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Standardization and quality evaluation of Idli prepared from Jackfruit (*Artocarpus heterophyllus*) Pulp Powder

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Abstract
Idli is a traditional fermented rice and black gram-based breakfast food of South India. Idli batter is prepared by soaking polished rice and decorticated black gram for 6 h at room temperature (30 ± 1°C) in water. The soaked mass was ground using a grinder with adequate amount of water. The blend ratios of 2:1, (w/w) batter were allowed for fermentation for whole night with the addition of 2% (w/w) of salt. Jackfruit is a dicotyledonous compound fruit of the jack tree (*Artocarpus heterophyllus* L.) which belongs to the family Moraceae grow in many of the tropical countries of Southeast Asia but is particularly abundant in India and Bangladesh. The present investigation was, therefore, undertaken to study the textural, colour and sensory characteristics of jackfruit (Barka) bulb powder idli. Idlis were prepared from Rice and Black gram dhal incorporating jackfruit (Barka) bulb powder. All the ingredients were collected from the local market. Two types of idlis namely standard idli (traditional) and Jackfruit (Barka) bulb powder idli were prepared using different combinations of ingredients such as rice (Polished), black gram, and Jackfruit bulb powder. The developed products were analyzed for textural, colour and Organoleptic evaluation. These scores were compared with standard. The developed Jackfruit bulb powder Idlis were highly acceptable by the subjects and notable change in textural parameters of idli was observed when compared to the standard. Idli prepared by using 55% Rice and 35% Black gram dhal and 10% Jack fruit bulb powder has hardness 85 g, Yellowness Index 105.0. Also, the sensory analysis, indicated that Idli (55% Rice and 35% Black gram dhal and 10% Jack fruit bulb powder) has good acceptability with highest score of 8.8 for flavour, 8.5 for texture, 8.2 for colour, and 8.57 for overall acceptability.

Keywords: Jackfruit, hardness, yellowness index

Introduction
Jackfruit or Phanas or fanos (*Artocarpus heterophyllus*) is a tropical fruit species found in tropical, high rainfall, coastal and humid areas of the world. It belongs to family Moraceae, Scientifically *Artocarpus heterophyllus*, it is the favourite fruit of many, owing to its sweetness. The Jackfruit tree is widely cultivated in tropical regions of India, Bangladesh, Nepal, Sri-Lanka, Vietnam, Thiland, Malaysia, Indonesia and the Philippines. Jackfruit is also found across Africa, e.g., in Cameroon, Uganda, Tanzania, and Mauritius, as well as throughout Brazil and Cribbean nations such as Jamaica. However, India is considered to be the native of jack fruit. Jackfruit occurs naturally in two textural forms; Barka (*Ghila*) with soft and pulpy perianth while Kapa (*Khaja*) with firm perianth when ripe. Additionally, there is another type named "Dorsha" having intermediate characteristics of Khaja and Ghila (Goswami *et al.,* 2010) [4]. The edible bulbs of ripe jackfruit are consumed fresh or processed into jam, jellies juice, beverage, squash and syrup products. The pulp of the ripe jackfruit may be eaten fresh or incorporated into fruit salad. (Odoemelam, 2005) [12].

Technologies for post-harvest handling, preservation of fresh fruits and preparation of primary processed products that can be used for production of other products need to be promoted and commercialized for ensuring availability of the fruit throughout the year and for avoiding the wastage of this wonderful fruit. 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) [14]. 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) [15]. Idli is also known as "Rise cake" is a traditional food of India. It is favorite breakfast food in south India with spongy texture attractive appearance, appetizing taste and flavor 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) [5].

Idlis are being consumed worldwide on a large scale in institutions such as army, railways, and industrial canteens, etc. In view of the scale up of this idli making process from the domestic to the industrial level, it is necessary to know the behavior of idli batter, starting from raw material selection and handling to its fermentation process. The textural, colour and sensory properties will provide an idea for the researchers and processors to identify structural materials for the atomization of the jackfruit bulb powder idli making process. This study is helpful in design and development of such equipment for complete atomization of the jackfruit bulb powder idli making.

People consumed it mostly as a fruit when ripe but also as vegetable in the unripe stage. The jackfruit significantly contributes to the nutrition of the people of this country as a source of vitamins, minerals and calories. Jackfruit have more protein, calcium, thiamine, riboflavin and carotene than banana but less nutritious than mango (Hossain *et al*., 1979). The yield of jackfruit is 10.5 t/ha which is manifold higher than mango, 4.76 t/ha (BBS, 2007). Therefore, vitamin and mineral production per unit area are higher in jackfruit than Mango. Edible bulbs of ripe jackfruit (*Artocarpus heterophyllus* L.) are consumed for their fine taste and pleasant aroma.

