Standardization of ethnic fermented sour beverages by indigenous red rice varieties and its nutritional characteristics

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Abstract

The study was aimed at investigating the appropriate fermentation technique for the development of ethnic fermented sour beverages and to standardize the product with improved stabilization for industrial purpose. Fermentation has been proven as a very feasible option to enhance the technological, sensory and especially nutritional and functional features of the cereal industry by-products. Through the increase of minerals, phenolics, bioavailability of vitamins, proteins digestibility and the degradation of anti-nutritional compounds as phytic acid, fermentation can lead to improved nutritional quality of the matrix. The neeragaram were prepared using mapillai samba and karungkuruvai, a notable and nutritious traditional red rice varieties of Tamil Nadu has been taken (raw and parboiled rice) with added species. The developed ethnic fermented sour beverages using rice will increase acceptability by the end users and also essential to improve the individual nutritional status as well as community health. The study concluded that mapillai samba raw rice is highly acceptable based on consumer acceptability with higher nutritional characteristics. The developed product will be highly suitable for commercialization with improved shelf stability.

Keywords: *Traditional rice, Natural fermentation, Nutritional characteristics, Industrial use.*

Introduction

Rice is produced in every region of the world including tropical, subtropical and temperate regions. It is a vital source of energy for humans, accounting for almost half of all food grain production. India is the second largest producer and consumer of rice in the world. Although there are over 40,000 varieties of rice exists only a few are widely cultivated, milled, polished and used for consumption at present. According to Ricepedia, Asia produces and consumes more than 90% of the world's rice, accounting for 87 percent of worldwide rice consumption. The net availability of food grains per capita increased after the Green Revolution, from 58.0 kg/year in 1951 to 69.3 kg/year in 2020. Diversified ethnic fermented cereal foods are consumed by the people across the world (Oko *et al.,* 2019). Microorganisms play an important in fermented food preparation as they improve the aesthetic properties, nutrient bioenrichment, health-promoting properties and food preservation (Haard *et al.,* 2019). In Tamil Nadu, fermented rice is a traditional staple food. To preserve food resources, leftover cooked rice is traditionally allowed to ferment overnight before being consumed on the next day. The fermented rice water known as pazhaya sadham kanchi or neeragaram, made from one-day-old, cooked, water-soaked and fermented rice, is used as a healthful water or drink in natural medicine (Rayaguru *et al.,* 2011). Rice extracts are an alternate beverage for ingesting healthy items with beneficial nutritional properties (Nout and Motarjemi, 2017).

Fermented sour beverages made with traditional rice provide the body with a high-energy, refreshing drink that restores good intestinal flora, prevents gastrointestinal disorders and acts as an immune barrier, which is one of the most promising ways to reduce the prevalence of health problems. It serves as a new market demand for non-dairy probiotic beverages. The Short Chain Fatty Acid (SCFA) molecules present in “torani”(Neeragaram) in good proportion have anti-inflammatory properties. “*Lactobacillus* present in ‘torani’ promotes secretory immunoglobulins that fight local infection, particularly in lungs and intestines”. SCFAs have multiple functions in our body. These are the source of energy and have anti viral properties (Balamurugan, 2021).

Materials and Methods

The mapillai samba and karungkuruvai paddy were procured from Tamil Nadu Rice Research Institute (TRRI), Aduthurai, Tamil Nadu and from organic rice growing farmer, Srivilliputhur, Tamil Nadu. This traditional rice variety was chosen based on the consumer’s preference and popularly cultivated in southern India. The processing of ethnic fermented sour beverages work was carried out in the Department of Food Science and Nutrition, Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai.

Figure 1 Traditional rice variety (Mapillai Samba and Karungkuruvai)

i. Standardization of process parameters for the development of ethnic fermented sour beverages (neeragaram):

The rice variety used in the present investigation was depicted (Figure 1). The ethnic fermented sour beverages (Neeragaram) were prepared using traditional rice varieties *viz.*, Mapillai Samba and Karungkuruvai. The preparation procedure was presented (Figure 2). The different treatments like raw and parboiled rice for processing of neeragaram were depicted (Table 1). The fermentation was carried out using incubator at 30°C for overnight. The known weight of rice (100g) was taken and 300 ml of water was added and allowed for pressure cooking about 20 mins. The cooked rice was added with required quantity of water, different spices such as salt (2g), green chillies (5g), small onions (20g), curry leaves and coriander leaves (1g) in a mud pot, allowed for overnight fermentation in a mud pot in an incubator at 30°C. The hulling and milling characteristics were analyzed by AOAC method (2000). The physical characteristics such as length, breadth, length/breadth ratio, thousand grains weight and gruel solid loss analyzed using AOAC method (2000). The nutritional characteristics such as energy, carbohydrates, protein, fibre, fat and minerals like calcium, iron, sodium and potassium were analysed using AOAC method (2000).

