

# Formulation and evaluation of cereal based health mix for pre-school children

■ SHILPA GUDDAD AND PUSHPA BHARATI

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See end of the paper for authors' affiliations

Correspondence to :

**PUSHPA BHARATI**

Department of Food Science and Nutrition, College of Rural Home Science, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA  
Email: pcbharati10@gmail.com

■ **ABSTRACT** : Investigation on multigrain mixes were formulated using cereals, pulses and oilseeds. The developed food mix was evaluated for sensory parameters, nutrient composition, digestibility and keeping quality. Based on protein quality, the mix with either garden cress seeds or carrot shreds was selected for further study. *Laddu* incorporated with 5 g of roasted groundnut pieces received significantly higher scores (between 8 and 9) with good flavour, colour and appearance, whereas *Laddu* with roasted edible gum was very good (between 7 and 8) and plain *Laddu* was good (between 5 and 6). *Thepla* with dried carrot shreds was acceptable with a overall acceptability score of 8.0. All the beneficiaries, *Anganwadi* staff, primary health care staff and mothers accepted *Laddu* and *Thepla*. *Laddu* mix had significantly higher amounts of crude protein (18.54%) while *Thepla* mix contained significantly higher amounts of ash (6.57%). However, there was no significant difference in moisture, crude fat, fibre, carbohydrate content and energy values of *Laddu* (3.60%, 8.55%, 3.88%, 61.85% and 399 Kcal, respectively) and *Thepla* mix (3.70%, 8.37%, 4.06%, 60.53% and 385Kcal, respectively). Calcium (250 mg) and phosphorus (483.5 mg) contents were significantly higher in *Thepla* mix while iron (11.80 mg) and zinc (2.16 mg) contents were higher in *Laddu* mix. The dietary fibre, IVPD and IVSD of both the mixes did not differ significantly. On storage, though decrease in sensory scores and increase in moisture and free fatty acids was observed, the mixes were acceptable even after 180 days of storage.

■ **KEY WORDS**: Food formulation, Nutrient composition, Sensory evaluation, Keeping quality, Acceptability, Target group

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India is home to more than one billion people, of which 43 crores are children in the age group of 0-18 years; 16 crore children are in the age group of 0-6 years. Among these, around 46 per cent of all children below the age of three are too small for their age, 47 per cent are underweight and at least 16 per cent are wasted. Many of these children are severely malnourished (Anonymous, 2012). This indicates the presence of protein energy malnutrition (PEM). PEM signifies an imbalance between the supply and the body's demand of protein and energy to ensure optimal growth and function.

In spite of immense number of supplementary feeding and health based programmes operating in the country,

nutritional requirement for energy and protein is not adequately met. The reasons being poverty, ignorance, frequent and less spaced pregnancies and prevailing unhygienic conditions. Direct intervention strategies with nutrient dense food formulation is need of the hour to improve the nutritional status of pre-schoolers.

Protein quantity and quality are important to meet the growing needs of children. The quality can be achieved either by animal foods or by combination of food ingredients to complement the amino acid composition. Cereals being the staple foods for majority of population in India, the combination of a cereal with an appropriate proportion of pulses and oilseeds complement each other and result in

improved nutritional qualities. Hence, the present study was undertaken with an objective to develop protein and energy dense multigrain mix suitable for pre-school children.

## RESEARCH METHODS

Based on the availability, nutrient content and cost, ingredients like *ragi*, rice, wheat, green gram dhal, soybean, groundnut, garden cress seeds were procured in one lot, cleaned and stored for further study. Carrots were procured from the local market and processed.

The grains *viz.*, *ragi*, rice, wheat, green gram dal and soybean were roasted separately till grains started puffing and aroma developed. Groundnuts were roasted and de-skinned. The roasted grains were mixed and powdered. Garden cress seeds were roasted till it puffs. Carrots were washed, peeled, grated and dehydrated in hot air oven at 60° C till it attained crisp texture.

