ASIAN JOURNAL
ISSN: 0976-3376

Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology
Vol. 2, pp.044-048, June, 2010

RESEARCH ARTICLE

PHYSICAL AND NUTRITIONAL EVALUATION OF IDLI PREPARED FROM SORGHUM *(Sorghum bicolor L. Moench)*

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Received 28th May, 2010; Received in revised form; 5th June, 2010; Accepted 15th June, 2010; Published online 19th June, 2010

Cereals and pulses are important sources of energy and protein particularly in the developing countries. The present research was undertaken to determine the physical properties of batter, physio- chemical properties and organoleptic evaluation of the developed Idlis. Idlis were prepared from Rice and Black gram dhal incorporating sorghum. All the ingredients were collected from the local market. Three types of Idlis namely standard idli, mixed idli and sorghum idli was prepared using different combinations of ingredients such as Rice (Parboiled), Black gram and sorghum. The developed products were analyzed for physical and chemical parameters and organoleptic evaluation. These scores were compared with standard. The developed Idlis were highly acceptable by the subjects and notable change in physical parameters of both millet incorporated batter and idli was observed when compared to the standard. Remarkable increase was observed in the nutrients such as protein, fat, fibre, iron except calcium in the mixed and sorghum Idlis compared to the standard Idlis.

Key Words: Sorghum, Batter, Physical parameters, Idli, Organoleptic evaluation

INTRODUCTION

Sorghum is one of the cereals that constitute a major source of proteins, calories, minerals for millions of people in Africa and Asia. This cereal is mainly considered as subsistence crop because of its unique tolerance to drought and adaptation to dry tropical and subtropical ecosystems throughout the world. The crop is rich in minerals but with bioavailability vary from less than 1% for some forms of iron to greater than 90% for sodium and potassium. The reasons for this are varied and complex, since many factors interact to determine the ultimate bioavailability of a nutrient (Miller, 1996). Like other grains, sorghum protein is generally low in the essential amino acids such as lysine and therionine (Murty and Renard, 2001).

Most varieties of sorghum have gained universal fame for production of fermented foods, because of the wide adaptability and low cost of production. Sudan seems to have the greatest number of fermented sorghum products. There are about 30 such products that are basically different from one another. Fermentation makes the foods easier to digest and the nutrients easier to assimilate and also it retains enzymes, vitamins, and other nutrients that are usually destroyed by food processing. Fermentation has been used for several thousand years as an effective and low cost means to preserve the quality and safety of foods. Fermentation is an oldest known form of food biotechnology.

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Food fermentations is an important technique in the developing countries where the lack of resources limits the use of recent techniques such as vitamin enrichment of foods and the use of energy and capital intensive processes for food preservation (Dirar, 1991). Millet grains can substitute for the rice or wheat component for the development of fermented foods like idli or dosa (Cheeptongkum 1976). Black gram originated in India where it has been in cultivation from ancient times and is one of the most highly prized pulses of India. Black gram has a mucilaginous material which makes it a valuable ingredient in idli preparation. The chief proteins present in black gram are albumins and globulins and glutelins. Fenugreek is used both as an herb (the leaves) and as a spice (seed). It is cultivated worldwide as a semi-arid crop. It is frequently used in curry and also as a main ingredient in the idli preparation.

Idli is a traditional cereal/legume-based naturally fermented steamed product with a soft and spongy texture which is highly popular and widely consumed as a food item in India (Renu Agrawal et al, 2000). Idli makes an important contribution to the diet as a source of protein, calories and vitamins, especially B-complex vitamins, compared to the raw unfermented ingredients (Srilakshmi, 2003). Idli is also known as “Rice cake” is a traditional food of India. It is a favourite breakfast food in south India with spongy texture, attractive appearance, appetizing taste and flavour to get with its easy digestibility and good nutritive value contribute to its increasing popularity in all parts of India and also in other countries (Manay and shadaksharaswamy, 2001). The present study was done to analyze the physical and physio

chemical qualities of batter and sorghum incorporated idli with a view to determine the organoleptic acceptability.

MATERIALS AND METHODS

Basic formulation of idlis

Three different types of idlis with varying proposition of ingredients were prepared and the composition is given in the Table 1.

