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Studies on the physico-chemical characteristics of traditional fermented rice (*Basi*)

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Abstract
Present study was carried out to prepare a traditional fermented rice (*Basi*). The *Basi* is consumed as a breakfast by the ethnic people of Chhattisgarh and Madhya Pradesh from many past decades. *Basi* is prepared by the natural fermentation of cooked rice with addition of water (1:3) in an earthenware pot. The physico-chemical composition of *Basi* were analyzed for three different fermentation time, T_1 (8 h fermentation), T_2 (10 h fermentation) and T_3 (12 h fermentation), beside control with cooked rice (T_0). The fermentation was performed at room temperature for 8, 10 and 12 h. The fat content in *Basi* was higher in control sample (T_0) and lower in T_3 sample. The T_3 sample of *Basi* was found to have increased protein and micronutrients contents as compared to T_0 sample. After overnight fermentation of T_3 sample, the carbohydrate content and pH were decreased. The *Basi* have higher amount of micronutrients as compared to cooked rice. Earlier it has been consumed by the ethnic people of Chhattisgarh, but now a days it have been found that it has been consumed by almost all the groups of the peoples as it is more palatable due to fermentation and also have enhanced mineral contents. As *Basi* is the rich source of some essential nutrients, it can also help in control of malnutrition.

Keywords: Traditional, fermented rice, *basi*, malnutrition

Introduction
The inception of rice has for quite some time been a wellspring of discussion for long time. In any case, it is sure that rice has been followed back to around 5000 BC, however precise development is accepted to have started in territories of China and southern and eastern Asia in about 2000 BC. *Oryza sativa* is the most common species of rice consumed in Asia. India ranked second in rice production all over the world with 157.2 MT in 2014-15 (Annual Report, MoFPI, 2016-17). Rice is also used in the preparation of different food products like *idli, dosa, dhokla, uttapam, selroti, ambeli, chakuli* and *anarshe* etc. and some regional fermented rice products are also prepared like *pazhankanji* or *vellachoru* in Malayalam, *pazhaya saadam* in Tamil, *paaniwala chawal* in Hindi and *Basi* in Chhattisgarh.

Rice is the second mostly consumed cereal grain all over the world. In India, Chhattisgarh is well known as "Bowl of Rice". The inhabitants of Chhattisgarh eat rice in almost all the meals. Fermented products from rice, like *Basi*, is one of the traditional recipes and popular breakfast of ethnic peoples of Chhattisgarh. It was prepared and eaten since time immemorial. Nutritionally rice is an important source of carbohydrates, protein, iron, calcium, thiamine, riboflavin and niacin (Verma and Shukla, 2011) [21] and some essential amino acids. In other countries fermented rice can be prepared in the household or in cottage industry using relatively simple techniques and equipment's (Aidoo *et al*. 2006) [1].

Fermentation not only preserves the foods, but also improves their flavour and palatability. (Terefe, 2016) [17]. Besides this a significant improvement occurs in the digestibility and availability of carbohydrate and protein. This method of preservation could also help to reduce the prevalence of diarrhoeal diseases (Shafi *et al*., 2014) [15]. The vitamin and essential amino acid content of rice products significantly increases during fermentation and remains at a superior level to the one existing in rice (Tongnual and Fields, 2006) [18]. It is quite popular as ready-to-eat breakfast due to ease of handling. Yonzan and Tamang (2010) [22] prepared product from fermented rice and reported that *Leuconostoc mesenteroides, Enterococcus faecium, Pediococcus pentosaceus,* and *Lactobacillus curvatus* and yeasts belonging to *Saccharomyces cerevisiae, Saccharomyces kluyveri, Debaryomyces hansenii* were found during fermentation.

These fermented type products can also provide energy and helps with stomach issues like bloating, constipation and diarrhea, thus prevent dehydration act as effective electrolyte solution. In addition regulate the body temperature and also protect skin from the sun due to

cooling effect and cures acne and red blisters of the face. (Varnakulendran *et al*., 2016) [20].

