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Microbial, Physico-Chemical and Nutrient Changes Associated with Idli Batter Fermentation

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ABSTRACT

Fermentation is one of the oldest methods of food preparation that originated centuries ago. Although idli is a common South Indian food, the method of preparation varies from one place to another. The study was carried by bringing out variations in the addition of ingredients namely rice and black gram dhal in various proportions like 3:1, 4:1 and 4.5:1 respectively and allowing the batter to ferment for 16 to 18 hours at different temperatures like 22 °C, 27 °C and 32 °C. Physico-chemical characters like pH, titrable acidity and batter volume, along with mean scores for the overall acceptability of the sensory parameters showed that the variations of rice: black gram 3:1 and 4:1 at room temperature (27 °C) were found to be highly acceptable. The total microbial count was found to improve gradually with an increase in the hours of fermentation (3x103 cfu/g at zero hours to TNTC at 36 hours). Leuconostoc sp. and Saccharomyces sp. isolated at zero hours and present up to 24 hours of fermentation were found to be the microorganisms responsible for fermentation of idli batter. A comparison of the nutrient content of idlis made from fermented and unfermented batters showed an increase in the proximate principles, minerals, B vitamins and a decrease in phytate content.

KEYWORDS : Fermentation, physico-chemical, organoleptic, counterparts

INTRODUCTION

Fermentation is one of the oldest methods of food preparation that originated centuries ago. It has been known and practiced by mankind long before the underlying scientific principles were understood[1]. With the rapid increase in the world population and the attendant poverty and hunger, more people may be compelled to depend on plant foods, many of which are fermented products that tend to be easily affordable[2]. Idli, a traditional food of South India is an example of an important group of fermented foods which utilize cereals (rice) and legumes (blackgram dhal) that depend on the indigenous flora of the ingredients to bring about fermentation[3]. Idli, a traditional cereal/legume based naturally fermented steamed product with soft and spongy texture is a popular food item which has been in use in South India since 1100 A.D[4]. The nutritive value of the legume based fermented foods are found to be higher than their unfermented counter parts. Also, specific information on microflora appears to be scanty for several indigenous fermented products. Hence, the present study was undertaken to identify the predominant micro organisms (bacteria and yeast) responsible for the fermentation of idli batter and also to determine the physico-chemical changes associated with the process of fermentation.

MATERIALS AND METHODS

Although idli is a common South Indian food, the method of preparation varies from one place to another. Since temperature plays an important role on the growth of microorganisms and thereby affecting the rate of fermentation, variations were brought about by adding the ingredients namely, rice and black gram in different proportions namely 3:1, 4:1 and 5:1 respectively at different temperatures like 22° C, 27° C and 32 °C (Table 1)

Table 1
Variations in the preparation of idli

S.No	Variation	Temperature°C	Rice :Blackgram
1	A1	22	3:1
2	A2	27	3:1
3	A3	32	3:1
4	B1	22	4:1
5	B2	27	4:1
6	B3	32	4:1
7	C1	22	4.5:1
8	C2	27	4.5:1
9	C3	32	4.5:1

Determination of Physico – Chemical properties

The physico – chemical properties namely changes in pH, titrable acidity and batter volume were determined for all the variations at different hours namely, 0, 8, 16, 24 and 36 respectively. The pH was determined by use of a pH meter and titrable acidity was determined in terms of per cent of acid in the sample (Nielsen 1994)[5] and batter volume using a measuring cylinder.

Determination of Organoleptic properties

Quality is the ultimate criterion for the desirability of any food product. The samples of idli prepared by using the batters of all nine variants were subjected to sensory evaluation by a panel of 25 semi-trained members. A five point score card was developed on the basis of numerical rating scale and the samples were tested for their organoleptic properties namely appearance, colour, texture, flavor and taste.

Identification of Microorganisms

The process of fermentation is caused by the action of microorganism. The serial-dilution agar plating method is used to enumerate the number of microorganisms present at 0, 8, 16, 24 and 36 hours respectively. Identification of bacteria and yeast involved in different hours of fermentation was done using a series of cultural, biochemical and morphological tests given by Cappuccino and Sherman (1999)[6] Mackie and Mc Cartney (1995)[7].

Analysis of Nutrients

Fermented (16 hours) and unfermented (zero hours) samples of idli in duplicates were used for the analyses of different nutrients. The carbohydrate content was analysed by Anthrone method, protein by Kjeltech nitrogen analyser and fat by Soxlet extraction method. The B- complex vitamins like thiamine and riboflavin were analysed by a fluorimeter whereas, niacin by colorimeter. The minerals namely calcium(titration), iron and phosphorus (colorimeter) and phytate content (colorimeter) were also determined for the samples in duplicates by the procedures given by Raghuramulu et al (2003)[8].

RESULTS

Changes in physico-chemical properties

pH: The results of the study indicated that with an increase in the hours of fermentation, there was found to be a decrease in the pH of the batter . It was found that at 22°C the pH was 6.5 at zero hours and gradually reduces to 4.6 at 36 hours. Similarly there was a decrease in pH from 6.2 to 4.2 at 27°C and from 6.0 to 4.1 at 32°C.

Titrable Acidity: The study showed an increase in the titrable acid-

ity from 2.65 to 17.27 per cent of lactic acid from zero to 36 hours at 22°C and from 3.04 and 3,17 to 21.02 to 22.14 percent at 27°C and 32°C respectively. The titrable acidity also increases with the rise in temperature.