Table 1 Treatments of ethnic fermented sour beverages (Mapillai Samba and Karungkuruvai)

S.No	Treatments	Mapillai Samba	Karungkuruvai
1.	T_1	Raw rice	Raw rice
2.	T_2	Parboiled rice	Parboiled rice

Figure 2 Preparation of ethnic fermented sour beverages (Neeragaram)

Rice grains (100g)

↓

Soaking the grains in water (5 hrs)

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Cooking the soaked rice grains by adding 300 ml water, 2.5 g salt (Pressure Cooker 20 mins)

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Adding 300 ml water and spices to the cooked rice in a mud pot

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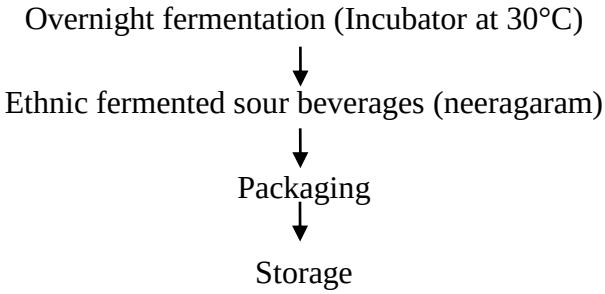

Parboiling of paddy

The initial moisture content of paddy was 13±1% w.b. The parboiling of paddy was conducted by Central Food Technology Research Institute (CFTRI) method. Cleaned paddy sample (one kg) was soaked in 1250 ml of hot water at 70ºC for three hours. Then the water was drained off and allowed for steaming about 20 mins. Water was drained off and soaked paddy was steamed in a vertical autoclave at 1.05 kg/cm2 (15 psi) for 30 mins. After steaming, paddy was sun dried for 4 hrs and then dried in a tray dryer at 60°C to reduce the moisture content to 13-14% (w.b.) which was suitable for the milling of the paddy.

Hulling and Milling of paddy

Raw and parboiled paddy samples of 500g from all treatments were dehusked in three replications by using Satake 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 Satake grain testing mill (No. 553228, Satake Engg Co Ltd, Tokyo, Japan).

Physico-chemical characteristics of selected rice variety

Length, Breadth, Length/Breadth ratio

Ten rice kernels (undamaged and sound) of selected rice variety were analyzed for length and breadth using vernier caliper and expressed in cm. The length/breadth ratio (L/B ratio) was calculated by dividing the length over the breadth of rice grains (Odenigbo *et al.,* 2014).

Thousand grains weight

Thousand grains from all samples were counted manually in triplicate and weighed by using an electronic weighing balance to determine thousand grains weight. Mean of three replications was calculated.

Gruel solid loss

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

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

Energy

The determination of total energy present in rice samples was assessed by the bomb calorimeteric method (AOAC, 2000).

Total carbohydrates

The determination of total carbohydrates present in rice samples was assessed by the phenol-sulfuric acid method (AOAC, 2005).

Protein

The crude protein present in the rice samples was determined by Kjeldahl (FOSS Tecator AB, 2100, Sweden) method by placing 0.8 g of rice flour in a digestion tube.

Fibre

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

Fat

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

Total Amylose

Total amylose from defatted rice flour was estimated as described by Bhattacharya and Sowbhagya (1971) using potato amylase (Sigma, USA) as a standard.

Estimation of minerals

Minerals such as calcium, iron, sodium and potassium were analysed by inductively coupled plasma (ICP) according to the method of Lindsey and Norwell (1969).

Sensory properties

Sensory properties of selected rice varieties after fermentation were analyzed by serving 100 ml of neeragaram to the untrained panelists from the Institute with the proper knowledge to distinguish the sensory characteristics of developed beverages. The panellists were asked to judge the quality in terms of appearance and colour, flavour, consistency, taste and overall acceptability through nine points hedonic scale (Wichchukit and O'Mahony, 2015).

Statistical analysis

Statistical analysis was conducted to study the significant effect of different parameters with respect to selected rice varieties and was done using SPSS software of 2017 version and completely randomized design (CRD) with a 5% CD value using statistical software AGREES.

