

Evaluation of some Selected Black Gram Varieties for Preparation of Fermented *Idli*

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Abstract

The quality characteristics of selected black gram varieties viz., T9, VBN 5, CO 6, ADT 3 and VBN 7 were evaluated for their suitability to prepare *idli*. The foaming stability and foaming capacity was found to be maximum in VBN 5 and T9. The arabinogalactan was also found to be high in VBN 5 (80.9 mg/g) and T9 (73.6 mg/g). The physico-chemical properties of *idli* batter for the selected varieties were evaluated. Maximum rise in volume was recorded in VBN 5 and ADT 3 (163 ml) followed by T9 (161 ml). The bulk density was found to be lower in VBN 5 (0.81 w/v) and T9 (0.88 w/v) which is an indication good quality of *idli*. *Idli* prepared using 5 black gram varieties were analysed for physico-chemical and microbial load. The texture profile viz., springiness, cohesiveness, chewiness and gumminess was evaluated for VBN 5, T9 and VBN 7 respectively. The protein content was higher in *idli* prepared from T9 (26.8/100 g) compared to VBN5 (24.00 g/100g). Among the selected varieties, T9 and VBN5 had good mucilaginous content, texture, and microstructure and was found to be the most suitable for *idli* preparation.

Keywords: *Idli*, black gram, fermentation, rice

Idli is a ubiquitous traditional fermented food of India and is a part of the daily diet particularly in the South India. Popularly referred to as rice cake *idli*, is prepared from a combination of rice and black gram in a specific ratio, soaked, ground, fermented to yield a gelatinous batter and steamed to *idli*. Black gram (*Phaseolus mungo*) is a commonly consumed pulse in south India. It provides a good amount of dietary protein, carbohydrates, vitamins and energy and it is rich in potassium, phosphorus and calcium with good amount of sodium. It also has small amount of iron, thiamin, riboflavin and niacin (Alla, 2010). It has superior digestibility, unique textural and sensory attributes (Kanchana *et al.*, 2013). The composition of black gram is greatly influenced by the genetic constitution of the variety.

Idli is mainly relished for its soft and spongy texture which is greatly influenced by the physico-chemical characteristics of black gram varieties. The components responsible for these properties are the

surface active proteins that generate foam and as a result impart a porous structure to the food, and the viscogenic mucilaginous polysaccharide (~6%) that stabilizes the porous structure against thermal disruption during steaming (Susheelamma and Rao, 1979). They also reported the role of arabinogalactan, a polysaccharide of black gram in contributing to the texture of leavened foods. During fermentation of black gram for the preparation of leavened foods, it was found that the mucilaginous polysaccharide undergoes compositional and rheological changes (Reddy *et al.*, 1990). The fermentation is due to the activities of endogenous micro flora in black gram and *Leuconostoc mesenteroides* in particular, in addition to the role of yeasts, lactic acid bacteria and other coliforms.

There is scanty information available on the suitability of various varieties of black gram to prepare *idli*. The aim of this paper is to screen blackgram varieties and to record the quality characteristics of

idli batter and to evaluate the textural, nutritional, organoleptic and microbiological characteristics of *idli*.

Materials and Methods

Samples used

The seeds of black gram variety *viz.*, VBN 3, VBN 4, VBN 5, VBN 6, VBN 7, CO 6, ADT 3, TMV, T9, VBg 010-024, VBg 010-025 and VBg 009-005 were procured from National Pulse Research Institute Vamban; Agricultural College and Research Institute, Madurai cleaned and made free and Department of Pulses, TNAU Coimbatore. The seeds of all the varieties were from extraneous material and stored in air tight plastic containers under ambient conditions. All other ingredients *viz.*, rice and fenugreek used in preparation of *idli* batter and *idli* preparation were procured from the local market in Madurai.

Functional and chemical properties of selected black gram varieties

Twelve black gram varieties were screened based on their functional and chemical properties. Functional characteristics such as foaming capacity (FC) and foaming stability (FS) of black gram were measured by volumetric method as described by Lin *et al.* (1974). The arabinose and galactose content of selected black gram varieties were analyzed using High Performance Liquid Chromatography (HPLC) as given by Tanaka (1975). The fatty acid composition was analyzed by solvent extraction method (Cohen, 1917).

