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Pradeep Ohariya
 Department of Food Science and
 Technology, Jawaharlal Nehru
 Krishi Vishwa Vidyalaya,
 Jabalpur, MP, India

Alpana Singh
 Department of Food Science and
 Technology, Jawaharlal Nehru
 Krishi Vishwa Vidyalaya,
 Jabalpur, MP, India

LPS Rajput
 Department of Food Science and
 Technology, Jawaharlal Nehru
 Krishi Vishwa Vidyalaya,
 Jabalpur, MP, India

Quality attributes of instant kodo- soy idli mix as affected by fermentation period

Pradeep Ohariya, Alpana Singh and LPS Rajput

Abstract

The present study was conducted to see the effect of fermentation period in the development of instant kodo-soy idli mix. Nutritionally and therapeutically improved instant idli mix was developed by replacing rice (75%) by kodo rice and blackgram (25%) by 0 – 25% full fat soy flour in different combinations. The idli prepared from formulation T₄ (70 % kodo rice, 15% blackgram and 10 % full fat soy flour) was liked the most with a higher mean score as well as exhibited highest volume with 48 hr fermentation period. The instant idli mix pre fermented for 48 hrs was found most suitable for good quality idli with nice fermentable aroma and soft texture.

Keywords: kodo millet (*Paspalum scrobiculatum* L), soy (*Glycine max* L.), fermentation, instant mix, sensory quality

Introduction

Millet is the generic name given to more than 6,000 species of wild annual grasses found throughout the world. India is the largest producer of millet grains and contributes 34 per cent of the total world production of millets (28 million tons). Among them, kodo millet (*Paspalum scrobiculatum* L.) grown over 0.7 million ha. with large area in Madhya Pradesh, Chhattisgarh, Maharashtra, Uttar Pradesh, Gujarat and Tamil Nadu. Its cultivation is mostly confined to tribal area grown under poor environment. The millet has protein of balanced amino acid profile and a good source of methionine, cystine and lysine. The millet carbohydrate is in the form of non-starchy polysaccharide and dietary fiber which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to blood stream during digestion. Soybean (*Glycine max* L.) is known for its polyphenols mainly iso-flavones, which are important phyto-estrogens and exert many beneficial effects, like reducing menopausal symptoms, reduction in bone loss, cancer, and antioxidant activity and also has hypo-cholesterolemic effect (Tsangalis *et al.* 2002) [20]. It provides high quality protein, cholesterol free fat and good amount of omega-3 fatty acids.

Nutritionally and functionally superior small millets and soy with nutraceutical properties are highly suitable in the development of therapeutic foods as metabolic disorders are emerging increasingly in the urban population. The most promising way could be inclusion of small millets in traditional food products, as these traditional foods occupy a very important place in Indian dietary. In recent time's fermented legume and cereal products are becoming popular in the developed countries due to organoleptic characteristics (Sanjeev and Dhanwant 1990) [13] and also considered as health foods. Foods are fermented for many reasons including enhancement of nutritive value and to improve the acceptability characteristics (Kasturiba and Phadnis 1987, Steinkraus 1967) [6, 16].

'Idli' is a traditional steam cooked, popular fermented breakfast food, especially in Southern parts of India. It is prepared by steaming the mixture of fermented rice (*Oryza sativa*) and black gram (*Phaseolus mungo*) batter in the ratio 3:1. The process of fermentation of ingredients is essential which determines the quality of the end product. High demand for ready-to-cook snack products (Singh and Shurpalekar 1989) [14] in India is due to rapid industrialization and urbanization. These foods are easy and fast to prepare but all these preparations need value addition ultimately to improve the nutritional value. Hence, the present study was conducted to see the effect of fermentation period on the development of instant kodo-soy idli mixes.

Correspondence
Alpana Singh
 Department of Food Science and
 Technology, Jawaharlal Nehru
 Krishi Vishwa Vidyalaya,
 Jabalpur, MP, India

Materials and methods

Experimental Materials

Kodo millet was procured from Zonal Agriculture Research Station, Dindori of the University and other raw materials i.e. black gram, soybean and rice were purchased from the local market in one lot for the entire study. The kodo seeds were de-hulled in order to separate the husk using kunaita (a traditional hand operated device). After cleaning, rice, kodo millet, black gram dal and soybean were soaked in water separately at room temperature and fermented for 24, 48 and 72 hrs. The fermented grains were dried in hot air oven at 55°C, coarsely ground and stored in plastic containers for further use.