Results and discussion

The hulling and milling characteristics was presented (Table 2). The hulling recovery was higher in karungkuruvai parboiled rice variety (80.0%). Parboiling process provided higher head rice yield as compared to raw rice. The milling recovery was significantly high in parboiled rice (69.5%), when compared to raw rice (68.7%) in karungkuruvai variety. Saif *et al.,* (2019) reported that the increase in length, width and thickness due to parboiling process,

leading to some advantages over the unparboiled one such as the strengthening of kernel integrity, increase of milling recovery and decrease of cooking losses (Bhattacharya, 2016).

Table 2 Hulling and Milling characteristics of paddy

S. No	Rice Varieties	Hulled rice (g)	Husk (g)	Milled rice (g)	Bran (g)	Hulling recovery (%)	Milling recovery (%)
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
3.	Raw - Karungkuruvai	75.3	24.1	59.5	2.9	76.3	68.7
4.	Parboiled - Karungkuruvai	79.3	24.0	60.9	2.6	80.0	69.5

The selected rice samples were analyzed for physical properties like length, breadth, L/B ratio, thousand grains weight and gruel solid loss to check the significant differences ($p > 0.05$) among the selected rice varieties and were depicted (Table 3). It was observed that among the traditional rice varieties, karungkuruvai raw rice showed the maximum length of 0.60 mm and minimum breadth of 0.19 mm in mapillai samba parboiled rice. The thousand grain weight was higher for mapillai samba parboiled rice of 26.7 g followed by other treatments respectively. Raw rice treatments in both varieties have gained popularity for greater L/B ratio. However the values reduced from 3.52 for raw rice to 3.50 for parboiled rice in karungkuruvai variety. The findings were similar to the results obtained by Odenigbo *et al.,* (2014) who analyzed the length, breadth and L/B ratios of traditional parboiled, non parboiled and parboiled rice variety of karungkuruvai milled rice and Raghuvanshi *et al.,* (2017) also opined that length of the white rice will be more than that of traditional rice varieties.

Parboiling reduced the amount of solid dissolution into the cooking water. The maximum gruel solid loss was observed in parboiled rice varieties and has negative correlation with cooking time (R^2=0.90). Decrease in the gruel solid loss was attributed to the stronger structure of rice imparted by gelatinization of starch (Soponronnarit *et al.*, 2019).

Table 3 Physico-chemical characteristics of selected rice varieties

S. No	Treatments	Length (mm)	Breadth (mm)	L/B ratio	1000 grain weight (g)	Gruel solid loss (%)	Amylose (%)	Amylopectin (%)
1.	Raw-Mapillai Samba	0.57	0.18	3.17	24.1	2.28	23.4	76.6
2.	Parboiled-Mapillai Samba	0.59	0.19	3.05	26.7	2.59	25.2	74.8
3.	Raw-	0.60	0.17	3.52	25.6	2.26	27.6	72.4

	Karungkuruvai							
4.	Parboiled-Karungkuruvai	0.56	0.16	3.50	23.7	2.50	28.7	71.3
	CD (5%)	0.04	0.05	0.34	0.27	0.26	0.57	0.49

Amylose content has an important role in determination of cooking, eating and pasting properties of rice (Asghar *et al.,* 2020). It was significantly ($p<0.05$) reduced from 28.7% for parboiled rice to 27.6% for raw rice in karungkuruvai variety. Similarly, same trend was noticed that 25.2% in parboiled rice to 23.4% in raw rice for mapilla samba variety. Rice containing intermediate amylose content (20-25%) cooks moist and soft and is consumed widely than that having high (>25%) or low amylose content (10-20%) rice (IRRI, 2017).

