



Development and Evaluation of Kodo Millet and Little Millet Based Boli Mix

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The mix suitable for *boli* (*Boli* is golden yellow sweet pancake from South India) based on the kodo millet (*Paspalum scrobiculatum*) and little millet (*Panicum milliare*) were developed and their nutritional qualities were evaluated in different packaging materials viz., high density polyethylene bag (HDPE- 400 gauge) and metalized polypropylene bag (MPP) during storage periods (90 days). A slight change was noted in the moisture (8.00-8.81% and 7.80-8.75%), protein (11.37-10.59 and 8.75-7.83%), reducing sugar (3.81-4.49% and 2.90-3.28%), total sugar (5.68 - 4.65g% and 3.78-3.46g%) and crude fibre (3.80-3.72 and 3.40-3.32g%) content of the kodo millet and little millet based boli mix during storage. The mix was used to develop traditional food product like boli. It was organoleptically acceptable and scored higher values (8.8-8.9 by using 9 point hedonic scale) at the end of the storage period. The microbial population of boli mix was found to be minimum initially (1.0×10^{-4}) and it was within the safer limit (5.0×10^{-4}) on storage. Statistically the moisture (increased up to 0.95%), protein (decreased up to 0.92%), reducing sugar (increased up to 0.68%) and total sugar (decreased up to 1.03%) showed highly significant difference at 0.01% level, but non significant difference was observed in ash, calcium, iron and tannin on storage. The shelf life of the kodo millet and little millet based *boli* mixes were found to be good up to 90 days at ambient conditions under MPP and HDPE packaging.

Key words: Kodo millet, Little millet, Mix, Boli, Organoleptic parameters

Millets are small seeded annual cereal grains. These are very hardy crops and can be grown successfully in infertile lands. These crops are less prone to diseases and pests. (Gopalan et al., 1997). Millets are particularly low in phytic acid and rich in dietary fibre, iron, calcium and B-vitamins. It also contains higher proportion of unavailable carbohydrates and release of sugar from millet is low. Kodo millet and little millet are nutritionally superior to rice and wheat and provide protein, minerals, vitamins and fibre and are rightly designated as nutritious cereals. Over the past three decades cultivation and production of nutritious cereals is decreasing significantly, because of poverty and low consumption of nutritious cereals (Seetharama and Rao, 2004). In the present era of food scarcity there exists a need to diversify the use of these millets by developing millet products (Malleshi and Desikachar, 1982). The millet products are available in the market at a higher price. The use of kodo millet and little millet in an improvised traditional products would increase their utilization. Hence, the present study was taken up to develop low cost kodo millet and little millet based boli mix.

Boli is golden yellow sweet pancake from South India. It is also called *Oppittu* in Tamil. Boli is processed snack specialty food for all the age group people. This is prepared with cooked Bengal gram dhal, jaggery and cardamom as a flavouring agent, mashed well and made into small balls. Refined wheat flour and millet flour is made into dough and small size balls and flattened. The ball of dhal mash is covered and again flattened like a thick roti. This is again shallow pan fried on both sides and served.

Materials and Methods

Preparation of flour

Kodo millet or varagu (*Paspalum scrobiculatum*), little millet or samai (*Panicum milliare*). Varagu and samai grains were cleaned well, sun dried and ground into flour by using bur mill and sieved twice before using for the formulation.

Process for preparation of boli

The dough was prepared from kodo millet flour, little millet flour, refined wheat flour, cow pea and horse gram flour. The stuff was prepared from processed pulses (Bengal gram dhal - 100g) with addition of sweetening (Powdered jaggery - 100g) and flavouring agents (Cardamom-1g). The

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sweetened stuff was covered by flattened dough and shallow fat fried on a preheated tawa (pan).

The combination of kodo millet and little millet based mixes were T₁, T₂, T₃, T₄, T₅, T₆, T₇ and T₈. All the combination of mixes were used to prepare the product boli. Among the combinations T₄ (40:40:20, K.M.F: R.W.F: C.P.F) and T₆ (50:40:10, L.M.F: R.W.F: H.G.F) were found to be better based on the nutrient content and organoleptic evaluation.