Optimization

Various combinations of raw materials were tried to arrive at the desired formulation with optimum percentage as recommended by acceptability studies. Colour & appearance, texture, aroma, taste, mouth feel and overall acceptability were considered as deciding factor by using the method described by Amerine *et al.* (1965)^[2].

Preparation of instant kodo idli mixes and its Idli

Instant kodo idli mixes were prepared with different combination of fermented & dried rice soji, kodo soji, black gram dhal & soy flour (table 1, Fig 1) along with 1g each of citric acid & sodium bicarbonate and 2g each of salt & dry yeast. Idli batter was prepared by mixing 100g instant idli mix with 120 ml distilled water and kept it for 10 min for rising. The batter was then poured in an oil smeared idli mould and steamed for 10 min.

Table 1: Different blends of kodo idli mix (100g)

Treatments	Rice (g)	Kodo (g)	Black gram (g)	Soy flour (g)
T1	75	0	25	0
T2	0	75	25	0
T3	0	75	20	5
T4	0	75	15	10
T5	0	75	10	15
T6	0	75	5	20
T7	0	75	0	25

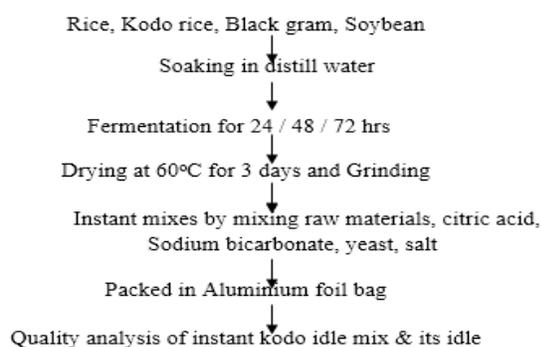


Fig 1: flow sheet for preparation of instant idli mix

Acceptability studies

The developed Idli as well as control Idli were put up before a panel of experts (15 trained judges) to evaluate its acceptability on a 9 point hedonic scale (from like extremely to dislike extremely) based on the various quality attributes by using the method described by Amerine *et al.* (1965)^[2]. The sample was served without any accompaniment. Water was supplied for rinsing the mouth between the samples. The panel members were supplied with scoring card and asked to

evaluate the idli and assign scores for all the attributes. The results are expressed in terms of average acceptability scores. The mean score of 7 above were considered as acceptable.

Physical characteristics of Kodo Idli

Thickness (T) of 4 Idli was measured by placing the Idli edge to edge and by stacking one above the other respectively. Measurements by rearranging and restacking were made and average values were taken and expressed as cm, (AACC, 1967)^[1]. The diameter (D) of Idli was measured by laying 1-4 Idli edge to edge and measuring to the nearest cm (AACC, 1967)^[1]. The Idli were rotated to 90° and their diameter was re-measured as a check determination. The average diameter of Idli was reported in cm. For taking weight of Idli, 4 Idli of uniform size and thickness were taken and weighed. The average weight was expressed as g. The circumference of idli was measured by the formula: Circumference = $2\pi r$. The area of idli was calculated by following formula: Area of Idli = πr^2

Where –

$$r = \text{radius of Idli (3.147 cm)}$$

$$\pi (\text{Pi}) = 22.7$$

Batter volume of instant kodo idli mix

5g of instant kodo idli mix prepared in to batter by adding 25 ml of water and transferred to a sterile measuring cylinder of 50 ml capacity covered with aluminum foil and incubated at room temperature for 10 min. The increase in volume at 0 and 10 min was recorded and the raise in batter volume was expressed as the % volume increase over the initial volume.

Bulk density of idli

Idli was cut in to pieces (2.5 cm diameter) and waxed by dipping in hot wax to plug the air pockets on surface. Bulk density was determined by water displacement of the waxed idli piece in a graduated cylinder (Sowbhagya *et al.*, 1991)^[15].

