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Texture profile analysis of *idli* made from parboiled rice and decorticated black gram

Balasubramanian S [1]*, Viswanathan R [2]

[1] Central Institute of Post-harvest Engineering and Technology, Ludhiana-141 004, India
[2] Department of Food and Agricultural Process Engineering, Agricultural Engineering College and Research Institute, Tamilnadu Agricultural University, Coimbatore-641 003, India
*E-mail:balaciphet@yahoo.com

Idli is a traditional fermented rice-black gram based breakfast food of South India. The texture of cooked *idli* is a subject of interest, to judge and optimize the production process of good texture *idli* with the selection and adoption of the ingredients and its process. The blend ratio (66% parboiled rice *(Oryza sativa*): 33% decorticated black gram (*Phaseolus mungo* Roxb.) was fermented for 12 h and the batter was steam cooked for 10 min. Texture profile analysis (TPA) test was performed for *idli*, making cylinder samples (13.5 mm diameter, 10 mm long) of *idli*. In Pearson correlation matrix, majority of the parameters were positively correlated at $p<0.01$ and $p<0.05$. The firmness value positively correlated with gumminess and chewiness, which depicts the soft nature of *idli*. Resilience is not correlated with other textural parameters. From principal component analysis (PCA), the first and second principal components, describ 42.5 and 27.2% of the variance, respectively in the TPA parameters. The first principal component is highly positively correlated with gumminess, chewiness and cohesiveness. The second principal component is positively correlated with firmness and negatively correlated with springiness. Resilience contributed very weakly to both these principal components. Based on the results of PCA, the firmness is the prime factor to illustrate *idli* texture followed by chewiness, gumminess, cohesiveness and springiness.

Keywords: *Idli*, Parboiled rice, Decorticated black gram, Texture profile analysis, Pearson correlation test

Idli, a popular fermented breakfast food consumed in the Indian subcontinent is made mainly from rice and black gram. It is very popular because of its textural and sensory attributes (Steinkraus et al 1967, Reddy et al 1981). Generally, parboiled rice and black gram *dhal* in various proportions are soaked and wet ground separately with added water to yield a batter of desired consistency. A small quantity of salt is added and allowed for fermentation overnight during which time *Leuconostoc mesenteroides* and *Streptococcus faecalis*, naturally present on the grains/legumes/utensils grow rapidly outnumbering the initial contaminants and dominating the fermentation. The organisms produce lactic acid and carbon dioxide, which make the batter anaerobic and leavens the product, (Reddy and Salunkhe 1980). The fermented batter is steam cooked to make *idli*. Black gram has been reported to play a major role in *idli* fermentation as a source of microorganisms and as a fermenting substrate (Radhakrishnamurthy et al 1961). Parboiled rice is better suited than raw rice for producing *idli*, i.e. it is soft without becoming sticky (Juliano and Sakurai 1985). Several workers have tried to use different proportions of black gram to rice for *idli* making (Joseph et al 1961, Khandwala et al 1962, Padhye and Salunkhe 1978, Reddy and Salunkhe 1980, Balasubramanian and Viswanathan 2007). Soybean, green gram and Bengalgram can bande substituted for black gram. Wheat or maize can be substituted for the rice to yield Indian *dhokla* (Ramakrishnan 1979, Steinkraus 1983, 1996). Attempts have been made to develop objective methods for measuring many cereal foods, but not *idli*. Relatively little work has been conducted towards the optimization of this Indian traditional fermented food. The texture of cooked *idli* is a subject of interest, to judge and optimize the cooking time for the production of good texture *idli* with the selection and optimization of the ingredients and the process. Hence, this work was aimed to study the textural characteristics of typical Indian traditional *idli* through texture profile analysis.

