ± 0.11^a	3.80 ± 0.26^c	4.09 ± 0.41^b	3.72 ± 0.30^d
4.	Fiber (%)	2.59 ± 0.53^a	1.25 ± 0.32^d	2.28 ± 0.32^b	1.26 ± 0.36^c
5.	Fat (%)	0.93 ± 0.57^d	0.71 ± 0.09^b	0.82 ± 0.57^c	0.66 ± 0.11^a
6.	Iron (mg)	4.21 ± 0.41^a	3.80 ± 0.26^c	3.98 ± 0.33^b	3.62 ± 0.37^d
7.	Potassium (mg)	181.7 ± 0.21^a	172.0 ± 0.19^b	152.6 ± 0.25^c	143.2 ± 0.16^d
8.	Sodium (mg)	61.23 ± 0.13^b	62.76 ± 0.11^a	56.45 ± 0.16^d	58.89 ± 0.22^c
9.	Zinc (mg)	2.32 ± 0.24^a	1.89 ± 0.35^c	2.10 ± 0.28^b	1.76 ± 0.15^d

approximately 2.59±0.53 %, followed by the other treatments, T_2 at 1.25±0.32 %, T_3 at 2.28±0.32 % and T_4 at 1.26±0.36 %. Fat contents of 0.66±0.11 %, 0.71±0.09 % and 0.82±0.57 % were noted in the T_4, T_2 and T_3 rice varieties, and a higher fat content was observed in T_1 (0.93±0.57%). The results showed that the protein and fat content decrease might be due to polishing treatment because the protein and fat content is present in the bran layer (Devika *et al.,* 2017). The data revealed that this result was similar to the results observed by Saikia *et al.,* (2014), who reported that the fat content ranged from 1.00 to 2.10/100 g in nonpigmented and pigmented indigenous rice varieties of Assam and Manipur.

The mineral content was analyzed for all the treatments. The developed fermented sour beverages of T_1 had higher mineral contents of 4.21 mg, 181.7 mg, 61.23 mg and 2.32 mg of iron, potassium, sodium and zinc per 100 ml, respectively, followed by other treatments. Fermented sour beverages will replace carbonated beverages with additional nutritional value, replenish them with higher mineral-rich energy drinks and help in the maintenance of body functioning. The results were similar to the study conducted by Praveen Kumar *et al.,* (2018) and they stated that mineral analysis of fermented rice had iron 0.20 mg, potassium 2.93 mg, sodium 1.36 mg per 10 g.

The scores of organoleptic evaluations performed for the developed fermented sour beverages by semi-

Table 5. Score card for the organoleptic evaluation of Mapillai samba neeragaram

Sensory characteristics	Sample code			
	T_1	T_2	T_3	T_4
Appearance & Color	8.5	8.2	8.4	8.2
Flavor	9.0	8.1	8.0	8.0
Consistency	9.0	8.5	8.4	8.4
Taste	9.0	8.3	8.0	8.0
Overall acceptability	9.0	8.3	8.2	8.1