Totally six multigrain mixes were formulated. Based on amino acid score, the mix with either garden cress seeds or carrot shreds was selected for further study. Multigrain mixes formulated by mixing the ingredients in particular proportions were subjected to sensory evaluation in the form of *Laddu* and *Thepla*. Sensory evaluation was carried out using a panel of 10-15 trained judges drawn from staff and students of the department, on a nine point hedonic scale. Products which received highest rank at laboratory level were tested for acceptability by target group. Here, *Anganwadi* children served as target group. Even *Anganwadi* staff, primary health care staff and mothers tested for acceptability of products. One serving of the product was provided to each consumer and were requested to indicate the opinion as 'like, dislike or neutral'.

The developed *Laddu* and *Thepla* mixes were analyzed for moisture, ash, protein, fat, crude fibre using AOAC methods (Anonymous, 1990). Calcium was estimated as per Raghuramalu *et al.* (1980); Iron, zinc and copper using atomic absorption spectrophotometer as per the method of Lindsay

and Norwell (1978). Dietary fibre was analyzed using Asp *et al.* (1983). Carbohydrate was calculated by difference method. Energy value was computed using Atwater factors and values of protein, fat and carbohydrate. Vitamins and amino acids were computed by Annapurna software. *In vitro* protein and starch digestibilities were estimated using suitable enzymatic method described by Mouliswar *et al.* (1993).

To test the keeping quality of formulated *Laddu* and *Thepla* mixes, each of the mixes were packed in low density polyethylene pouches, heat sealed and stored at ambient temperature for a period of six months. The samples were drawn fortnightly for evaluation of quality in terms of sensory and biochemical parameters *viz.*, moisture and free fatty acid (FFA).

## RESEARCH FINDINGS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

### Organoleptic evaluation of protein and energy dense multigrain mixes:

*Laddu* mix with variations of addition of 5 g of roasted edible gum and 5 g of roasted groundnut pieces were tried. Plain mix without any addition was used for comparison. Table 1 reveals that although all the three variations were accepted with overall acceptability of 7.1, 7.4 and 8.1, *Laddu* incorporated with 5 g of roasted groundnut pieces received significantly higher scores (between 8 and 9) with good flavour, colour and appearance, whereas *Laddu* with roasted edible gum was very good (between 7 and 8) and plain *Laddu* was good (between 5 and 6). The selected *Laddu* mix consisted of three cereals (20 % *ragi*, 20 % rice and 20 % wheat), two pulses (15 % greengram dal and 15 % soybean) and an oilseed (5 % ground nut). This flour mix was incorporated with 5 per cent each of roasted groundnut pieces and garden cress seeds. *Laddu* was prepared from the mix

Table 1: Mean sensory scores for *laddu* and *thepla*

Variations	Colour and appearance	Texture	Taste	Aroma	Overall acceptability	Acceptability index
<i>Laddu</i>						
Plain	7.00	7.30	7.20	6.70	7.10	78.44
Gum	7.20	7.10	7.30	7.30	7.40	80.66
Groundnut	8.10	8.00	8.20	8.10	8.10	90.00
Mean	7.43	7.47	7.57	7.37	7.53	-
F value	5.61**	3.54*	4.24*	5.30*	3.90*	-
SEM	0.25	0.25	0.27	0.30	0.26	-
CD	0.72	0.73	0.78	0.88	0.75	-
<i>Thepla</i>						
Carrot <i>thepla</i>	8.10	7.80	8.10	8.00	8.00	88.88

\* and \*\* indicate significance of values at P=0.05 and 0.01, respectively

with 75 per cent jaggery.

To the *Thepla* mix, carrot shreds, spices like salt (5g), red chilli powder (5g), gingelly seeds (5g), turmeric (2.5g) and cumin powder (2.5g) were added. *Thepla* with dried carrot shreds was acceptable with a overall acceptability score of 8.0. Several scientists prepared supplementary foods with multiple ingredients (Salve *et al.*, 2011) with roasted flours of wheat, soybean and chickpea flour (Gahlawat and Sehgal, 1993), with wheat, barley, green gram and jaggery using household technologies like roasting and malting).

#### Acceptability by target group and stake holders:

*Laddu* and *Thepla* were evaluated by pre-school children, *Anganwadi* staff, primary health care staff and mothers (Table 2). Hundred per cent of consumers liked *Laddu* incorporated with roasted groundnut pieces and *Thepla* incorporated with carrot.