Idli batter preparation

For estimating the apparent grain volume, 25 g of split *dhal* of each variety were measured in a measuring cylinder. The initial batter volume was estimated by measuring the increase in black gram batter in a measuring cylinder, soon after grinding and mixing of rice batter and black gram batter. The final batter volume was estimated by measuring the fermented rice and black gram batter volume after gentle stirring.

Idli preparation

Milled parboiled rice and dehusked black gram *dhal* were soaked separately in potable water for 6 to 8 hours. The water was drained and the soaked rice was ground to a fine gelatinous paste and the drained black gram *dhal* was ground with sufficient water to a fluffy soft texture. The rice and black gram batter were mixed together and 0.8 % salt was added and the *idli* batter was incubated at room temperature and the fermentation was allowed to take place for 12 h. The fermented batter was poured in to the individual rice moulds which were steamed in an *idli* steamer.

Analysis of idli batter

Idli batter was studied for batter volume, batter weight, and increase in batter volume as per the method given by Kanchana *et al.* (2013). Acidity and pH were analysed as per the method given by Saini *et al.* (2000).

Physico-chemical properties and sensory evaluation

The *idli* samples were analyzed for the contents of moisture (AOAC, 1995), ash, fat, protein (AOAC, 1998), starch (AOAC, 2005), calcium, phosphorus and iron were analyzed by dry ashing method (AOAC, 2005). Microbial load of the products were enumerated by Istavankiss (1984). The sensory quality of the product was evaluated using a nine point hedonic rating scale (Asp *et al.*, 1983).

Sensory quality of *idli* was evaluated by 30 semi trained judges using 9 point hedonic scale rating and the sensory scores are given in Table 3. The quality attributes were assessed for colour, flavour, texture, taste and overall acceptability. With respect to colour, flavor and texture, the score value was higher for VBN 5 and T9.

Texture and microstructure analysis of idli

Textural parameters of *idli* (VBN5, VBN7 and T9) *viz.*, hardness, cohesiveness, adhesiveness, springiness, gumminess and chewiness were studied by using texture analyzer (Model TA-Ti,

Stable Microsystems, UK). The microstructure of *idli* samples was studied through Microscope (Euromex Cmx 3, Netherlands)

Statistical analysis

All results of triplicate samples were statistically analyzed using Fisher's least significant differences (LSD) test to differentiate the treatment means and the level of significance ($P < 0.05$). Statistical analysis was performed by using Statistica Version 5.5 (Statsoft Inc., OK, and USA) software. In reporting data, the results of individual samples were reported as the mean \pm standard deviation. Factorial Completely Randomized Design (FCRD) as per the method described by Gomez and Gomez (1984) was employed for the analysis with triplicate number of samples.

Results and Discussion

Functional and chemical properties of selected black gram varieties

The foaming capacity of the 12 black gram varieties ranged between 33.33 (VBN 7) to 35.71 (VBN 5) g per cent. Foaming stability was maximum for T9 (35.2 g per cent), followed by VBN 5 (35.12 g per cent) and minimum for VBN 4 (32.46 g per cent) after 120 min of fermentation. The FC and FS have a significant influence on the textural and leavening properties of *idli* (Kavitha *et al.*, 2013). The mucilaginous texture of black gram is attributed to the arabinogalactan, present exclusively in

black gram which is also responsible for smooth, spongy texture of *idli*. The arabinose and galactose content of variety VNB 5 (19.8 and 23.6 mg g⁻¹) was significantly higher followed by T9 (16.9 and 20.1 mg g⁻¹). Black gram polysaccharide may therefore be accounted for exerting higher foaming stability (Muralikrishna *et al.*, 1987; Kavitha *et al.*, 2013).

Based on the functional and chemical properties, five black gram varieties *viz.*, VBN 5, T9, ADT 3, CO 6 and VBN 7 were screened out and used for preparation of South Indian breakfast *idli*.