Results and discussion

Development and optimization of Instant Kodo Idli mix

Idlis were made from various mixes containing 75% rice / kodo rice, 5-25% black gram dal, 5-25% soy flour, 0.5-1% citric acid, 0.5-1% sodium bicarbonate, 1-2% dry yeast, 0.8-3% salt and 100-140 ml water separately and cooked for 8-15 minutes. In the primary sensory evaluation test, the scores for the products with 75% kodo millet, 5-25% black gram, 5-25% soy flour, 1% citric acid, 1% sodium bicarbonate, 2% dry yeast, 2% salt and 120 ml water were acceptable in terms of all sensory attributes. The panelists suggested that lower amount of citric acid, dry yeast, and sodium bicarbonate in idli formulation adversely affected the texture and fluffiness of the final product. They advised that higher amount of citric acid and water in formulation results the excess sourness and stickiness to the idli respectively. Judges indicated that addition of salt at the rate 3gm/100g raw material imparted more saltiness to the idli. They also suggested that the idli must be steamed for 10 min. and raw materials pre fermented for 48 hrs for good quality idli with nice fermentable aroma and soft texture. Fermentation time of 72hrs adversely affected the aroma of final product. Nisha *et al.* (2005)^[8] suggested that during the preparation of idli, fermentation time is an important step which determines the sensory attributes (in terms of flavor and texture) and nutritional quality of idli. Prabhakar and Rajyalakshmi (2006)^[10] also realized the health promoting effect of minor millets and

developed value added convenience foods of commercial importance using foxtail millet. Similarly Rekha and Vijayalakshmi (2011) added underutilized okara for the preparation of 'idli' in which black gram was partially substituted with soy okara in the ratio of (1:1).

In present study proportion for kodo rice, black gram and soy used was 75:15:10 whereas Kumar *et al.* (2006) revealed that idli and dosa made in the ratio of 2:1 (Kutki: Blackgram dhal) was good in all sensory attributes. Venkatasubbaiah *et al.* (1983) [22] also prepared idli by mixing rice and blackgram in 2:1 and keeping the ground batter for fermentation period of 15 to 24 hr. at 30 °C. 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 Viswanathana 2007) [4, 7, 9, 3]. The findings of Subeelamma and Rao (1979) are in contrast with the present findings as they found 30-50% black gram flour optimum for producing the soft and spongy texture with uniform porosity and physical stability, whereas for chemically leavened batter, it was only 10-15% of the mix.

Acceptability studies of the Instant Kodo Idli

The final acceptability of Idli formulations was again judged by sensory quality characteristics of the developed product (table 2-4). Results indicated that the sensory score of original idli as well as developed formulations differed significantly from each other with respect to all the sensory attributes studied. Higher sensory scores were found in 48 hr. of fermentation irrespective of the blend. It is obvious from the table 3 that the formulation T₁ (control) and T₄ were liked the most with higher mean scores for colour and appearance, taste, texture, aroma, mouth feel and lowest value exhibited by T₇ treatment. Most of the sensory attributes scored lower values with the fermentation period of 24 hr. as compared to the mixes prepared from 48 hr fermentation period while mixes prepared from 72 hr fermentation were found unacceptable with lower scores due to poor texture and unpleasant aroma.

Table 2: Sensory attributes of Idli prepared from Instant Kodo Idli mix (24 hrs. fermentation)

Treatments	Colour & appearance	Taste	Texture	Aroma	Mouth feel	Overall acceptability
T ₁	8.38	8.10	8.20	8.02	8.10	8.20
T ₂	7.14	7.02	6.44	7.36	7.80	7.24
T ₃	7.11	6.84	6.50	7.30	7.74	6.76
T ₄	8.33	8.04	8.10	7.88	7.80	8.02
T ₅	7.80	7.50	7.06	7.50	7.22	7.40
T ₆	6.54	6.10	7.08	6.56	6.80	6.50
T ₇	6.20	6.05	6.24	6.03	6.38	6.07
SEM±	0.070	0.100	0.110	0.140	0.100	0.100
CD at 5%	0.220	0.290	0.340	0.410	0.300	0.290

Table 3: Sensory attributes of Idli prepared from Instant Kodo Idli mix (48 hrs. fermentation)

Treatments	Colour & appearance	Taste	Texture	Aroma	Mouth feel	Overall acceptability
T ₁	8.45	8.36	8.42	8.24	8.28	8.32
T ₂	7.28	7.14	7.01	7.48	8.02	7.37
T ₃	7.08	7.02	7.01	7.36	7.96	6.80
T ₄	8.38	8.26	8.12	8.01	8.04	8.16
T ₅	7.86	7.68	7.50	7.66	7.36	7.50
T ₆	6.62	6.12	7.16	7.06	7.03	6.52
T ₇	6.28	6.04	6.43	6.48	6.52	6.04
SEM±	0.070	0.050	0.050	0.090	0.090	0.110
CD at 5%	0.200	0.160	0.170	0.270	0.290	0.330