Table 1. Proportion of Ingredients in Idli

Standard Idli	Mixed Idli	Sorghum Idli
Rice (Parboiled) -75g Black gram -15g Fenugreek seeds – 5g Water - required consistency	Rice(Parboiled) – 45g Black gram – 15g Sorghum – 30g Fenugreek seeds – 5g Water- required consistency	Sorghum – 75g Black gram – 15g Fenugreek seeds – 5g Water- required consistency

Flow chart for Idli preparation

Porboiled Rice / Sorghum — Black gram dhal & Fenugreek

↓ ↓

Wash and soak for 5 hours — Wash and soak for 2 hours

↓ ↓

Grind coarsely — grind finely

↓ ↓

Combine slurries into thick batter and mix well

↓

Add salt

↓

Allow to Ferment for 14 hours in a warm place (30-32°c)

↓

Pour batter into small cups in idli cooker

↓

Steam for 20 minutes

↓

Ready for consumption

Preparation of Idlis

The ingredients of different variables in the above specified proportion were soaked over night and ground separately. Rice (Parboiled), sorghum was ground coarse and black gram to a fine paste with Fenugreek seed. Ingredients were mixed together and salt was added. Parboiled rice is found to be more suitable than raw rice for making soft and spongy textured idlis. The specialty of Black gram in idli preparation is owing to the mucilaginous material present in it which is absent in other edible legumes. This mucilaginous principle helps in the retention of carbon dioxide evolved during fermentation. The batter was allowed to ferment for 14 hours after that it was poured in an idli steamer and steamed till it was done.

Physical properties of developed batters before and after fermentation

Various physical properties of the developed batters such as height, weight, pH, spread ability and specific gravity of the batter are analyzed using standard techniques.

Physical parameters of developed idlis

Various parameters such as diameter, width, weight of the cooked idlis, time taken for complete steaming were assessed using standard procedures. A special test called 'INK print test' was done to record the appearance of idlis permanently by means of photography on Ink prints. These prints furnish a record of number of pores per square inch in the graph sheets which indicates the softness of the developed idlis.

Organoleptic evaluation

The developed idlis were served to a group of 30 semi-trained panelists for the evaluation of appearance, colour, flavor, taste, texture and overall acceptability on a 9 point hedonic scale with a scores ranging from 9 to1 where scores 9 to1 represented like extremely and dislike extremely respectively. The quality parameters were quantified and the mean scores of the three evaluations were calculated.

Table .2 Mean Physical Properties of the batter

Parameters*	Standard			Mixed Idli			Sorghum Idli		
	I	F	D	I	F	D	I	F	D
Height(cm)	3.0	4.30	1.3	3.0	4.0	1.0	3.0	4.5	1.5
Weight(g)	20.0	18.5	1.5	20.0	18.3	1.7	20.0	18.2	1.8
pH	6.60	5.27	1.33	6.59	5.56	1.03	6.62	5.87	0.75
Spreadability(cm)	4.4	4.65	0.25	4.7	5.1	0.4	4.8	5.0	0.2
Specific gravity (g/cm^3)	1			1.25			1.4		

Note:
I-Initial, F-Final, D-Difference
*values are averages of three replicates in each sample

Table 3. Co- relation matrix of the physical properties of the batter

	Height(cm)	Weight(g)	pH	Spreadability (cm)	Specific gravity (g/cm^3)
Height(cm)	1				
Weight(g)	0.861	1			
pH	0.728	0.133	1		
Spreadability(cm)	0.791	0.348	0.481	1	
Specific gravity (g/cm^3)	0.831	-0.999*	0.104	0.378	1

* Co-relation is significant at 0.05 level (2- tailed)

Table 4. Physical parameters of the developed idlis

Parameters	Standard	Mixed Idli	Sorghum Idli
Diameter (cms)	8.0	7.0	7.4
Width (cms)	2.9	1.6	2.0
Cooked Weight (g)	50	40	56
Cooking time(min)	7	13	12
Number of Pores in a square inch	15	12	9

Table 5. Mean Organoleptic Scores of idlis

Type of variation	Appearance	Colour	Flavour	Texture	Taste	Over all acceptable
Standard	8.72±0.32^c	8.54±0.36^c	8.84±0.11^c	8.74±0.20^c	8.72±0.17^c	8.58±0.37^a
Mixed idli	7.82±0.29^b	7.84±0.21^b	7.60±0.54^b	8.17±0.08^b	7.86±0.63^b	7.78±0.81^{ab}
Sorghum idli	7.06±0.51^a	7.04±0.35^a	6.82±0.45^a	6.98±0.04^a	6.70±0.32^a	7.00±0.35^a
F-ratio	22.42	27.34	29.93	219.77	28.28	10.13
P-value	0.000**	0.000**	0.000**	0.001**	0.000**	0.003**