Materials and methods

The raw materials selected for this study were rice (*Oryza sativa)* of variety 'Mahamaya' ('*IET-10749'*) commercially called 'Kranthi' and black gram (*Phaseolus mungo* Roxb.). The parboiled rice and the decorticated black gram were obtained from the local market. After cleaning, they were soaked in water separately at 30±1°C for 4 h. The soaked materials were ground in a motorized, stone wet-grinder, commonly used for making *idli* batter. The grinding time was kept constant at 30 min. The mean particle size of *idli* batter was 0.5-0.7 mm (Nagaraju and Manohar 2000). The batter (blend ratio of 66% parboiled rice and 33% decorticated black gram) was allowed to ferment naturally at 30±1 °C for 12 h in a stainless steel vessel. After fermentation the batter was steam cooked for 10 min to make *idli*.

Preparation of sample for textural studies: The *idli* cylindrical samples (13.5 mm diameter, 10 mm long) were made using a cork borer and sharp blade (Shult and Brusewitz 1998). Since it was difficult to prepare cylindrical samples with perfectly flat ends, it was necessary to compensate for any unevenness of the two ends by preloading the sample with 0.5% of the total load experienced by the sample. The samples were brought down to the room temperature (30±1°C) before subjecting for instrumental measures.

Texture profile analysis (TPA): The texture profile analysis test was performed for the *idli* using a texture analyzer (Model TA-XT *2i,* Stable Micro Systems

Ltd.,Vienna Court, Lammas Road, Godalming, Surrey GU71YL, UK). A crosshead speed of 1 mm/sec with a 5 kg compression load cell of 45 mm compression probe was performed for compressing cylindrical cooked *idli* sample. The sample was subjected to 30% strain with a time gap of 2 sec between the compressions. Experiments were replicated 15 times/treatment. The degree of compression was selected, based on the preliminary experiments where a need to increase the degree of compression was detected. Standard TPA parameters viz., firmness, cohesiveness, springiness, gumminess, chewiness, and resilience (Bourne 1982, Szczesniak 1985) were recorded.

Statistical analysis: The experimental data were statistically (Pearson correlation test, and principal component analysis) analyzed using the software (SPSS 11.0 for Windows (SPSS Inc. Headquarters, 233 S. Wacker Drive, Chicago, Illinois 60606).

Results and discussion

Correlation coefficients among idli texture profile analysis parameters: Firmness was significantly correlated to springiness ($r = -0.472$, $p<0.05$), gumminess ($r = 0.756$, $p<0.01$) and chewiness ($r = 0.719$, $p<0.01$). From the significance terms chewiness, (applies for solid products) and the gumminess (relates to the semi-solid products) correlation with *idli* firmness, illustrates criteria of *idli* softness nature between these 2 products characters. Assuming the firmness value is the peak force of the first compression of the product and its positive correlation with gumminess and chewiness is appreciated and supported the direct impact in the definition. The negative peak during the unloading of the first stoke was relatively small, indicating limited adhesiveness of the sample. There is no significant fracturability value. This is in agreement with the hardness rated by others (Kulwinder Kaur et al 2000).

The cohesiveness is significantly correlated with gumminess ($r = 0.577$, $p<0.01$) and chewiness ($r = 0.612$, $p<0.01$). It is likely that samples exhibiting higher firmness sustained shearing and compression strains applied during spring back. This observation is supported by the negative correlation reported between firmness and springiness. Chewiness is in direct relation with firmness, and this trend also appreciated. The springiness was significantly correlated ($p<0.05$) to gumminess with a regression value of -0.340. The gumminess was significantly correlated very positively with chewiness ($r = 0.995$, $p<0.01$), ($r = 0.756$, $p<0.01$). This is strongly supported with the influence of firmness in the calculation of gumminess and chewiness. Resilience is not correlated with the rest of the parameters. Therefore, the usefulness of the TPA resilience parameter in evaluating *idli* texture is doubtful, it was not sensitive to detect any difference among the treatments and this parameter is not useful in describing the textural properties of *idli*.