Batter Volume: The rise in batter volume was found to be propotinal to the rise in temperature as well as the hours of fermentation. The variation with rice:blackgram in the propotion of 3:1 was found to have a higher batter volume than the other variants.

Sensory Evaluation

The organoleptic evaluation of all the nine variants showed that the variation with a propotion of ingredients rice:blackgram (3:1and 4:1) at 27°C were found to be highly acceptable in terms appearance, colour, texture, flavor and taste. These sample were considered as standard and used for further analysis.

Identification of Microorganisms

Both bacteria and yeast, whenever present tend to increase significantly with the progress in fermentation (Soni and Sandhu,1999)[9]. The total plate count of microorganisms at a dilution of 10^3 for different hours of fermentation namely 0,8,16,24 and 36 resulted in a gradual increase of microbial count with an increase in the fermenting hours. At zero hours, the colony forming units were 3x 10^3 cfu/g and with a gradual increase, the total count was too numerous to count (TNTC) at 36 hours. The bacteria identified at 0,8,16,24 and 36 hours of fermentation belonged to the species of genus namely Leuconostoc, Bacillus, Lactobacillus, Staphylococcus, Proteus and Streptococcus. Leuconostoc sp., the predominant bacteria which was isolated at zero hours was present until 24 hours of fermentation. Staphylococcus sp., which was present at zero hours disappeared with the progress of fermentation. Bacillus sp., was identified at zero and eight hours and the Lactobacillus sp., was identified at eight and 16 hours of fermentation. The Streptococcus was identified at 24 and 36 hours of fermentation. The predominant yeast identified belonged to the species of genus namely, Candida, Saccharomyces, Trichosporon and Torulopsis. The Saccharomyces sp., was predominantly present and was identified at 0,8,16 and 24 hours of fermentation. The Candida sp. was identified at 0 and 8 hours, Trichosporon sp., at 8 hours and Torulopsis sp., at 16 hours of fermentation (Table 2).

Nutrient Content

In the case of the proximate principles, a slight increase of about 0.6g, 0.02g and 0.16g in the mean values of carbohydrate, fat and protein content was observed in the fermented samples than their unfermented counterparts. The chemical changes during fermentation include an increase in free sugars and amino nitrogen indicating the partial breakdown of carbohydrates and proteins (Ramakrishnan 1979)[10]. The iron content remained the same before and after fermentation and an increase in 0.2mg of calcium was observed in the fermented sample. Fermentation had an effect on the phosphorus content with a reduction of 2mg which can be attributed to the degradation of phytate which was significantly reduced to 37 mg on fermentation. An increase in the content of the B-vitamins namely thiamine (0.08mg), riboflavin (0.08mg) and niacin (1.15mg) was observed in all the samples which were prepared after fermentation.

TABLE 2
MICROORGANISMS ISOLATED AT SUCCESSIVE HOURS OF FERMENTATION

S. NO	TIME (Hours)	PROPOTION R:BG	TPC	MICROORGANISM ISOLATED		PROPOTION R:BG	TPC	MICROORGANISM ISOLATED	
				BACTERIA	YEAST			BACTERIA	YEAST
1	0	3:1	3 x 10^3 CFU/g	Leuconostoc sp. Bacillus sp. Staphylococcus sp.	Candida sp. Saccharomyces sp.	4:1	3 x 10^3 CFU/g	Leuconostoc sp. Bacillus sp. Staphylococcus sp.	Candida sp. Saccharomyces sp.
2	8	3:1	7 x 10^3 CFU/g	Leuconostoc sp. Bacillus sp. Lactobacillus sp.	Candida sp. Saccharomyces sp. Trichosporon sp.	4:1	5 x 10^3 CFU/g	Leuconostoc sp. Bacillus sp. Lactobacillus sp.	Candida sp. Saccharomyces sp. Trichosporon sp.
3	16	3:1	15 x 10^3 CFU/g	Leuconostoc sp. Lactobacillus sp. Proteus sp.	Saccharomyces sp. Torulopsis sp.	4:1	12 x 10^3 CFU/g	Leuconostoc sp. Lactobacillus sp. Proteus sp.	Saccharomyces sp. Torulopsis sp.
4	24	3:1	28 x 10^3 CFU/g	Leuconostoc sp. Streptococcus sp.	Saccharomyces sp.	4:1	23 x 10^3 CFU/g	Leuconostoc sp. Streptococcus sp.	Saccharomyces sp.
5	36	3:1	TNTC x 10^3 CFU/g	Streptococcus sp.	Absent	4:1	TNTC x 10^3 CFU/g	Streptococcus sp.	Absent

R-Rice ; BG-Blackgram ; TPC-Total Plate Count ; CFU-Colony Forming Units

CONCLUSION

Fermentation of cereal based foods has been one of the major sources of energy for people since ancient times. The physico-chemical changes brought about help in the growth of microflora that produces lactic acid. These organisms of bacteria namely species of Leuconostoc, Bacillus, Lactobacillus, Staphylococcus, Proteus and Streptococcus and of yeasts namely species of Candida, Saccharomyces, Trichosporon and Torulopsis have been proven beneficial to the human beings. More over the idli prepared from the fermented batter had a better nutrient content with respect to proximate principles and B vitamins and also as a preferred food for all age groups of people.

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