9-point hedonic scale is as follows: 1—dislike extremely, 2—dislike very much, 3—dislike moderately, 4—dislike slightly, 5—neither like or dislike, 6—like slightly, 7—like moderately, 8—like very much, 9—like extremely.
** Significant difference is at 0.01 level
* Significant difference is at 0.05 level
Values are means (± SD). Means not sharing a common superscript letter in a column are significantly different at ($p \leq 0.05$) as assessed by Tukey's Post HOC test.

Nutritive value of the developed idlis

Nutrients like carbohydrates, protein, fat, calcium and iron were analyzed. Total carbohydrates were determined by volumetric method as described by Lane & Eynon method (Ranganna, 2004), protein by Micro-kjeldhal method using a conversion factor of 6.25, fat by Soxhlet extraction method using petroleum ether (B P60 -70°C), fiber by AOAC method, calcium content was determined by KMno4 titration method, and iron content were estimated by the calorimetric methods as described by Ranganna (2004).

Statistical analysis

The collected data was compiled and analyzed by using statistical methods. Descriptive statistics, ANOVA and Correlation is computed using s statistical software SPSS

version 15.0. Tukey's Post HOC test was applied to determine the significant differences between the idlis.

RESULT AND DISCUSSION

Physical properties of the batter

In the present study, the mean initial height of the batter was noticed as 3.0cm for all the variations. After fermentation (14hrs), the raise in height was higher for sorghum (1.5cm) followed by standard (1.3cm) and the least was occupied by the Mixed idli batter (1.0cm), regarding the mean weight, increase weight was observed in sorghum batter (1.8g) followed by Mixed idli batter (1.7g) and standard idli batter (1.5g). About pH, high reduction was noted in standard batter (1.33) followed by mixed idli (1.03) and least by standard idli batter (0.75). High difference in spread ability was noted in mixed idli (0.4 cm) compared to the standard. High specific gravity was noted in the sorghum batter (1.4g/ml) compared to the mixed idli and standard idli batter. According to Nagaraju and Manohar (2000), there was a decrease in diameter of the product as the ratio of rice to black gram increases in the batter. According to Narpinder et al (2007) The effect of substituting rice with extrusion cooked (75, 100 and 125C) rice flour at 10, 20, 30 and 40% levels had significant effects on the specific gravity, acidity and pH of the idli batter, and textural and sensory quality of the idlis.

There was a significant co-relation between the variables of weight and specific gravity of the batter at 5% level in negative sense which shows if weight increases air holding capacity decreases. Spreadability of the batter has strong positive co-relation with the pH of the batter at 1% level (Table-3). According to Soni et al (2000), density of the batter decreases as the level of air incorporation or water addition to the batter increased .The spreadability of batter was directly proportional to the water content but inversely proportional to the air in corporation in the batter. The radial growth decreased linearly with increase in apparent viscosity of batter.

Physical parameters of the developed idlis

Physical parameters of the idlis are given in Table 4. The diameter of the standard idli was found to be high with a value of 8.0 cm followed by sorghum idli (7.4cm) and mixed idli (7.0cm) respectively. The highest width value (2.9cm) was obtained by standard idli followed by sorghum idli (2.0cm). The cooked weight of the sorghum idli was found to be high (56g) followed by standard and mixed idli. More cooking time was taken by the mixed idli (13 minutes) and least in standard idli (7minutes). The greater number of pores(15) per square inch in the ink print test was noted in the standard idli followed by mixed idli (12) and least by the sorghum idli (9) which shows that if the number of pores increases the softness of the idli will also increases (Table 4).