Table 4 Nutritional characteristics of ethnic fermented sour beverages

S.No	Nutrients	T_1	T_2	T_3	T_4
1.	Energy (Kcal)	68.29 ± 0.25^a	57.15 ± 0.31^c	67.02 ± 0.29^b	51.29 ± 0.49^d
2.	Carbohydrates (%)	11.15 ± 0.88^a	10.59 ± 0.86^b	10.73 ± 0.98^c	9.66 ± 0.42^d
3.	Protein (%)	4.21 ± 0.11^a	4.09 ± 0.41^b	4.10 ± 0.26^c	3.12 ± 0.30^d
4.	Fibre (%)	2.59 ± 0.53^a	2.28 ± 0.32^b	2.25 ± 0.32^d	1.06 ± 0.36^c
5.	Fat (%)	0.93 ± 0.57^d	0.82 ± 0.57^c	0.87 ± 0.09^b	0.69 ± 0.11^a
6.	Calcium (mg)	6.98 ± 0.24^a	3.92 ± 0.28^b	6.12 ± 0.35^c	1.02 ± 0.15^d
7.	Iron (mg)	4.21 ± 0.41^a	3.98 ± 0.33^b	4.18 ± 0.26^c	3.82 ± 0.37^d
8.	Sodium (mg)	61.23 ± 0.13^b	56.45 ± 0.16^d	62.76 ± 0.11^a	58.89 ± 0.22^c
9.	Potassium (mg)	181.7 ± 0.21^a	152.6 ± 0.25^c	177.0 ± 0.19^b	143.2 ± 0.16^d

T_1 - Raw - Mapillai Samba T_2 - Parboiled- Mapillai Samba
T_3 - Raw- Karungkuruvai T_4 - Parboiled- Karungkuruvai

The nutritional characteristics of neeragaram is presented in (Table 4) and (Figure 3). The traditional red rice variety T_1 beverage was found to be nutritious which yields total energy of 68.29 ± 0.25 kcal when compared to white rice (IR 20 variety) which provides total energy of 49.34 kcal upon consumption (Raghuvanshi *et al.,* 2017). The highest carbohydrate content of 11.15 ± 0.88% was found in T_1 followed by other treatments with a less carbohydrate content of 10.73 ± 0.98% in T_3 followed by T_2 10.59 ± 0.86% and T_4 9.66 ± 0.42%. The highest protein content of 4.21 ± 0.11% was found in T_1 followed by T_3 4.10 ± 0.26%, T_2 4.09 ± 0.41% and T_4 3.12 ± 0.30%. With this context, traditional rice varieties showed the highest protein contents.

The fibre content of T_1 was found to be 2.59 ± 0.53%, T_2 2.28 ± 0.32% and T_3 2.25 ± 0.32%, followed by T_4 1.06 ± 0.36% respectively. The fat content of 0.69 ± 0.11%, 0.82 ± 0.57%, and 0.87 ± 0.09% was noted in T_4, T_2 and T_3 rice varieties with a considerable amount of fat up to 0.93 ± 0.57% were noted in T_1 of traditional rice varieties. This reduction in protein and fat content in other treatments might be due to the degree of polishing which tends to the removal of outer bran layer where most of the protein and fat concentrated leads to deprivation of fat and protein content (Devi *et al.,* 2015; Manickavasagan *et al.,* 2017). The

observation was comparable with the results found by Saikia *et al.*, (2012) who reported that fat value in pigmented and non pigmented aromatic rice will be 1.00 to 2.10/100 g.

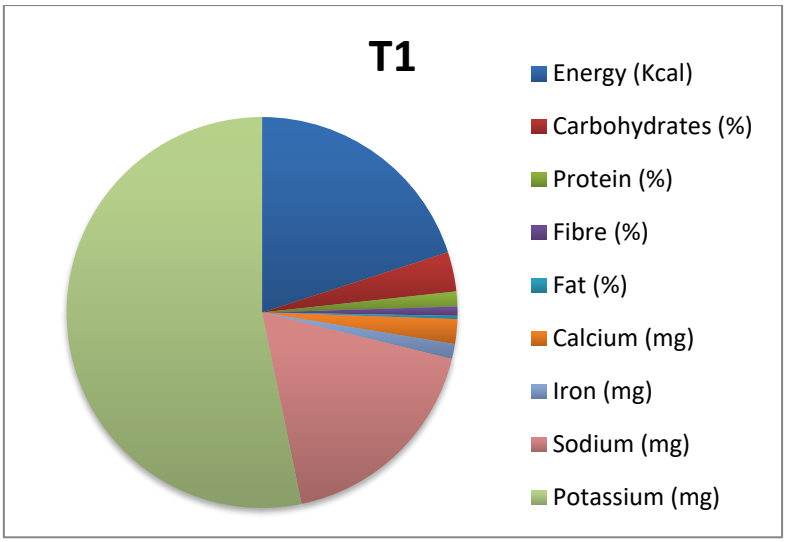

Figure 3 Nutritional characteristics of mapillai samba raw rice neeragaram (T_1)

The mineral analysis of neeragaram showed that it was rich in iron, potassium, sodium and zinc. The developed fermented sour beverages of T_1 had higher mineral content 6.98 mg, 4.21 mg, 181.7 mg, 61.23 mg and 2.32 mg of calcium, iron, sodium and potassium per 100 ml respectively followed by other treatments. The developed ethnic fermented sour beverages could serve as a mineral rich drink and it contains essential minerals for the metabolic activities of our normal body functioning. The results were similar to the study conducted by Praveen Kumar *et al.*, (2018).