Products	Like	Dislike	Neutral
<b>Beneficiaries (n=200)</b>			
<i>Laddu</i>	200 (100.00)	-	-
<i>Thepla</i>	200 (100.00)	-	-
<b>Anganwadi staff (n=30)</b>			
<i>Laddu</i>	30 (100.00)	-	-
<i>Thepla</i>	30 (100.00)	-	-
<b>Primary health care staff (n=10)</b>			
<i>Laddu</i>	10 (100.00)	-	-
<i>Thepla</i>	10 (100.00)	-	-
<b>Mothers (n=200)</b>			
<i>Laddu</i>	200 (100.00)	-	-
<i>Thepla</i>	200 (100.00)	-	-

Figures in the parenthesis indicates percentage

#### Nutrient composition of protein and energy dense multigrain mix flour:

Composition of proximates, minerals and vitamins of the formulated mixes is presented in Table 3. *Laddu* mix possessed significantly higher amounts of crude protein (18.54%) while *Thepla* mix contained significantly higher amounts of ash (6.57%). However, there was no significant difference in moisture, crude fat, fibre, carbohydrate content and energy values of both *Laddu* (3.60%, 8.55%, 3.88%, 61.85% and 399 Kcal, respectively) and *Thepla* mix (3.70%, 8.37%, 4.06%, 60.53% and 385Kcal, respectively) as indicated by Student 't' test. The proximate composition of formulated food meets the BIS specifications for cereal based complementary foods. Significant difference was observed in crude protein and ash content in the mixes was probably due to variations in the composition of mixes.

The amounts of calcium (250 mg) and phosphorus (483.5 mg) were significantly higher in *Thepla* mix compared to *Laddu* mix (135 and 418 mg), probably due to addition of gingelly seeds. Iron (11.80 mg) and zinc (2.16 mg) contents were higher in *Laddu* mix compared to *Thepla* mix (9.75 and 1.83 mg), while copper (2.36 mg) and manganese (4.39 mg) were higher in *Thepla* mix. However, this difference was not statistically significant.

Computed values of the vitamin content of *Laddu* and *Thepla* mix are presented in Table 3. Garden cress seed incorporated *Laddu* mix contained lower total carotenes (98 mcg), while carrot shreds incorporated *Thepla* mix contained higher amount of total carotene (689 mcg) as carrot is good source of carotenoids. Both the mixes contained 0.5-0.6 mg of thiamin, 0.2 mg of riboflavin, 4.7-4.93 mg of niacin and 48.9-59.3 mcg of folic acid.

Table 3 : Proximate, mineral and vitamin composition of protein and energy dense multigrain mix flour

Nutrients	<i>Laddu</i> mix	<i>Thepla</i> mix	t-value	BIS Standards #
<b>Proximate (%)</b>				
Moisture	3.60	3.70	1.62 <sup>NS</sup>	10.00 (max)
Crude protein	18.54	16.77	13.51*	14.00 (min)
Crude fat	8.55	8.37	1.02 <sup>NS</sup>	7.50 (max)
Ash	3.31	6.57	9.36*	5.00 (max)
Crude fibre	3.88	4.06	1.98 <sup>NS</sup>	5.00 (max)
Carbohydrate	61.85	60.53	0.86 <sup>NS</sup>	45.00 (min)
Energy value (kcal)	399	385	2.27 <sup>NS</sup>	-
<b>Minerals (mg/100g)</b>				
Calcium	135	250	5.21*	-
Phosphorus	418	483.5	4.50*	-
Iron	11.80	9.75	3.14 <sup>NS</sup>	-
Zinc	2.16	1.83	2.78 <sup>NS</sup>	-
Copper	2.32	2.36	0.13 <sup>NS</sup>	-
Manganese	3.98	4.39	0.66 <sup>NS</sup>	-
<b>Vitamins \$</b>				
Carotene (mcg)	98	689	-	-
Vitamin A	24.5	172.3	-	-
Vitamin B1 (mg)	0.5	0.6	-	-
Vitamin B2 (mg)	0.2	0.2	-	-
Niacin (mg)	4.93	4.7	-	-
Vitamin B6 (mg)	0.1	0.1	-	-
Folic acid (mcg)	48.9	59.3	-	-
Vitamin C (mg)	-	1.0	-	-
Choline (mg)	38	101.0	-	-

# BIS Guidelines (2006) for cereal based complementary foods

\$ Computed values, NS= Non- significant,

\* indicate significance of value at P=0.01

**Dietary fibre:**

The total dietary fibre content of both *Laddu* and *Thepla* mix was 9.96 per cent of which the soluble fibre content of *Laddu* mix was 8.40 per cent and the insoluble fibre content was 1.56 per cent and that of *Thepla* mix was 8.5 and 1.46 per cent, respectively (Fig. 1). The dietary fibre fractions of all weaning foods were comparatively low due to the incorporation of de-hulled legumes (Ghasemzadeh and Ghavide, 2011) and removal of bran portion by sieving.