Analysis of *idli* batter

The prepared *idli* batter was studied for physicochemical characteristics. Batter quality analysis such as batter weight (g), batter volume (ml), raise in batter volume (ml), pH and acidity were analyzed from the selected black gram varieties as described here. The physico-chemical analyses of *idli* batter prepared using the selected 5 black gram varieties were assessed for and the results are given in Table 1. The batter weight reduced on fermentation over a period of 18 hours and batter volume increased almost two folds in all the black gram varieties. The increase in volume ranged between 158 and 163 ml for the batter prepared from 100g of rice and 30 g of black gram. Maximum rise in volume was found in VBN 5 (163 ml) and ADT 3 (163 ml) followed by T9 (161 ml), CO 6 (160 ml) and VBN 7 (158 ml). Rise in volume is an indication of good quality of batter

Table 1: Physicochemical characteristics of *idli* batter

Varieties	Batter weight (g)		Batter volume (ml)		Increase in batter volume (ml)	pH		Acidity (g/100g)	
	Initial	Final	Initial	Final		Initial	Final	Initial	Final
T9	320	318	85	248	163	6.26	4.51	0.0715	0.4426
VBN 5	320	319	90	251	161	6.21	4.30	0.0736	0.4422
CO 6	315	308	87	250	163	6.18	4.28	0.0712	0.4406
ADT 3	316	310	89	249	160	6.20	4.35	0.0716	0.4410
VBN 7	312	317	85	243	158	6.16	4.00	0.0713	0.4402
SED	0.1204		0.1483		0.1235	0.2241		0.3162	
CD (P < 0.01)	0.2552 **		0.3571 **		0.4831 **	0.3872 **		0.5912 **	

which is highly suited for *idli* preparation. The pH of the batter ranged from 6.18 to 6.20 and after fermentation the corresponding values were in the range of 4.28 (ADT 3) to 4.52 (VBN 5). The change in pH may be attributed to a concomitant increase in acidity, which in the freshly ground batter was 0.0712 to 0.0756 g/100 g, that increased to 0.4406 - 0.4445 g/100 g after 18 hours of fermentation. Lu *et al.* (2003) reported an acidity of 0.10 per cent in rice flour fermented for 12 hours. In our study, acidity was recorded as 0.4% which was mainly influenced by the difference in the raw ingredient proportion, fermentation time and storage condition. Sura *et al.* (2001) reported that with utilization of sugars during storage, organic acids were produced which might also have contributed to the increase in acidity observed during storage.

Physico-chemical properties and sensory evaluation of idli

Physical properties of idli

The physical properties of the *idli* prepared from VBN 5, T9, ADT 3, CO 6 and VBN 7 black gram varieties were assessed and the data have given in Table 2. The bulk density of *idli* was 0.81 in VBN 5, 0.88 in T9, 0.89 in VBN 7, 0.91 in ADT 3 and 0.91 in CO 6. A reduction in bulk density is an indication of good quality of *idli*. The diameter of *idli* for different varieties ranged between 8.50 in VBN 5 and 8.00 in VBN 7. Statistical analysis revealed highly significant difference for the different

physical parameters of *idli*. The texture of *idli* was assessed in terms of the number of pores measured by ink print test method, wherein the applied prints furnish a record of the number of pores per square inch in the graph sheets (Nazini and Shalini, 2010). The texture of the *idli* was evaluated by observing the porosity which is an indication of the softness of the developed *idli*. Among the selected varieties, VBN 5, T9, and VBN 7 showed maximum pores of 14, 13 and 10, respectively.

Chemical characteristics of idli

The prepared *idli* was studied for chemical characteristics such as moisture, protein, ash, fat, starch and sensory characteristics from the selected black gram varieties. The chemical composition was given in Table 3. Higher moisture content was found in VBN 5 (34.10 g/100g) and CO 6 (32.46 g/100g). The moisture content was the highest in the *idli* sample prepared from VBN 5 indicating a moist and soft texture which is a desired sensory attribute for optimum *idli* quality. Maximum value for ash content was noted in CO 6 (9.10 g/100g) followed by VBN 5 (9.0 g/100g), ADT 3 (9.0 g/100g), T9 (8.90 g/100g) and VBN 7 (8.10 g/100g). The fat content of the *idli* sample ranged from 1.11 to 1.60 g/100g with minimum and maximum values noticed in the *idli* prepared from varieties T9 and VBN 7 respectively. *Idli* prepared from variety VBN 5 and ADT 3 had a fat content of 1.50 g /100g. Higher protein content was observed in ADT 3 and CO 6 variety *idli* with the values of 26.00 and 25.45 g/100g. Significant