Table 5 Score card for the organoleptic evaluation of mappillai samba neeragaram

SENSORY CHARACTERISTICS	SAMPLE CODE			
	T_1	T_2	T_3	T_4
Appearance & Colour	8.5	8.2	8.4	8.2
Flavour	9.0	8.1	8.3	8.0
Consistency	9.0	8.5	8.4	8.4
Taste	9.0	8.3	8.3	8.0
Overall acceptability	9.0	8.3	8.6	8.1

Sensory properties of developed ethnic fermented sour beverages were evaluated through the sensory panelists and the results were illustrated (Table 5) and (Figure 4) which confirms that among the different treatments, mapillai samba raw rice beverage scored the highest overall acceptability of 9.0 followed by other treatments. The obtained results were in parallel with the findings of Simonelli *et al.*, (2017).

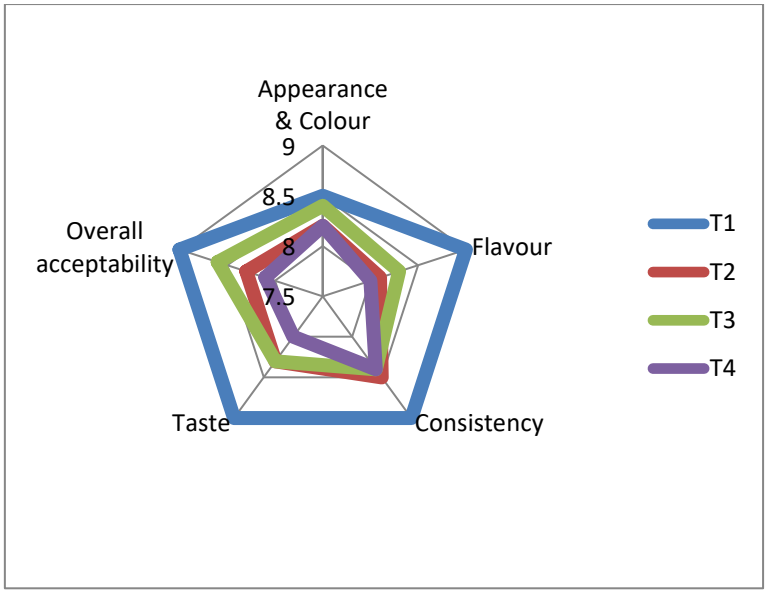

Figure 4 Sensory properties of developed fermented sour beverages

Conclusion

Most of the Asiatic rice considers it inferior to white rice because of its shorter shelf-life, longer cooking time and unappealing taste and texture. As a consequence, strategies to encourage the consumption of brown rice over polished rice in order to improve consumer health are unlikely to succeed at the population level, whereas a more effective approach may be to reduce the glycemic impact of polished rice through the development and introduction of suitable traditional rice varieties, thereby lowering cardiovascular risk and improving nutritional benefits.

Some traditional fermented foods are not explored geographically, hence the study of these fermented sour beverages required and formulates the product with defined micro-flora then it maintains the characteristics and quality of food. The medicinal properties of neeragaram such as body heat reduction, cure peptic ulcer by establishing probiotics, abdominal pain and constipation. Fermented sour beverages known as “pazhasooru kanchi or neeragaram” also used as healthy water in natural medicine in ancient times. It provides energy and helps with stomach issues like bloating, constipation and diarrhea, thus prevent dehydration act as an effective electrolyte solution. Moreover, due to its cooling action, it regulates body temperature and protects skin from the sun, as well as curing acne and red blisters on the face. Due to optimal pH of neeragaram, it keeps hair shiny and long hair, improving skin elasticity, reducing surface friction and preventing grey hair. In spite of its great importance in day to day human life, scientific approaches with respect to microbial and chemical studies are not much expedited. Therefore, the present generation is reluctant to take these types of traditional foods nowadays. The present study evolves the nutritional characteristics of neeragaram to the community health with all benefits.

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Conflicts of Interest

The authors declare no conflict of interest.

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