Development of food product

Preparation of dough

The salt was dissolved in water. Millet flour, refined wheat flour and pulse flour were mixed with water and little amount of oil (2ml) and kneaded well to get soft and smooth dough. Then it was allowed to stand for 30 minutes at room temperature. The dough was prepared from each treatment for standardizing the level of millet flour, refined wheat flour and pulse flour as given in Table 1.

Preparation of stuff

The cleaned Bengal gram dhal (100g) was pressure cooked for 5 minutes by adding 300ml of water. The cooked dhal was cooled at room temperature and ground coarsely in a mixie. The powdered jaggery (100g) and cardamom (1g) were mixed with the ground dhal.

Preparation of boli

The prepared dough was made into balls of even size (25g). Each ball was rolled in to a thin sheet of

6cm diameter and 0.4cm thickness by applying oil (2ml) and stuffing (15g) was placed in the centre, covered and folded into a round ball. The stuffed ball was rolled again into thin sheet (10cm diameter and 0.2cm thickness). It was shallow fat fried on a preheated tawa by smearing oil (10ml) for two minutes.

The prepared mix was packed in different packaging materials (HDPE & MPP) stored in ambient conditions and analysed for proximate composition of moisture, protein, fat, reducing sugar, total sugar, crude fibre, ash, calcium, iron and tannin content by the following methods.

The product was analyzed for Moisture (Hot air oven method), Protein (Kjeldahl method), Reducing sugar & Total sugar (Shaffer Somogyi), Starch (Anthrone Method), Fibre (Acid and Alkali titration), Tannin (Calorimeter), Sensory evaluation (Hedonic rating scale 9-1) and Statistical analysis (Factorial Complete Randomized Design-FCRD) as per procedure given in the references.

Results and Discussion

Moisture

The boli mix prepared from kodo millet (T₄) and little millet (T₆) had a moisture content of 8.00 per cent and 7.80 per cent. It is lower than refined wheat flour (10.70%). The moisture content of the mixes increased gradually depending on the different packaging materials (8.81, 8.52 for HDPE, MPP in T₄ and 8.75, 8.32 for HDPE, MPP in T₆) at the end of

Table 1. Formula for boli dough

Treatment	Ingredients					
Control		Refined wheat flour (100g)		salt (pinch)	oil (5ml)	fat (10g)
T1	Kodo millet flour (40g)	Refined wheat flour (50g)	Cow pea flour (10g)	salt (pinch)	oil (5ml)	fat (10g)
T2	Kodo millet flour (50g)	Refined wheat flour (40g)	Cow pea flour (10g)	salt (pinch)	oil (5ml)	fat (10g)
T3	Kodo millet flour (60g)	Refined wheat flour (30g)	Cow pea flour (10g)	salt (pinch)	oil (5ml)	fat (10g)
T4	Kodo millet flour (40g)	Refined wheat flour (40g)	Cow pea flour (20g)	salt (pinch)	oil (5ml)	fat (10g)
T5	Little millet flour (40g)	Refined wheat flour (50g)	Horse gram flour (10g)	salt (pinch)	oil (5ml)	fat (10g)
T6	Little millet flour (50g)	Refined wheat flour (40g)	Horse gram flour (10g)	salt (pinch)	oil (5ml)	fat (10g)
T7	Little millet flour (60g)	Refined wheat flour (30g)	Horse gram flour (10g)	salt (pinch)	oil (5ml)	fat (10g)
T8	Little millet flour (40g)	Refined wheat flour (40g)	Horse gram flour (20g)	salt (pinch)	oil (5ml)	fat (10g)

storage. The moisture absorption is low in metalized poly propylene bag (MPP) than high density polyethylene bag (HDPE). The moisture content of the mixes showed highly significant differences at 0.01 per cent level on storage. Duhan et al., (2002) stored the processed full fat soy flour in polyethylene bags and plastic bottles at 30, 35, 40°C and room temperature for 10, 20, 30, 45 and 60 days. Fresh