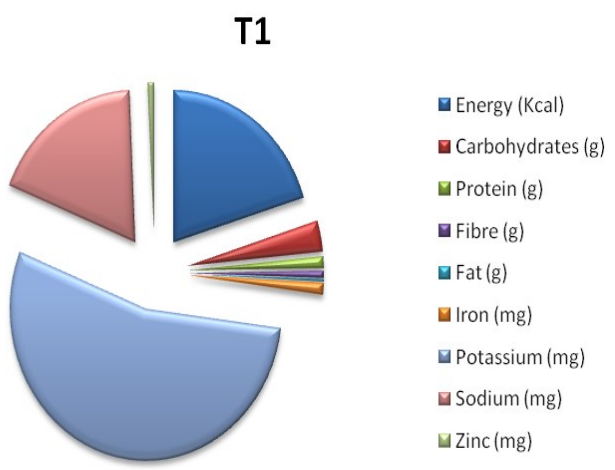


Fig. 4. *Nutritional characteristics of raw - unpolished neeragaram (T_1)*

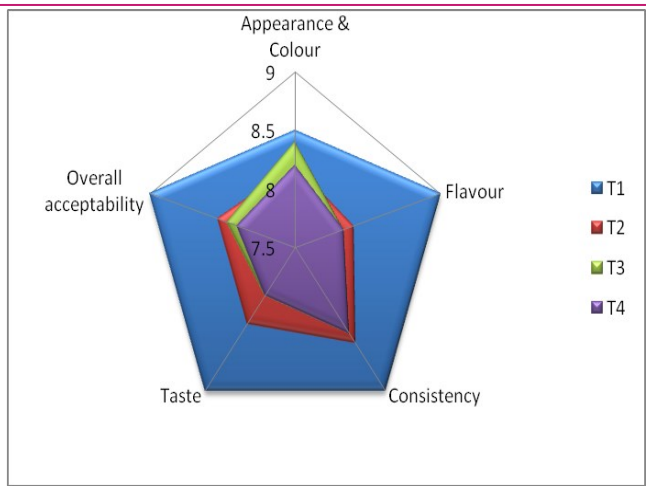


Fig. 5. *Sensory properties of developed fermented sour beverages*

trained panellists are depicted in Table 5 and Fig. 5. Of the different treatments, raw-unpolished-Mapillai samba neeragaram scored the highest overall acceptability of 9.0, followed by raw-polished, parboiled-unpolished and parboiled-polished. The observed data were in accordance with the results obtained by Simonelli *et al.* (2017), and they reported that among 10 different Italian rice varieties, the sensory profiles of Gange and Selenio aromatic rice varieties were highly accepted by the consumers.

Conclusion

The present study concluded that among different treatments of fermented sour beverages (neeragaram), mapillai samba raw unpolished (T_1) showed a significant increase in the nutritional characteristics and overall acceptability. The neeragaram has been developed by the natural fermentation method and it helps in increasing the protein and mineral contents. It acts as a probiotic source and produces short-chain fatty acids in the human intestine and also helps to heal stomach related disorders. India is considered the rice bowl of diversity. Traditional rice varieties are regarded as ethnic practice in medicine by many religious people, and they possess several health effects on the human body apart from the scientific world prevailing now. The cultivation of indigenous rice varieties in Tamil Nadu should consequently be increased for the consumption level among the population. The nutrient content was higher for indigenous rice varieties than for genetically modified ones. The optimum pH of the developed neeragaram helps to maintain hair density, enhance skin elasticity and decrease skin surface friction. There are only few relevant studies on fermented sour beverages' chemical and microbiological aspects. Thus, the present study evolves the nutritional characteristics of neeragaram to community health with all benefits.

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Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Association of Official Analytical Chemists (2000). Official methods of analysis (17th ed.). Minneapolis, MN: Association of Official Analytical Chemists (AOAC).
2. Association of Official Analytical Chemists (2005). Official Methods of Analysis of international 18th Ed., Association of Official Analytical Chemists (AOAC) International, Gaithersburg, MD, USA, Official Method 2005.08.
3. Asghar, S., Anjum, F. M., Amir, R. M. & Khan, M. A. (2020). Cooking and eating characteristics of Rice (Oryza sativa L.)-A review. *Pakistan Journal of Food Sciences*, 22 (3), 128-132.
4. Ayamdoo, A. J., Demuyakor, B., Saalia, F. K. & Francis, A. (2014). Effect of varying parboiling conditions on cooking and eating/sensory charactoristics of Jasmine 85 and Nerica 14 rice varieties. *Am J Food Technol* 9, 1-14.
5. Balamurugan Ranadoss (2021). Pakhala boosts immunity, finds city AIIMS study, Times of India, July 8, 2021.
6. Bhattacharya, K. R. & Sowbhagya, C. M. (1971). Water uptake by rice during cooking. *Cereal Science Today*, 16 (12), 420-424.
7. Battacharya, K. R. (2016). Parboiling of rice, in rice chemistry and technology. *st. paul mina America Association of cereal chemists*, 285-348.
8. Devika, N. G., Padmavathi, G., Babu, R. V. & Waghray, K. (2017). Proximate nutritional evaluation of rice. *Journal of Rice Research,* 8(1), 23-32.
9. Gomez, K.H. & Gomez, A.A (1984). Statistical procedures for Agricultural Research, 2nd Edition, *John Wiley and*