Table 4: Sensory attributes of idli prepared from Instant Kodo Idli mix (72 hrs. fermentation)

Treatments	Colour & appearance	Taste	Texture	Aroma	Mouth feel	Overall acceptability
T ₁	8.03	8.10	8.01	7.5	7.50	7.80
T ₂	7.50	7.86	7.02	7.04	6.50	7.56
T ₃	6.70	7.50	7.54	7.04	6.01	7.16
T ₄	6.80	7.80	7.82	5.80	6.04	7.50
T ₅	6.70	6.74	7.48	5.42	6.04	6.70
T ₆	5.50	6.47	7.56	5.34	6.04	5.80
T ₇	5.01	5.60	6.02	5.05	5.04	5.40
SEM±	0.160	0.190	0.080	0.050	0.070	0.120
CD at 5%	0.490	0.570	0.230	0.160	0.200	0.380

Natural fermentation of soybean brings desirable changes in taste and texture and may result in the breakdown of some of the anti-nutritional factors. With increase in level of soy flour more than 15% in the formulation, the sensory score for texture, taste, aroma, mouth feel of kodo idli decreased. The control samples had maximum overall acceptability whereas kodo idli containing 75% of kodo millet, 5% black gram and 20 - 25% soy flour were unacceptable to the panelists. Reduced acceptability of soy flour in kodo idli may be attributed to the hardness and poor flavour contributed by soy flour at higher level. Idli is famous for its soft spongy texture, desirable sour taste and characteristics aroma. The results showed that the softness was higher in T₄ formulation and comparable to control. This indicated that soy when combined with kodo rice and black gram gave soft textured idli.

Physical characteristics of instant kodo idli mix / idli

Idli volume

In present investigation attempts were made to find out the best combination after steaming of Idli. Data on the effect of different combinations on volume of cooked idli prepared from instant kodo idli mixes pre fermented for 24 and 48 hrs indicated that treatment T₄ exhibited highest volume 223.18 cm³ and 232.24 cm³ respectively among all the combinations whereas minimum volume of idli was exhibited by T₁ treatment. The initial volume of all combinations has kept constant (113.29 cm³).

Table 5: Volume of idli prepared from instant kodo idli mix pre-fermented for 24 hrs.

Treatments	Idli volume (cm ³)					
	Before steaming			After steaming		
	Diameter r (cm)	Thickness d (cm)	Volume (cm ³)	Diameter r (cm)	Thickness d (cm)	Volume (cm ³)
T ₁	6.00	1.01	113.29	6.00	1.80	203.92
T ₂	6.00	1.01	113.29	6.00	1.83	207.32
T ₃	6.00	1.01	113.29	6.00	1.92	217.52
T ₄	6.00	1.01	113.29	6.00	1.97	223.18
T ₅	6.00	1.01	113.29	6.00	1.92	217.52
T ₆	6.00	1.01	113.29	6.00	1.95	220.91
T ₇	6.00	1.01	113.29	6.00	1.92	217.52
SEM±	1.730	0.010	0.010	1.730	0.010	0.010
CD at 5%	5.250	0.030	0.040	5.250	0.040	0.040

Bulk density of Idli and its mixes

It is clear from the table 7 & 8 that bulk density of idli prepared from control was significantly higher (0.63-0.64g/ml) while the lowest bulk density (0.49g/ml and (0.53g/ml) was found in treatments T₃ and T₄ respectively with 24 hr fermentation period. The bulk density of idli reduced with modifications which is an indication of good quality porous product as reported by Kanchana *et al.* (2008)

^[5]. The average bulk density of instant Idli mixes is constant (0.83%) for all mixes in case of 24 hr fermentation whereas it reduced from 0.83 to 0.76 to g/ml. with 48 hrs fermentation period. The bulk density of idli mix pre-fermented for 48 hrs

especially T1, T2, T3 was higher when compared to other formulations indicating that the product may be easily digestible and absorbable. The similar results are reported by Varnashree *et al.* (2008) ^[21].

Table 6: Volume of idli prepared from instant kodo idli mix pre fermented for 48 hrs.