The *Basi* may be the most appropriate food that fulfills the nutritional requirement of the peoples of every age. Malnutrition is a condition which is caused by the lack of essential nutrition. Children of poor families are not getting the proper amount of nutrition, due to this they suffer from malnutrition. Deficiency of essential nutrients causes anemia (blood disorder), diarrhea, weight loss, improper bone growth and muscle formation etc. In order to fulfil the nutrition requirement, *Basi* can be the best source as it contains various nutrients required by the body. In malnutrition deficiency of iron, copper, zinc, manganese, potassium etc. causes various types of diseases and other health disorders. *Basi* contains essential nutrients in sufficient amount thus may become a perfect food for undernourished peoples.

Studies on the effect of fermentation time on the production of *Basi* will help to generate information about *Basi* quality. Thus, the present investigation was done to identify suitable fermentation time to produce *Basi* that has good physico-chemical and sensory qualities.

Materials and Methods

Preparation of sample

In this work, *Basi* was prepared by the traditional method. For the preparation of *Basi*, raw rice grains were cleaned, washed and cooked in an open vessel. Then the cooked rice was soaked in water in an earthenware pot at 30 ± 2˚C for different fermentation time (8h, 10 h and 12 h). The ratio of rice to water in an earthenware pot was maintained at 1:3. The control sample was prepared by without fermentation of rice. At the end of fermentation period, the rice was separated from the water. After natural fermentation of rice for different fermentation period, the 3 experimental samples of *Basi* was obtained as T_1 (8h fermentation), T_2 (10h fermentation) and T_3 (12h fermentation) and one control sample (T_0).

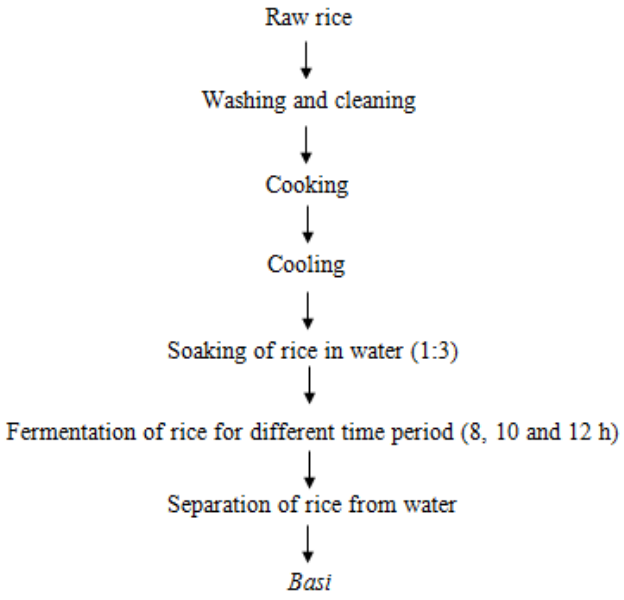

Fig 1: Flow chart for preparation of *Basi*

Physico-chemical analysis

The fat content was determined by ether extraction using a glass soxhlet (AOAC, 1990) [4]. The protein content of the sample was determined by Kjeldahl method. The carbohydrate content of *basi* was determined by difference method. The pH of the sample was determined directly by digital pH meter (EUTECH Model- pc 510). The titratable acidity of the sample was expressed as % LA and it was determined by titrating the sample with 0.1 N sodium hydroxide to the phenolphthalein indicator. Moisture content was determined by using hot air oven. The ash content of the sample was determined by using Muffle Furnace (AOAC, 1990) [4]. Iron, zinc, copper and manganese were estimated in an atomic absorption spectrophotometer (Varian Model AA240). Sodium and potassium were estimated by Flame photometer (ESICO Model- 1382).

Sensory evaluation of *Basi*

The *Basi* samples were organoleptically evaluated for their sensory characteristics. The effect of different fermentation time on *Basi* samples on the sensory characteristics like colour and appearance, aroma, taste and overall acceptability were evaluated on a 9-point Hedonic scale by a panel of judges.