Jackfruit is rich in Vitamin A, Vitamin C, thiamin, riboflavin, calcium, Potassium, iron, sodium, zinc and niacin among many other nutrients. Jackfruit also benefits one's health as it has a low caloric content: 100grams of jackfruit only contains 94 calories. It is also a seasonal fruit. The edible bulb contains pH 5.1, Carbohydrates 25% and 1% total ash (Nanjundaswamy, 1990) [9].

Rice (*Oryza sativa*) is a staple food crop for a large part of the world's population, making it the second most consumed cereal grain. Rice provides more than one fifth of the calories consumed worldwide by humans. Rice contains approximately 7.37% protein, 2.2% fat, 64.3% carbohydrate available, 0.8% fiber, and 1.4% ash content (Zhoul *et al.,* 2002) [17]. Black gram (*Phaseolus mungo*) is one of the most highly prized pulses of India. It has a mucilaginous material which makes it a valuable ingredient in idly preparation. The chief proteins present in black gram are albumins and globulins and glutelins. (Nazni and Shalini, 2010) [7].

The ripe fruit contains well succulent, aromatic and flavorful yellow sweet bulbs and are shortly perishable so the technologies for post-harvest handling, preservation of fresh fruits and preparation of primary processed products that can be used for production of other products need to be promoted and commercialized for ensuring availability of the fruit throughout the year and for avoiding the wastage of this wonderful fruit.

The objective of the present study was to develop the technology for making jackfruit (Phanas) bulb powder idli and to study the effect of composite batter on the textural properties of idli and sensory acceptability of the end product.

Material and Methods

Raw Materials: The raw materials selected for this study were polished rice (*Oryza sativa*), decorticated black gram (*Vigna radiate*) and freshly harvested ripen jackfruit of Barka (Soft flesh) variety (*Artocarpus heterophyllus*) fruits that were purchased from a local market Fig. 1.

Fig 1: Barka Jackfruit Barka Bulbs (Soft Flesh)

The fruits were cleaned and it was washed reasonably with fresh water. Then the fruits cut manually by sharp knife and the fruit bulbs were removed and deseeded for making pulp using a pulper (Pulper, Smart Shop™, India). All experiments were conducted at room temperature and carried out in three replications.

Barka Bulb (Soft flesh) Powder: Barka (Soft flesh) bulb was dried by using tray dryer. The dried bulbs will be finally milled using pulveriser as shown in Fig. 2. Dried Jackfruit bulbs and Jackfruit bulb powder is as shown in Fig. 3.

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Fig 2: Pulveriser

Fig 3: Dried Jackfruit bulbs and Jackfruit bulb powder

Composition of Batter for Jack Fruit Idli: Batter for making Jackfruit idli formulation in the different proportions was prepared as per Table 1.

Table 1 : Formulations of Jackfruit Bulb Powder Batter for Jack Fruit Idli

Sr. No.	Treatments	RICE (%)	Black Gram (%)	Jack Fruit Bulb Powder (%)
1	Control	65	35	00
2	T1	65	30	05
3	T2	55	35	10
4	T3	55	30	15

Method of Preparation of jackfruit bulb powder (Phanas) idli

Rice and black gram dhal
↓
Washing
↓
Soaking
↓
Grinding
↓
Mixing
↓
Addition of Salt
↓
Fermentation
↓
Mixing ← Jackfruit Bulb Powder
↓
Making Idli
↓
Steaming
↓
Jackfruit Idli

Fig 1: Process flow diagram for Jackfruit bulb powder (Phanas) Idli

Preparation of Jackfruit bulb powder (Barka) idli batter and idli

Preparation of Idli Batter: Rice and Black gram in the ratio of 2:1 by weight were taken, carefully washed and soaked separately for 6 h. After draining the water, rice and black gram were separately ground in a wet grinder. Water was added as and when necessary. This formed a batter for the preparation of fermented idli.

Fermentation: After batter was ready, table salt was added and allowed to ferment at room temperature for 12 hours naturally.

Preparation of Jackfruit Bulb Powder Idli: The jackfruit (Barka) bulb powder was mixed with the fermented batter at a predetermined quantity. Apply edible oil in the vessel before pouring the mixture in the vessel. Then mixed it properly and pour equal volume of batter samples for better shapes, placed in the plates stacked one above the other and steamed for 20 minutes in an idli steamer. After 20 minutes remove the plates from the container and serve.