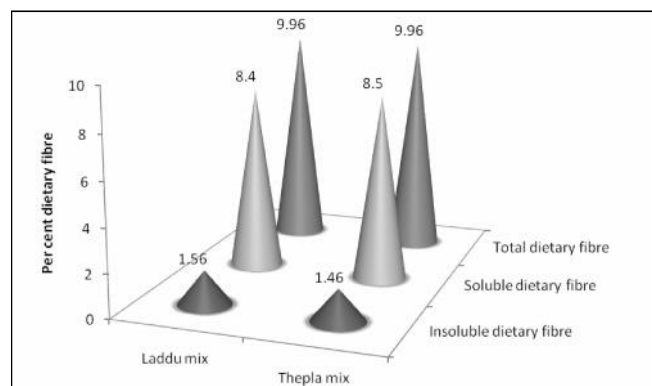


Fig. 1 : Dietary fibre content of protein and energy dense *Laddu* and *Thepla* mix

**In vitro protein digestibility (IVPD) of *Laddu* and *Thepla* mix:**

*In vitro* protein digestibility (IVPD) of the *Laddu* and *Thepla* mixes are shown in Fig. 2 which were found to be 63 and 61.4 per cent, respectively. This difference was statistically not significant. Protein quality is a measure of the efficiency of utilization of proteins by the body which depends on the amino acid composition, digestibility of the proteins and the biological availability of its amino acids for the synthesis of tissue proteins (Ikujenlola and Fashakin, 2005).

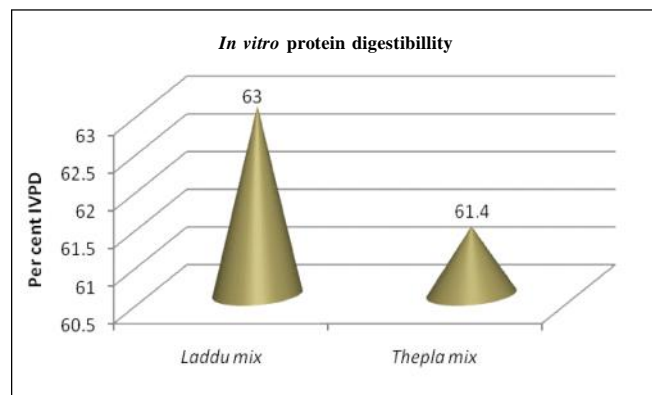


Fig. 2 : *In vitro* protein digestibility of *Laddu* and *Thepla* mix

***In vitro* starch digestibility (IVSD) of *Laddu* and *Thepla* mix:**

*In vitro* starch digestibility (IVSD) of the formulated

mixes at different hours (Table 4) did not differ significantly as indicated by student 't' test. Mean IVSD was 91.53 mg of glucose for every 100 g of *Laddu* mix and 88.10 mg for *Thepla* mix. At 30, 60, 90 and 120 mins the IVSD of *Laddu* mix was 62.10, 81.25, 106.89 and 115.87 mg/g while that of *Thepla* mix was 60, 81.13, 105.63 and 105.63 mg/g, respectively. As the time of digestibility progressed, starch digestibility also enhanced.

Table 4: *In vitro* starch digestibility (IVSD) of *laddu* and *thepla* mix

Mix	IVSD (mg glucose / 100 g)				Mean
	30 min	60 min	90 min	120 min	
<i>Laddu</i>	62.10	81.25	106.89	115.87	91.53
<i>Thepla</i>	60.00	81.13	105.63	105.63	88.10
t-value	2.10 <sup>NS</sup>	2.29 <sup>NS</sup>	4.83 <sup>NS</sup>	3.31 <sup>NS</sup>	

NS= Non- significant of value

**Storage quality of developed mixes:**

Storage quality of any food is an important aspect of utilization by consumers. A product with excellent storage quality besides retaining its sensory profile is a boon for entrepreneurs also.