Statistical analysis

The experiment was replicated 4 times and the data generated under physico-chemical and sensory analysis were subjected for statistical analysis as under. Statistical analysis was carried out by using one way ANOVA.

Result and Discussion

Proximate composition of rice

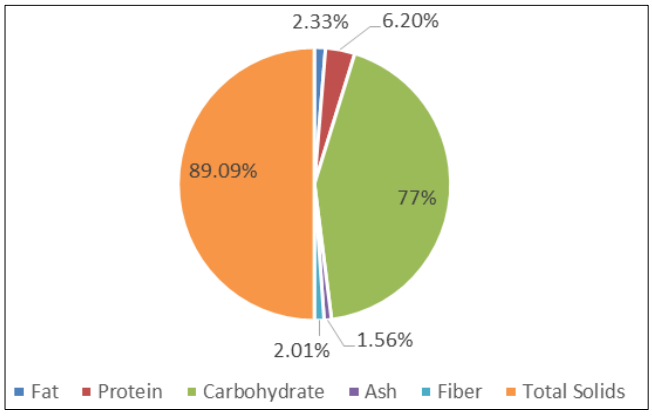

Fig 2: Proximate composition of rice

Effect of different fermentation time on physico-chemical property of *Basi*

The observation of the different fermentation time on the physico-chemical quality of *Basi* is displayed in Table 1:

Table 1: Physico-chemical quality of *Basi*

Treatments	Per 100g on dry basis in *Basi*				Moisture % in *Basi*	Acidity % LA	pH
	Fat	Protein	CHO	Ash			
T_0	2.2	6.93	89.40	1.47	55.79	0.02	6.1
T_1	1.89	8.10	89.08	0.93	59.45	0.19	5.5
T_2	1.75	8.49	88.95	0.81	60.96	0.22	5.2
T_3	1.66	8.74	88.88	0.72	62.14	0.24	4.9

CHO – Carbohydrate; LA – Lactic acid

In the *Basi* samples, the fat content were found to be 2.2, 1.89, 1.75 and 1.66 % for T_0, T_1, T_2 and T_3, respectively and it differed significantly ($P < 0.05$) from each other. The fat content in the *Basi* decreased during fermentation, which might be due to increased lipase activity observed in fermenting medium (Odunfa, 1983) [13].

The protein content of *Basi* of different treatments T_0, T_1, T_2 and T_3 were found to be 6.93, 8.10, 8.49 and 8.74 % respectively. The protein content of *Basi* samples were significantly increased (p<0.05) during fermentation. The higher protein content in T_3 suggested the optimum conditions for the growth and activities of the proteolytic organisms. They hydrolyze protein and its complexes with the release of free amino acids (Frazier and Westhoff, 1978) [9] which are then used for the synthesis of new proteins. Many workers have reported for increased protein quality due to fermentation (Eka, 1980; Anosike and Egwuatu, 1981; Van der Riet *et al*. 1987; Rao and Pulusani, 1988) [7, 3, 19, 14].

The carbohydrate content of *Basi* samples were found to be 89.40, 89.08, 88.95 and 88.88 % in T_0, T_1, T_2 and T_3, respectively. The decreased carbohydrate in *Basi* samples were attributed to increased activity of α-amylase (Odunfa, 1983) [13] which hydrolyzed starch to simpler sugars (glucose). The sugars provide a source of energy for the fermenting microorganisms. The ash content of *Basi* samples were significantly decreased (p < 0.05) from 1.47 to 0.72 % in T_0 to T_3 respectively. The fermentation decreased the ash content probably because of loss of dry matter, which normally occurs during fermentation (Nnam and Obiakor, 2003) [11].