Table 2. Nutrient content of boli mixes

Products	Moisture (g)	Protein (g)	Fat (g)	Ash (g)	Reducing Sugar(g)	Total Sugar(g)	Crude fibre (g)	Calcium (mg)	Iron (mg)	Starch (g)	Tannin (mg)
Refined wheat flour (C)	10.70	10.05	0.95	0.48	2.65	5.98	0.92	21.00	2.50	54.50	2.50
Kodo millet mix (T ₄)	8.00	11.37	0.85	0.54	3.81	5.68	3.80	26.40	3.13	49.75	16.50
Little millet mix (T ₆)	7.80	8.75	1.75	1.08	2.90	3.78	3.40	36.20	6.28	42.75	19.00

stored in high density polyethylene bag (HDPE) and metalized poly propylene bag (MPP) and the values were 10.59 and 10.63 and 7.83 and 7.90 at the end

of storage period. The loss in protein content was found to be more in high density polyethylene bag (0.78g% in T₄ and 0.92g% in T₆) than metalized poly

Protein

Protein content of kodo millet based boli mix is higher (11.37g %) than refined wheat flour (10.05g%). During storage the protein content declined in kodo millet (T₄) and little millet (T₆) mix

of storage period. The loss in protein content was found to be more in high density polyethylene bag (0.78g% in T₄ and 0.92g% in T₆) than metalized poly

Table 3. Nutrient changes of boli mix during storage

Storage	Nutrient	Moisture ** (g)				Protein** (g)				Reducing Sugar ** (g)				Total Sugar ** (g)			
		Kodo millet mix (T ₄)		Little millet mix (T ₆)		Kodo millet mix (T ₄)		Little millet mix (T ₆)		Kodo millet mix (T ₄)		Little millet mix (T ₆)		Kodo millet mix (T ₄)		Little millet mix (T ₆)	
		HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP
Initial (0 days)		8.00	8.00	7.80	7.80	11.37	11.37	8.75	8.75	3.81	3.81	2.90	2.90	5.68	5.68	3.78	3.78
Final (90 days)		8.81	8.52	8.75	8.32	10.59	10.63	7.83	7.90	4.49	4.42	3.28	3.23	4.65	4.67	3.46	3.48

propylene bag (0.74g % in T₄ and 0.85g% in T₆). Statistically highly significant difference at 0.01 per cent level was observed on storage. Jagannathan, (1999) studied on the rice based instant idli mix had initial protein content of 11.37 per cent and the reduction in protein content to be 1.40 per cent during storage.

Reducing sugar

The boli mix had higher reducing sugar content (3.81% for T₄, 2.90% for T₆), when compared to refined wheat flour (2.65%). The initial reducing

sugar content of the kodo millet and little millet mixes were 3.81 per cent and 2.90 per cent whereas refined wheat flour was 2.65 per cent. It was increased to 4.49 per cent for HDPE and 4.42 per cent for MPP of kodo millet mix and 3.28 per cent for HDPE and 3.23 per cent MPP of little millet mix on storage. The conversion of total sugar to simple sugar during storage might have increased the reducing level in the stored mixes. Statistically highly significant difference at 0.01 per cent level was observed on storage. Chitra (2000) reported that the banana based weaning food mixes exhibited an increase in

Table 4. Nutrient changes of boli mix during storage

Storage	Nutrient	Crude fibre **				Iron (mg)				Tannin (mg)			
		Kodo millet mix (T ₄)		Little millet mix (T ₆)		Kodo millet mix (T ₄)		Little millet mix (T ₆)		Kodo millet mix (T ₄)		Little millet mix (T ₆)	
		HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP	HDPE	MPP
Initial (0 days)		3.80	3.80	3.40	3.40	3.13	3.13	6.28	6.28	16.50	16.50	19.00	19.00
Final (90 days)		3.72	3.77	3.32	3.38	3.07	3.11	6.22	6.25	16.47	16.48	18.95	18.98

HDPE - High Density Poly Ethylene Bag MPP - Metalized Poly Propylene Bag **Highly significant

the reducing sugar content during storage (3.35 to 5.10%) of 180days of storage.

Total sugar

A decreasing trend in the total sugar during storage was observed. The kodo millet and little millet based boli mix had low total sugar (5.68 and 3.78g%) when compared to refined wheat flour (5.98g%) initially. At the end of storage period the total sugar content of the kodo millet and little millet mixes were 4.65g per cent for HDPE and 4.67g per cent for MPP and 3.46g per cent for HDPE and 3.48g per cent for MPP respectively. Among the packaging

materials higher per cent retention of total sugar content was observed in the samples packed in MPP followed by HDPE. Statistically high significant difference at 0.01 per cent level was observed on storage. Kalai (1998) reported on the storage of chappathi mix prepared with wheat, ragi and green gram. The study indicated that the total sugar content decreased from 2.62 to 2.58g per cent per 100g on 120 days of storage.