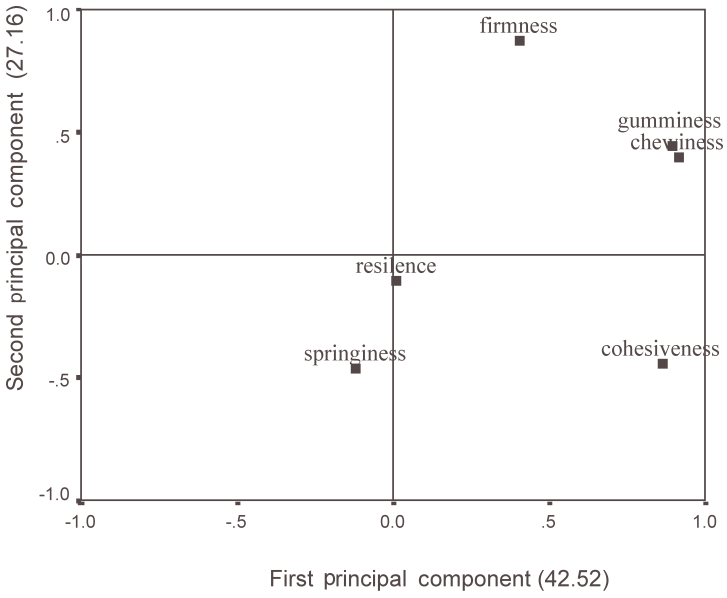

Fig. 1. Loading plot with first and second components of the principal components analysis of texture profile analysis parameters of *idli*

Principal component analysis (PCA) loading for idli texture profile analysis parameters: The first and second principal component explained 42.5 and 27.2%, respectively, of the variation in the data. PCA performed with 6 normalized parameters (Table 1) of the texture profile analysis of *idli*, a large number of variables are reduced to smaller number of orthogonal variable called principal component, which accounted for the variance in the data as a whole (Mainly 1994). The loading plot of the two first principal components described 70% of the variance in *idli* TPA (Fig. 1.). PC1 was highly correlated positively with gumminess, chewiness and cohesiveness. PC2 positively correlated with firmness and negatively correlated with springiness. Resilience contributed very weakly to PC1 and PC2. All of these attributes have already been shown to be highly correlated in Pearson correlation (Table 2).

Conclusion

The texture of cooked *idli* is a sub-

Table 1. Correlation coefficients between principal component and *idli* texture profile analysis parameters

	1st comp (42.5)*	2nd comp (27.2)*
Firmness	-0.627	1.346
Cohesiveness	0.000	0.000
Springiness	0.000	0.000
Gumminess	0.725	-0.287
Chewiness	0.647	-0.287
Resilience	0.000	0.000

*Percentage of variation explained by the component (comp)

Table 2. Pearson correlation coefficients among instrumental (TPA) measures

	Firmness	Cohesiveness	Springiness	Gumminess	Chewiness	Resilence
Firmness	1.000	-0.078	-0.472**	0.756**	0.719**	-0.092
Cohesiveness		1.000	0.013	0.577**	0.612**	-0.009
Springiness			1.000	-0.340*	-0.261	0.210
Gumminess				1.000	0.995**	-0.045
Chewiness					1.000	-0.019
Resilience						1.000

Total number of observations, n=45; *p≤0.05; **p≤0.01

ject of interest, to judge and optimize the production process of good textured *idli* with the selection of the ingredients and the process. Owing to the defference in raw materials, composition, process and region, the fermentation periods are slightly different for *idli* making. Among the TPA test attributes of *idli*, majority of the parameters are positively correlated. The firmness value is positively correlated with gumminess and chewiness, which depicts the softness of *idli*. Resilience is not correlated with other TPA parameters. In the PCA, the first principal component is highly correlated positively with gumminess, chewiness and cohesiveness. The second principal component is positively correlated with firmness and negatively correlated with springiness. Resilience contributed very weakly to both these principal components.

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