The moisture content in *Basi* samples was differed significantly (p< 0.05) from each other. The moisture content in different treatments T_0, T_1, T_2 and T_3 were 55.79, 59.45, 60.96 and 62.14 % respectively. The acidity were significantly increased from 0.02 to 0.24 % LA in T_0 to T_3 respectively. The pH of the *Basi* sample of T_0, T_1, T_2 and T_3 were 6.1, 5.5, 5.2 and 4.9 respectively and it differed significantly (P < 0.05) from each other. The cause of the increase in acidity and consequent drop in pH during fermentation of cereal was likely due to utilization of free sugars by yeasts and lactic acid bacteria (Efiuvwevwere and Akona, 1995; Zvauya *et al*., 1997) [6, 23].

Table 2: Mineral content of *Basi*

Treatments	mg/100g, on dry basis					
	Iron	**Zinc**	**Copper**	**Manganese**	**Potassium**	**Sodium**
T_0	0.66	0.62	0.19	0.23	24.63	2.6
T_1	1.54	0.83	0.32	0.4	39.31	2.13
T_2	2.17	0.95	0.37	0.51	43.67	2.01
T_3	2.7	1.04	0.42	0.59	47.83	1.91

The iron content in *Basi* were significantly increased (p<0.05) from 0.66 mg/100g in control sample (T_0) to 2.70 mg/100g in *Basi* with 12h fermentation (T_3). Tamang and Thapa, (2006) [16] and Goyal and Khetarpaul, (1994) [10] also reported for increased iron content in rice due to fermentation. The most widespread nutritional deficiency worldwide is iron deficiency. Iron deficiency can lead to 'anemia'. This is a blood disorder that causes fatigue, weakness and a variety of other symptoms. The *Basi* is a rich source of iron, consumption of *Basi* ultimately results in a supply of nutrients required by the body to overcome malnutrition.

In *Basi*, the highest zinc content among the experimental samples were found to be 1.04 mg/100g in T_3 sample followed by 0.95 mg/100g in T_2 and 0.83 mg/100g in T_1 and the control sample (T_0) had the lowest zinc content of 0.62 mg/100g among all the samples. The zinc content was increased due to increased enzyme activity and favorable condition for Zn extractability. Nout (1990) [12] reported increased mineral due to fermentation. Zinc deficiency is thought to be quite common in infants, adolescents, women and elderly populations. Zinc intake in malnourished children improves growth and immunity. Zinc intake also reduces the chances of occurrence of diarrhea. The consumption of *Basi* provide sufficient amount of zinc, thus fulfilling the nutritional demand of the hosts.

The copper content in the samples of T_0, T_1, T_2 and T_3 were found to be 0.19 mg/100g, 0.32 mg/100g, 0.37 mg/100g and 0.42 mg/100g respectively. The copper content of *Basi* was differed significantly (p<0.05) from each other. Nnam and Obiakor (2003) [11] reported increased copper content in rice grains due to fermentation. Copper is present in the ceruloplasmin, a major copper carrying protein in the blood. Castillo-Duran and Uauy (1988) [5] reported that the copper intake by the children resulted in weight gain. The *Basi* samples contains copper which ultimately results in the control of malnutrition when consumed by the undernourished children.

Manganese content in the samples of T_0, T_1, T_2 and T_3 were 0.23 mg/100g, 0.40 mg/100g, 0.51 mg/100g and 0.59 mg/100g respectively and it differed significantly (p<0.05) from each other. Manganese content in *Basi* was increased during fermentation which may help in control of malnutrition in children's. Manganese is necessary for normal bone growth and cartilage development. Intake of manganese by children also contribute in control of malnutrition.

The Potassium content of T_0, T_1, T_2 and T_3 were 24.63 mg/100g, 39.31 mg/100g, 43.67 mg/100g and 47.83 mg/100g respectively. Potassium content in the *basi* samples was significantly increased (p<0.05) during fermentation period. Tamang and Thapa (2006) [16] and Nnam and Obiakor (2003) [11] also reported for increased potassium content due to fermentation in *Bhatti Jaanr* and rice respectively. Deficiency of potassium in children's body causes diarrhoea. Potassium, an electrolyte, must be balanced with sodium. Potassium deficiency is usually associated with sodium deficiency and both are associated with dehydration stemming from excessive losses of body fluid. Presence of sufficient quantity of potassium in body ultimately result in control of diarrhoea and other losses of body fluid. The fulfilment of potassium requirement in children results in control of malnutrition.