Table 6. Co- relation matrix for the physical parameters with organoleptic scores of the idlis

	Diameter (cm)	Thickness (cm)	Weight (g)	Number of pores (sq inch)	Cooking time (min)	Texture	Taste	Over all acceptability
Diameter (cm)	1							
Thickness (cm)	0.343	1						
Weight (g)	0.091	0.288	1					
Number of pores (sq inch)	0.186	0.768)	0.385	1				
Cooking time (min)	-0.316	-0.752)	-0.333	-0.946**	1			
Texture	0.497	0.305	0.129	0.336	-0.226	1		
Taste	-0.170	-0.264	0.167	0.380	-0.261	0.328	1	
Overall acceptability	0.183	0.428	0.378	0.892**	-0.816**	0.433	0.732*	1

** Co-relation is significant at 0.01 level (2- tailed)
* Co-relation is significant at 0.05 level (2- tailed)

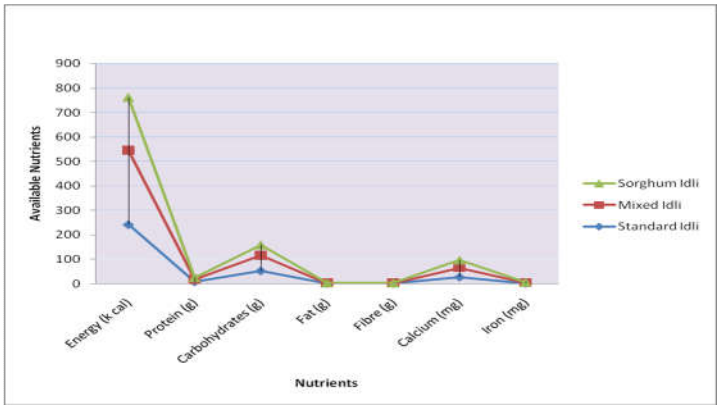

Fig 1. Nutritive value of the developed idlis

Organoleptic evaluation of idlis

The mean acceptability scores obtained by the sensory evaluation of millet idlis are in Table 5. Among the different variations standard idli has got a highest scores of 8.72 followed by the variation mixed idli with a score of 7.82and the least score 7.06 is obtained by the Sorghum idli for the appearance attributes. Regarding the colour attributes the highest score 8.54 is obtained by standard idli followed by mixed idli and Sorghum idli score is 7.04. The texture attributes was found to be maximum for the standard with the score of 8.74 followed by the mixed idli (7.60). Regarding the taste attributes the highest score of 8.72 is obtained by the standard which is followed by the mixed idli with the score of 8.17. The overall scores of standard were found to be slightly higher (8.58) than the mixed idli with the score of 7.78 and the lowest was obtained by sorghum idlis (7.00). Tukey's Post HOC test reveals that there was significant difference between standard and other variations for all the attributes such as appearance, colour, flavor, texture, taste and overall acceptability. It was found that there was a strong negative correlation for the number of pores with cooking time and over all acceptability and positive correlation between cooking time with overall acceptability at 5% level. It was found that there was a strong positive correlation between overall acceptability and taste of the developed idlis at 1% level.

Nutritive value of the developed idlis

The data pertaining to nutritive value of the developed sorghum based idlis is presented in Fig.1. Energy values of Sorghum idli (216.82Kcal) though less in comparison to standard (241.94 Kcal) and mixed idli (303.32Kcal) the difference was not significant. On comparing the protein content of the three types of ldli, it was found to be maximum in mixed idli (9.85g) followed by Sorghum idli (8.22g) and standard idli (7.0g). Fat content was improved in Sorghum idli (1.24g) in comparison to mixed (1.07g) and standard idli (0.54g), carbohydrate content of mixed idli (66.32g) was maximum followed by standard idli (52.10g) and minimum for Sorghum idli (43.18g). Fiber in Sorghum idli (1.25g) was the highest amount than in mixed (1.17g) and standard idli (0.62g). Calcium content was found to be maximum in mixed idli (37.92mg) followed by Sorghum (31.79mg) and standard idli (26.76mg). Presence of iron in Sorghum, mixed and standard idli was 2.56mg, 2.31 mg and 1.16 mg respectively.

Conclusion

Cereals are less costly source of energy compared to fats in the developing countries. Sorghum can be used in idli preparation instead of rice in scarcity areas. Grain sorghum is the sixth most important dietary source of calories for the world's population after rice, wheat, sugar, maize and potatoes. The grain is rich in carbohydrates like other cereals and millets and contains several water soluble B-complex vitamins and minerals. Complete or partial replacing of rice with Sorghum had good impact on the nutritive value by increasing the protein, fat, fibre, calcium and iron content in the developed idlis. Thus developed Sorghum idli is found to be acceptable in both sensory and nutritional quality.

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