Crude fibre

The fibre content of the kodo millet and little millet mix was higher than refined wheat flour. i.e. 0.92g

Table 5. Data analysis of boli mix

	Moisture		Protein		Reducing sugar		Total sugar		Fibre		Iron	
	SED	CD(0.01%)	SED	CD(0.01%)	SED	CD(0.01%)	SED	CD(0.01%)	SED	CD(0.01%)	SED	CD(0.01%)
Treatment	0.0057	0.0150**	0.0040	0.0107**	0.0025	0.0067**	0.0030	0.0081**	0.0030	0.0080**	0.0027	0.0071**
Package	0.0046	0.0122**	0.0033	0.0087**	0.0020	0.0054**	0.0025	0.0066**	0.0025	0.0066**	0.0022	0.0058**
Storage	0.0087	0.0229**	0.0062	0.0164**	0.0038	0.0102**	0.0047	0.0124**	0.0046	0.0123**	0.0041	0.0109 NS
TP	0.0080	0.0212**	0.0057	0.0152**	0.0036	0.0095**	0.0043	0.0115**	0.0043	0.0114**	0.0038	0.0101 NS
PS	0.0123	0.0324**	0.0088	0.0232**	0.0055	0.0145**	0.0066	0.0175**	0.0066	0.0174**	0.0058	0.0154 **
TS	0.0150	0.0397**	0.0108	0.0284**	0.0067	0.0177**	0.0083	0.0212**	0.0081	0.0213**	0.0071	0.0189**
TPS	0.0213	0.0562**	0.0152	0.0402**	0.0095	0.0251**	0.0112	0.0303**	0.0114	0.0302**	0.0101	0.0267**

** Highly significant

NS- Non Significant

per cent for refined wheat flour and 3.80g per cent for kodo millet mix and 3.40g per cent for little millet mix. A slight change was observed in the fibre content 3.72g per cent for HDPE and 3.77g per cent for MPP of kodo millet mix and 3.32g per cent for HDPE and 3.38g per cent for MPP of little millet mix at the end of storage period. Among the packaging materials the retention of fibre content was better in the boli mix packed in metalized polypropylene (MPP) bags. Statistically highly significance at 0.01 per cent level on storage. Meenatchi sundaram (2005) stated that

the fibre content of the stored ready to use beverage mix with finger millet and sorghum showed slight change in fibre content (0.92-0.91g%) and (0.54-0.53g%) packed in polyethylene bags

Iron

A slight change was observed in the samples during storage. The kodo millet (T₄) and little millet (T₆) mix had higher iron content (3.13mg and 6.28mg) than refined wheat flour (2.50mg). It was decreased to 3.07 mg for HDPE and 3.11 mg for MPP in T₄ and

6.22mg for HDPE and 6.25mg for MPP in T₆. Nithya, (2004) stated that there was a slight reduction in the iron content of the nutrimix stored in polyethylene bag without vacuum and pet jar.

Tannin

Tannin content of the mixes was higher (16.50 and 19.00mg) in kodo millet (T₄) and little millet (T₆) mix than refined wheat flour (2.50mg). A slight change was observed in the tannin (16.47mg for HDPE and 16.48mg for MPP in T₄ and 18.95mg for HDPE and 18.98mg for MPP in T₆) at the end of the storage period. Meenatchi sundaram (2005) reported a slight decrease in tannin content (12.70-12.68 and 59.26-59.25mg per 100g) of beverage mix (finger millet and pearl millet based) after 180 days of storage at room temperature. Rooney (2005) stated the tannins are beneficial to human health.