Treatments	Idli volume (cm3)					
	Before steaming			After steaming		
	Diameter r(cm)	Thickness d(cm)	Volume (cm3)	Diameter r(cm)	Thickness d(cm)	Volume (cm3)
T1	6.00	1.01	113.29	6.00	1.86	210.72
T2	6.00	1.01	113.29	6.00	1.91	216.38
T3	6.00	1.01	113.29	6.00	1.97	223.18
T4	6.00	1.01	113.29	6.00	2.05	232.24
T5	6.00	1.01	113.29	6.00	1.93	218.65
T6	6.00	1.01	113.29	6.00	1.96	222.05
T7	6.00	1.01	113.29	6.00	2.02	227.71
SEM±	1.730	0.010	0.010	1.730	0.010	0.010
CD at 5%	5.250	0.030	0.040	5.250	0.040	0.040

Table 7: Physical characteristics of instant kodo idli mix & its idli Pre fermented for 24 hrs.

Treatments	Quality attributes						
	Bulk density of idli (g/ml)	Bulk density of idli mix (g/ml)	Batter volume (%)	Weight (g)	No. of idli (100g mix)	Area (mm)	Circumference (mm)
T ₁	0.64	.83	09.54	17.70	8	28.94	19.55
T ₂	0.53	.83	09.09	19.58	8	28.94	19.55
T ₃	0.49	.83	09.06	19.73	8	28.94	19.55
T ₄	0.53	.83	13.63	21.69	8	28.94	19.55
T ₅	0.58	.83	09.09	21.98	8	28.94	19.55
T ₆	0.63	.83	13.63	22.71	8	28.94	19.55
T ₇	0.56	.83	13.63	20.72	8	28.94	19.55
SEM±	0.17	0.04	0.140	1.80	0.56	2.36	2.33
CD at 5%	0.51	0.08	0.410	5.50	0.80	7.15	7.08

Table 8: Physical characteristics of instant kodo idli mix & its idli pre fermented for 48 hrs.

Treatments	Quality attributes						
	Bulk density of idli (g/ml)	Bulk density of idli mix (g/ml)	Batter volume %	Weight (g)	No. of idli (100g mix)	Area (mm)	Circumference (mm)
T ₁	0.63	0.83	09.09	20.68	8	28.94	19.55
T ₂	0.56	0.83	09.09	20.77	8	28.94	19.55
T ₃	0.59	0.83	13.63	19.63	8	28.94	19.55
T ₄	0.53	0.76	13.63	19.81	8	28.94	19.55
T ₅	0.59	0.76	09.09	20.75	8	28.94	19.55
T ₆	0.56	0.76	13.63	20.07	8	28.94	19.55
T ₇	0.59	0.76	09.09	21.19	8	28.94	19.55
SEM±	0.02	0.04	0.170	2.29	0.56	2.36	2.33
CD at 5%	0.07	0.012	0.530	6.95	0.80	7.15	7.08

Batter volume

The data revealed that average batter volume of idli mix ranged from 09.00% to 13.63% and formulations T₄ and T₆ showed the maximum volume with same value in both fermentation periods. Whereas the percent increase in volume of batter was more in instant mixes pre-fermented for 48 hrs (Table 8). It was also seen that rise in batter volume was relatively higher for blend incorporated with kodo millet and soy flour. This relatively more increase in batter volume of blend might be due to more microbial activity resulting in to more production of gases during the fermentation process. Fortification of soy to instant mix has also a beneficial effect in terms of higher amount of gas production and leavening during natural fermentation. The increase in volume might be due to the CO₂ production by the yeast during natural fermentation of raw materials used for preparation of instant idli mix which is a measure of their metabolic activity. This is also because of combined contribution of both hetero-

fermentative lactobacilli and non-LAB (Thyagaraja *et al.* 1992) ^[19].

The average weight of different Instant kodo idli prepared from mixes pre-fermented for 24 and 48 hrs ranged from 17.70 - 22.71 g and 19.63 to 21.19 g respectively. It is clear from the table 7 & 8 that all the formulations gave similar no. of idli and exhibited the same area i.e.28.94 mm and circumference i.e.19.55 mm. irrespective of blends and fermentation period.

Conclusion

Kodo rice can be used up to 75% along with 15% black gram and 10% soy flour in rice based fermented product idli to enhance the quality and nutritive value which could solve the nutritional problem of the vulnerable segment of the society to a greater extent without changing the food habits or incurring higher expenditure. The optimized recipe differed from basic recipe in kodo millet, black gram, soy flour, citric

acid, sodium bicarbonate, yeast, salt, water and fermentation time. Kodo millet and soy in instant idli mix with good acceptability, batter volume and higher nutritive value can be promoted at urban markets enhancing the contribution of these underutilized crops to the food basket.

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