Hardness of Jackfruit (Barka) Bulb powder Idli: Texture is the property of food, which is associated with the sense of feel or touch experienced by fingers or in the mouth. Hardness is the force required to compress a substance between the molar teeth or between tongue and palate to a given deformation or penetration and designated as soft, firm or hard. This is expressed as the maximum load (N) applied to the sample during the first compression (Shirsat and Thakor, 2014) [16].

The peak force as an indication of hardness. The texture of 'Jackfruit bulb powder Idli' was analyzed using Texture Pro CT V 1.3 Build 15 Texture Analyzer (Brookfield Engineering Labs, Inc., USA) using TA3/100 probe (Fig. 4). The test speed was 0.5 mm s^{-1} and the curve was recorded and analyzed by Texture Exponent 32 software program (version 3.0). Ten measurements were performed on each sample.

Fig 4: Textural Analyser

Colour of Jackfruit (Barka) Bulb Powder Idli: Colour of the idli is one of the most important parameter for the acceptability of the product. The colour parameters of idlis were measured using a Hunter Lab Colour Flex meter (Fig.5). Colour (YI and WI values) of the samples was determined by using Hunter Colour Flex Meter. YI is known as Yellowness Index and Yellowness is defined as a measure of the degree to which the color of a surface is shifted from preferred white (or colorless) towards yellow. WI is Whiteness Index and Whiteness is defined as a measure of how closely a surface matches the properties of a perfect reflecting diffuser, i.e. an ideal reflecting surface that neither absorbs nor transmits light, but reflects it at equal intensities in all directions. For the purposes of this standard, the color of such a surface is known as preferred white. Three measurements were taken for each sample and their means were recorded.

Fig 5: Color Flex Meter

Sensory Analysis of Jackfruit (Barka) Bulb Powder Idli: A semi-trained panel of 15 students and from faculty of the Agricultural Process Engineering Department at University of Dr. BSKKV, Dapoli evaluated the jackfruit (Barka) bulb powder idli for appearance, taste, colour, and overall acceptability on a 9-point hedonic scale. The panelists were naïve to project objectives. Samples were coded using three-digit random numbers and served with the order of presentation counter-balanced. Panelists were provided with a glass of water, and were instructed to rinse and swallow water between two samples. They were given written instructions and asked to evaluate the products for acceptability based on its appearance, texture, taste, color, and overall acceptability using nine-point hedonic scale (1=dislike extremely to 9= like extremely; Meilgaard *et al.*, 1999) [6].

Results and Discussion

Textural properties of Jack Fruit (Barka) Bulb Powder Idli

Table 2 shows the result of textural parameters of 'Idli's prepared using control and jackfruit bulb powder fortified batter. Idli has a circular shape of approximately 7-10 cm diameter (depending on the mould size) flat with lower and upper surface bulging, so that the product is thick at the centre (2-4cm) and tapering towards periphery (Nisha *et al*., 2005) [11]. Hardness is measured as the peak force during compression in the first cycle. Hardness of control (traditional) idli was 88.33g and idli prepared with jackfruit bulb powder was 85g. These values indicated that the jackfruit bulb powder idli offered less resistance to compression than that of control idli.

Idlis were prepared using different batter combinations and by using jackfruit bulb powder.Textural analysis was carried out using textural analyzer. The hardness for 55% Rice and 35% Black gram dhal and 10% jackfruit bulb powder 85g. Table 6 shows the textural properties i.e. Hardness, Adhesive Force, Stringiness, Springiness, Gumminess and Chewiness of Barka (Soft flesh) jackfruit bulb powder idli. The ANOVA for textural properties of Barka (soft flesh) jackfruit bulb powder idli is also given in the Table6. It was observed that hardness, adhesive force, stringiness, springiness, gumminess and chewiness of Barka (Soft flesh) jackfruit bulb powder idli are not significantly different at $p \leq 0.05$.

Table 2: Textural properties of Jack Fruit Bulb (Barka) Powder Idli

Treatments	Hardness, g	Adhesive Force, g	Stringiness, mm	Springiness, mm	Gumminess, g	Chewiness, mJ
T1	85.00	10.00	3.98	2.31	27.83	0.57
T2	84.50	5.00	2.17	2.03	28.83	0.58
T3	80.00	10.00	3.74	2.44	31.33	0.71
Control	84.66	5.00	5.28	2.06	25.40	0.53
S.E.	0.27	0.00	0.01	0.01	0.13	0.02
C.D. at 5%	1.24	0.00	0.03	0.05	0.59	0.07
	SIG	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**

Colour measurement of Jack Fruit Pulp (Barka) and Jackfruit Bulb Powder Idli:

Colour was determined by using hunter lab colorimeter. Table 3 shows the colour properties i.e. Yellowness (YI) Index of jackfruit bulb powder idli. It was observed that the idli prepared by using Rice (55%), blackgram dhal (35%) and jackfruit bulb powder (10%) recorded Yellowness Index (YI = 105.00). Fig. 6 shows the jackfruit bulb powder idlis.