Table 6. Sensory qualities of food product prepared from boli mix on storage (0-90days)

SCORE	PRODUCT		BOLI							
	Kodo millet mix (T ₄)				Little millet mix (T ₆)					
	HDPE		MPP		HDPE		MPP			
	0	90	0	90	0	90	0	90		
Color & Appearance	8.9	8.8	8.9	8.8	8.9	8.8	8.9	8.8		
Flavor	8.8	8.5	8.8	8.6	8.8	8.4	8.8	8.5		
Texture	8.8	8.6	8.8	8.6	8.8	8.6	8.8	8.6		
Taste	8.9	8.6	8.9	8.6	8.9	8.5	8.9	8.5		
Overall acceptability	8.9	8.6	8.9	8.7	8.9	8.6	8.9	8.7		

HDPE- High Density Poly Ethylene Bag

MPP - Metalized Poly Propylene Bag (MPP)

of the storage period. Among the packaging materials metalized poly propylene (MPP) packed samples had low microbial population in all the treatments. It was within the safer limit on storage.

Conclusion

It can be concluded that kodo millet and little millet based boli mixes were highly nutritious, low cost and effectively used in the preparation of nutritious food items like boli after suitable processing. The shelf life of mixes were found to be good up to 90 days at ambient conditions under high density polyethylene bag (HDPE) and metalized poly propylene bag (MPP).

References

- Chitra, P. 2000. Processing and preservation of selected products from three banana cultivars. M.Sc., Thesis. Tamil Nadu Agricultural University, Coimbatore.
- Duhan, R.K. and Grewal, R.B. 2002. Sensory and chemical changes in full fat soy flour during storage in different packaging materials and temperature. Proc. National Seminar on "Value Addition of Soya for Better Utilization", Madurai. Feb., 14-16: 79p.
- Gopalan, C., Ramasastri, B.V. and Balasubramanian, S.C. 1997. Nutritive Value of Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.
- Jaganmohan, R. 1999. Studies on the rice based convenience foods. Ph.D., Thesis. Tamil Nadu Agricultural University, Coimbatore.

Sensory characteristics

Table 5 shows the sensory characteristics like colour and appearance, flavor, texture, taste and overall acceptability of boli scored higher values at the end of the storage periods (90 days). The score values ranged from 8.8 to 8.9 for HDPE and MPP packaging initially and 8.5 to 8.8 for HDPE and MPP in T₄ and 8.4-8.8 for HDPE and MPP in T₆ at the end of the storage period. The food product i.e. boli was acceptable up to 90 days of storage period.

Microbial Population

The microbial population of boli mix was found to be minimum initially. It was increased from 1.0 x10⁻⁴ to 5.0 x10⁻⁴ for HDPE and from 1.0 x10⁻⁴ to 3.0 x10⁻⁴ for MPP in T₄ and 1.0 x 10⁻⁴ to 4.0 x 10⁻⁴ for HDPE and 1.0 x 10⁻⁴ to 3.0 x 10⁻⁴ for MPP in T₆ at end

Kalai, R. 1998. Effect of incorporation of cereal and pulse flour on the characteristics of chapattis suitable for diabetic patients. M.Sc., Thesis. Tamil Nadu Agricultural University, Coimbatore.

Malleshi, N.G. and Desikachar, H.S.R. 1982. Formulation of weaning food with low hot paste viscosity based on malted ragi and green gram. *J. Food Sci. Technol.*, **19**: p.193-197.

Ma, T. and Zuazaga, G. 1942. *Ind. Eng. Chem., Anal. Edn.* **14**: p 1-13.

Mc Donald, F.J. and Foley, B.Y. 1960. *J. Assoc. Office. Agri. Chem.*, **43**: 645p.

Meenatchisundaram, P. 2005. Processing food products from malted millets. M.Sc., Thesis. Tamil Nadu Agricultural University, Coimbatore.

Nithya, A. 2004. Impact of nutrimix on the selected female athletic performance. M.Sc., Thesis. Tamil Nadu Agricultural University, Coimbatore.

Ranganna, S. 1995. Manual of analysis of fruits and vegetable products. *Tata Mc Graw Hill Publishing Co., Ltd.*, New Delhi, 71p.

Rooney, L. 2005. Sorghum Research-Ten Myths about tannins in sorghum. *ISMN*. **46**: 3-5.

Sadasivam, S. and Manickam, A. 1996. Biochemical methods. IInd edition, *New Age International (P) Ltd.* New Delhi, 63p.

Seetharama, N. and Rao, D.B. 2004. Sustaining Nutritional Security. The Hindu, Survey of Indian Agriculture, 37p.