Table 2: Physical characteristics of *idli*

Varieties	Weight (g)	Volume (ml)	Bulk density (w /v)	Diameter (cm)	Number of pores (Per square inch)
VBN 5	53	65	0.81	8.50	14
T9	55	62	0.88	8.15	13
ADT 3	54	59	0.91	8.10	11
CO 6	54	60	0.91	8.20	12
VBN 7	52	58	0.89	8.00	10
SED	0.2204	0.1582	0.2235	0.2241	0.2235
CD(P < 0.01)	0.2562 **	0.4671 **	0.6830 **	0.3892 **	0.7815**

Table 3: Chemical analysis and sensory score of *idli* prepared from screened blackgram varieties

Parameters	VBN 5	T9	ADT 3	CO 6	VBN 7	SED	CD (0.01)
Moisture (g /100g)	34.10	32.10	32.10	32.46	30.10	0.3451	0.4178 **
Ash (g /100g)	9.0	8.1	8.90	9.1	9.0	0.3161	0.4228 NS
Fat (g /100g)	1.50	1.11	1.50	1.47	1.60	0.0212	0.2092 *
Protein (g /100g)	24.50	25.00	26.00	25.45	25.00	0.6755	0.7211 *
Starch (g /100g)	30.58	32.68	32.50	31.52	28.00	0.7801	0.7925 **
Calcium (mg /100g)	27.20	28.58	24.00	21.00	23.00	0.6821	0.6922 **
Iron (mg/100g)	5.2	5.1	5.2	5.1	5.0	0.4050	0.5860 **
Mean Sensory score							
Parameters	VBN 5	T9	ADT 3	CO 6	VBN 7		
Appearance	9.0	9.0	8.9	8.8	8.6		
Colour	9.0	9.0	8.8	8.5	8.3		
Flavour	9.0	9.0	8.8	8.4	8.4		
Texture	9.0	9.0	8.7	8.4	8.4		
Taste	9.0	9.0	8.9	8.5	8.3		
Over all acceptability	9.0	9.0	8.8	8.4	8.5		

* Significant

variation was observed for protein content among the *idli* samples. The *idli* prepared from varieties VBN 7, VBN 5, CO 6, ADT 3 and T9 had starch content of 28.00, 30.58, 31.52, 32.50 and 32.68 g/100g respectively. Significant difference was observed for starch content among the *idli* samples prepared from the different varieties.

The data pertaining to the calcium and iron content revealed that in variety VBN 7 was 23.00 and 5.00 mg/100g respectively. The calcium content for the other *idli* samples prepared from varieties CO 6, ADT 3, VBN 5 and T9 was 21.00, 24.00, 27.20 and 28.58 mg/100g respectively and the corresponding values for iron content was 5.1, 5.2, 5.2 and 5.1 mg/100g respectively. Statistical analysis revealed a highly significant difference between all the *idli* samples. Nazini and Shalini (2010) reported that on comparison of the calcium, iron and protein content was found to be maximum in pearl millet

idli (41.44, 4.7 mg/100g and 9.16 g/100g) followed by multi grain *idli* (30.48, 2.43 mg/100g and 9.10 g/100g) and control *idli* (26.76, 1.16 mg/100g and 7.28 g/100g). Asha *et al.*, (2005) assessed the chemical characteristics of sorghum and moth bean incorporated *idli* at 50 per cent level. The moisture, protein, ash and fat content were observed as 32.70, 25.6, 8.20 and 1.65 g/100g.

Sensory evaluation of *idli*

The score for taste and overall acceptability ranged between 9.0 and 8.8. The *idli* samples prepared from black gram varieties VBN 5 and T9 were found to have good organoleptic characteristics and hence are considered promising varieties for *idli* preparation. Balasubramaniam and Viswanathan (2007 a) reported that parboiled rice (IR variety 20) and black gram (variety ADT 3) were found suitable for *idli* preparation with good sensory profile.