Sons, New York, 381.
10. Haard, N.F., Odunfa, S.A., Lee, C.H., Quientero-Ramirez, R., Lorence-Quinones, A. & Wacher-Radarte, C. (2019). Fermented cereals. A global perspective. FAO Agric. Serv. Bull. No. 138.
11. International Rice Research Institute (2017). Rice Quality Training Manual. International Rice Research Institute
12. Lindsey, W. L. & Norwell, M. A. (1969). A new DPTA-TEA soil test for zinc and iron. In Agron Abstr, 61,84-91.
13. Maynard, A.J. 1995. Methods in Food Analysis. Academic Press, New York. 176.
14. Nout, M.J.R. & Motarjemi, Y. (2017). Assessment of fermentation as a household technology for improving food safety: A joint FAO / WHO workshop. *Food Control*, 8, 221 -226. https://doi.org/10.1016/S0956-7135(97)00021-2
15. Odenigbo, A. M., Ngadi, M., Ejebe, C., Woin, N. & Ndindeng, S. A. (2014). Physicochemical, cooking characteristics and textural properties of TOX 3145 milled rice. *Journal of Food Research*, 3(2), 82-96. https://doi.org/10.5539/jfr.v3n2p82
16. Oko, A., Ubi, B. E., Efisue, A. & Dambaba, N. (2019). Comparative Analysis of the Chemical Nutrient Composition of Selected Local and Newly Introduced Rice Varieties Grown in Ebonyi State of Nigeria. *International Journal of Agriculture and Forestry*, 2(2), 16-23. https://doi.org/10.5923/j.ijaf.20120202.04
17. Praveen Kumar, P., Hazeena Begum, V. & Kumaravel, S. (2018). Mineral nutrients of 'pazhaya sadham': A traditional fermented food of Tamil Nadu, India. *International Journal of Nutrition and Metabolism*, 4(11), 151-152. https://doi.org/10.5897/IJNAM11.068
18. Raghuvanshi, R. S., Dutta, A., Tewari, G. & Suri, S. (2017). Qualitative characteristics of red rice and white rice fermented beverages procured from the local market of Uttarakhand: A comparative study. *Journal of Rice Research*, 10, 49-53.
19. Rayaguru, K., Pandey, J. P. & Routray, W. (2011). Optimization of process variables for accelerated aging of basmati rice. *Journal of Food Quality*, 34(1), 56-63. https://doi.org/10.1111/j.1745-4557.2010.00366.x
20. Saif, S. M., Suter, D. A. & Lan, Y. (2019). Effects of processing conditions and environmental exposure on the tensile properties of parboiled rice. *Biosystems engineering*, 89(3), 321-330. https://doi.org/10.1016/j.biosystemseng.2004.08.010
21. Saikia, S., Dutta, H., Saikia, D. & Mahanta, C. L. (2014). Quality characterization and estimation of phytochemicals content and antioxidant capacity of aromatic pigmented and non-pigmented rice varieties. *Food Research International*, 46(1), 334-340. https://doi.org/10.1016/j.foodres.2011.12.021
22. Simonelli, C., Galassi, L., Cormegna, M. & Bianchi, P. (2017). Chemical, physical, textural and sensory evaluation on Italian rice varieties. *University Journal of Agricultural Research*, 5(2), 104-112. 10.13189/ujar.2017.050204
23. Soponronnarit, S., Nathakaranakule, A., Jirajindalert, A. & Taechapairoj, C. (2019). Parboiling brown rice using super heated steam fluidization technique. *Journal of Food Engineering*, 75(3), 423-432. https://doi.org/10.1016/j.jfoodeng.2005.04.058
24. Wichchukit, S. & O'Mahony, M. (2015). The 9-point hedonic scale and hedonic ranking in food science: Some reappraisals and alternatives. *Journal of the Science of Food and Agriculture*, 95(11), 2167-2178. https://doi.org/10.1002/jsfa.6993