Table 3: Colour measurement of Jack Fruit (Barka) Bulb Powder Idli

Treatments	Yellowness Index (YI)
	J. F. Bulb Powder Idli
T1	84.21
T2	**105.0**
T3	111.40
Control	33.69

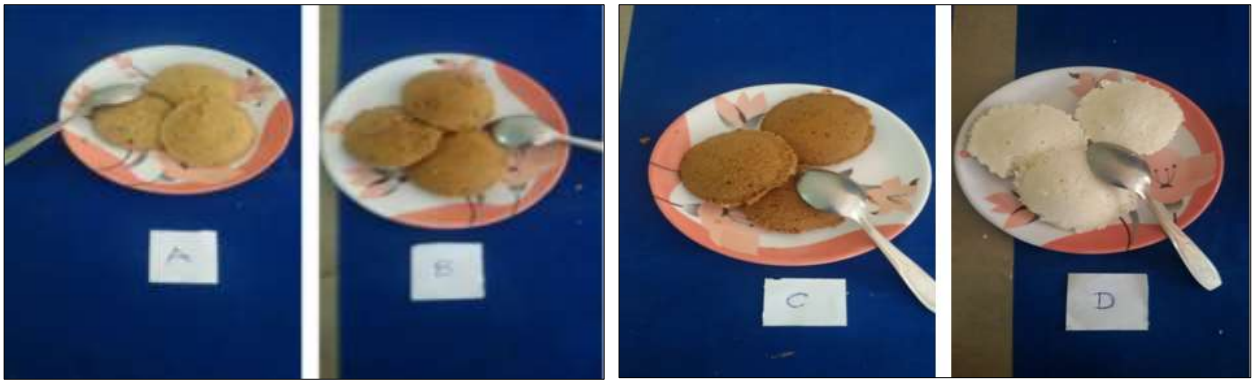

Fig 6: Jackfruit Bulb Powder Idlis

Sensory evaluation of Jack Fruit Bulb (Barka) Powder Idli

Sensory evaluation of Jackfruit bulb powder (Barka) idli was carried out, it was observed that idlis prepared from 55% rice and 35% black gram dhal and 10% jackfruit bulb powder recorded highest score for flavour (8.8), texture (8.5), colour (8.2),and for overall acceptability (8.57).

Table 4 shows the sensory properties i.e. Colour, Flavour, Texture and Overall Acceptability of Barka (Soft flesh) jackfruit bulb powder idli. The ANOVA for sensory evaluation properties of Barka (soft flesh) jackfruit bulb powder idli is also shown in Table 4. It was observed that colour, flavour, texture and overall acceptability of Barka (Soft flesh) jackfruit bulb powder idli are not significantly

different at p≤0.05.

Table 5 shows the nutritive properties of jackfruit bulb (Barka) powder Idli.

Table 4: Sensory Evaluation of Jack Fruit Bulb (Barka) Powder Idli

Treatments	Sensory Parameters			
	Colour	Flavour	Texture	Overall Acceptability
T1	6.30	6.46	7.48	6.55
T2	8.15	8.82	8.47	8.57
T3	5.99	6.00	6.49	5.99
Control	7.88	8.41	7.97	8.18
S.E.	0.07	0.07	0.07	0.03
C.D.at 5%	0.20	0.20	0.22	0.10

Table 5: Nutritive properties of Jackfruit bulb (Barka) powder Idli

Nutritional parameter	T1	T2	T3	Control
Protein, (%)	1.3125	1.925	1.225	2.0125
Fat, (%)	1.5	1.3	0.4	0.25
Reducing Sugar	2.6	1.66	1.185	1.63
Non-Reducing Sugar	4.625	3,515	1.875	1.82
Total Sugar	7.225	5.175	3.06	3.45

Conclusions

Idli prepared by using 55% rice and 35% black gram dhal and 10% jackfruit bulb powder has hardness 85 g, yellowness index 105.0. Also, the sensory analysis, indicated that idli (55% Rice and 35% black gram dhal and 10% jackfruit bulb powder has good acceptability with highest score of 8.8 for flavour, 8.5 for texture, 8.2 for colour, and 8.57 for overall acceptability. It is also concluded that the idlis prepared using jackfruit bulb powder are more nutritious.

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