Texture Profile Analysis (TPA) and microstructure

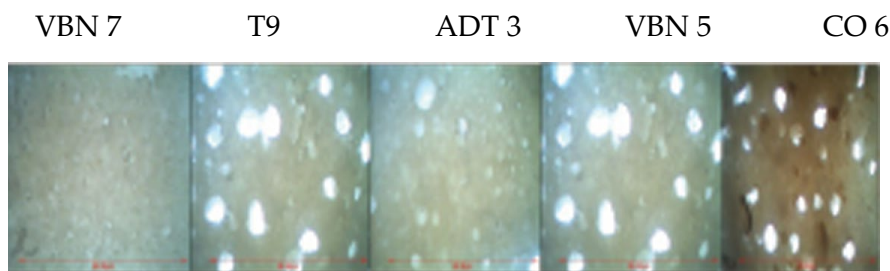
Based on physico-chemical properties and sensory evaluation, VBN 5 and T9 were found to be have maximum acceptability. Hence, texture profile and microstructure of *idli* prepared from these two varieties along with a control variety (VBN 7) were analyzed. The texture values of *idli* are given in Table 3. The springiness values of the *idli* samples prepared from varieties, T9, VBN 5 and VBN 7 was 1.056 mm, 1.377 mm and 1.054 mm respectively. The springiness of *idli* prepared from VBN 5 and T9 varieties were higher when compared to VBN 7 *idli*. Higher springiness value was found in the *idli* samples prepared from VBN 5 (1.377 mm) which was found to be statistically significant ($p < 0.05$) compared to the springiness values of the *idli* prepared from other black gram varieties. Cohesiveness was maximum for VBN 5 (0.430 mm) than VBN 7 and T9 which was 0.400 and 0.420 mm respectively. Chewiness was maximum in T9 (2.981 mm) compared to 2.371 and 1.773 mm in variety VBN 5 and VBN 7 respectively. Highest value for gumminess was observed in T9 (2.692 mm) followed by VBN 5 (2.205 mm) and VBN 7 (1.681 mm). Significant difference ($p < 0.05$) was observed for cohesiveness, gumminess and chewiness of the *idli* prepared from the different black gram varieties for VBN 5 incorporated *idli*. Springiness *ie.*, the ability to retain shape and attain the original values after withdrawal of pressure force was maximum for VBN 5 (1.377 mm) which also had the highest cohesiveness (0.430 mm). So also the chewiness and gumminess were moderate for *idli* prepared from VBN 5 variety (2.205 mm) compared to 1.681

and 2.692 mm obtained for VBN 7 and T9. This indicated that VBN 5 was most suitable for *idli* making compared to VBN 7 and T9. Tharnathan and Mahadevamma (2003) reported that the fluffiness and sponginess of *idli* was increased with increase in the proportion of black gram *dhal* and fermentation time. The maximum score for fluffiness was 11.4 for the *idli* made with a cereal: pulse combination of 3:2 at 12 hours fermentation time.

Microstructure of idli

Microstructure of the *idli* samples prepared from black gram varieties VBN 5, T9 and VBN 7 was analysed by cutting the *idli* horizontally into two halves and then subjecting the halves under microscope for the cross sectional view and the results are shown in Fig 1. Microstructure profile reveals the linear profile of leavening of the batter and incorporation of air and porosity of the product. Higher numbers of pores are generally found to correlate positively to batter quality, foaming capacity and the combination of the mucilaginous substance arabinogalactan in the black gram variety. The texture and softness level was higher in *idli* developed from VBN 5 and T9 varieties compared to VBN 7. Kanchana *et al.* (2013) studied the microstructure rupture of *idli* from selected rice and pulse varieties. The texture was found to be very soft and more pores were present in *idli* prepared from rice variety of Ambai 16, Ambai 36, ASD 19, CR 1009 using black gram variety T9. Similar observations were seen in the present study with variety T9 which exhibited good *idli* making quality on par with variety VBN 5.

Fig. 1: Microstructure of *idli*



Conclusion

In this study, VBN 5 and T9 were found to be better for *idli* preparation. The best varieties contains higher amount of arabinogalactan and mucilagenous content. Due to higher batter quality and good foaming stability, the textural properties of *idli* was soft and good in nature in VBN 5 and T9 varieties. *Idli* prepared were found to be as nutritionally superior in terms of protein, starch, fat, and mineral contents and organoleptically.

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