In *Basi*, the lowest sodium content among the experimental sample was found to be 1.91 mg/100g in T_3 sample followed by 2.01 mg/100g in T_2 and 2.13 mg/100g in T_1. The control sample (T_0) had the highest sodium content of 2.60 mg/100g among all the samples. In the *Basi* samples, the sodium content was significantly (p<0.05) decreased during fermentation period.

The observed increased and decreased mineral concentrations of the grains were likely due to the metabolic activities of the fermenting microorganisms which hydrolyze the metal-phytate complexes to release free minerals for use (Fardiaz and Markakis, 1981) [8], and also due to the losses in dry matter which led to apparent increases in minerals (Van der Riet *et al.,* 1987) [19].

Sensory evaluation of *Basi*

The sensory evaluation of *Basi* samples of different fermentation time were evaluated and displayed in Table 3:

Table 3: Average sensory scores of *Basi* samples with different fermentation time

Treatments	Colour & Appearance	Aroma	Taste	Overall Acceptability
T_0	7.2	7.6	7.5	7.4
T_1	7.5	7.9	7.7	7.7
T_2	7.7	8.0	7.6	7.8
T_3	7.8	8.1	7.7	7.9

The colour and appearance scores of *Basi* samples prepared with different fermentation time period (8h, 10h and 12h) were evaluated. The samples T_0, T_1, T_2 and T_3 of *Basi* had scored 7.2, 7.5, 7.7 and 7.8 respectively for colour and appearance attributes. The *Basi* samples had scored 7.6, 7.9, 8.0 and 8.1 for the samples T_0, T_1, T_2 and T_3 respectively for the aroma. The taste scores of *Basi* obtained for samples T_0, T_1, T_2 and T_3 were 7.5, 7.7, 7.6 and 7.7 respectively. The overall acceptability scores obtained for *Basi* samples T_0, T_1, T_2 and T_3 were 7.4, 7.7, 7.8 and 7.9 respectively. The sample T_3 have vast acceptability in terms of appearance, aroma, taste and greater overall acceptability score in 9- point hedonic scale.

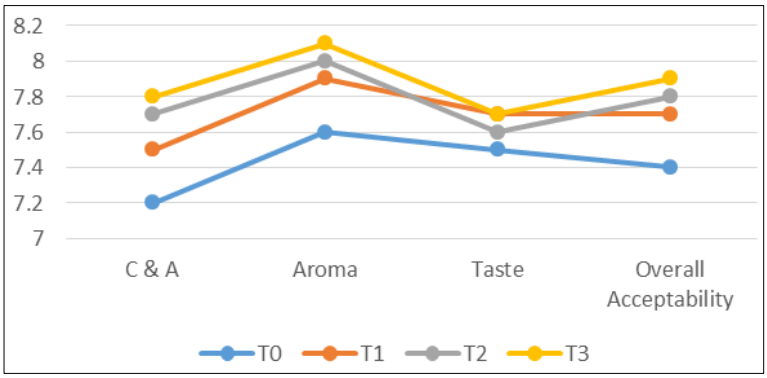

Fig 3: Sensory scores of *Basi*

Conclusion

Basi, the traditional fermented rice is a package of various nutritional elements like fat, protein, carbohydrates, vitamins and other micro- and macro-nutrients. In the experimental samples, the fat, carbohydrate, ash and pH of *Basi* were decreased during fermentation while protein, moisture and acidity were increased during fermentation period. The mineral contents like iron, zinc, copper, manganese, potassium were increased at the end of the fermentation period. The consumption of *Basi* provide sufficient amount of essential nutrients which may help in cure of blood disorder like anemia, proper bone growth and muscle formation, reduces the chances of occurrence of diarrhea, reduces other losses of body fluids etc. that may be helpful in control of malnutrition. As it contains almost all the nutritional elements which makes it as a perfect food which ultimately helps fulfilling nutritional requirement of undernourished children's.

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