**Effect of storage on sensory parameters of formulated mixes:**

Visual observation of *Laddu* and *Thepla* mix revealed no insect or mould infestation in the unit packages even up to six months of storage. Storage had a significant effect on all the sensory parameters at the end of 180 days of storage and between the mixes there was significant difference (Fig. 3). Sensory scores for *Laddu* mix decreased from extremely good (between 8 and 9) to moderately good (between 6 and 7) whereas that of *Thepla* mix decreased from extremely good (between 8 and 9) to very good (between 7 and 8). Overall acceptability of *Laddu* mix ranged from 8.40 (zero day) to 6.73 (180 days) while that of *Thepla* mix ranged from 8.53 (zero day) to 7.73 (180 days) of storage. Though storage had a significant effect on the overall acceptability of both products, the scores were within acceptable range. The biochemical changes which undergo during storage *viz.*, moisture and FFA might be responsible for this reduction.

**Effect of storage on moisture and free fatty acid content:**

As the storage period progressed, a steady increase in moisture was observed in both the mixes (Fig. 4). Surprisingly initial increase in moisture was only two per cent in *Laddu* mix and 3.14 per cent in *Thepla* mix which augmented to 30.50 and 24.5 per cent at the end of 180 days of storage. The increase in moisture between the mixes and days of storage was statistically significant. Itagi *et al.* (2011) also reported an increase in moisture content in *Halwa* mixes prepared from cereals, millets, legumes, nuts and condiments from 4 to 32 per cent after 180 days of

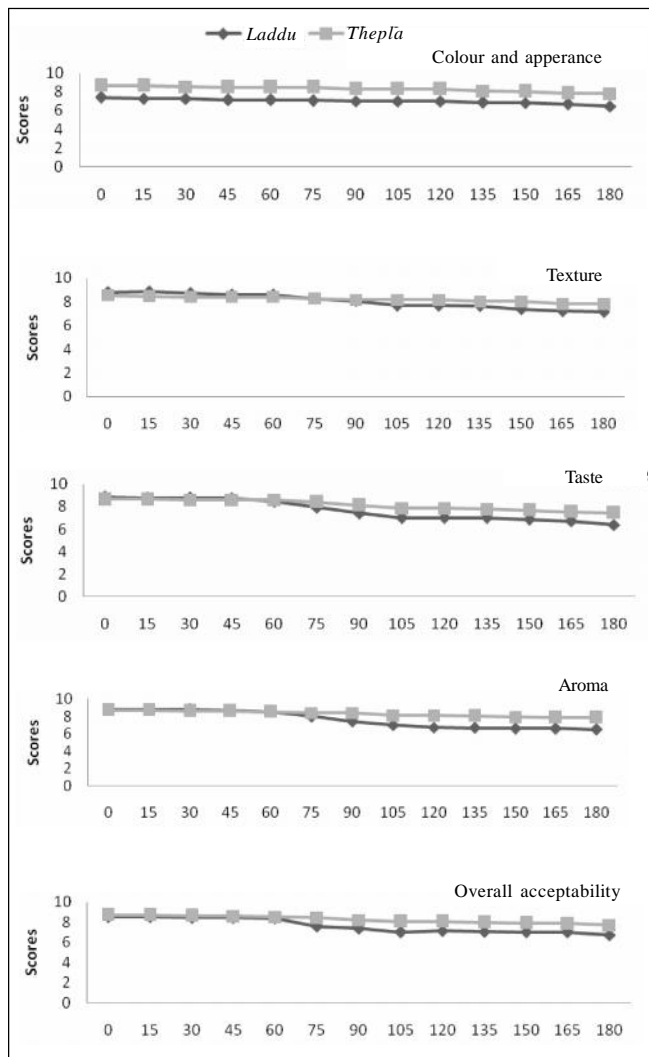


Fig. 3 : *In vitro* protein digestibility of Laddu and Thepla mix

storage in low density polyethylene package. The package used was reported to support exchange of gases resulting in leaching of atmospheric humidity into the products (Radha, 2005).

The FFA content of Laddu mix increased from 0.39 to 3.05 per cent of oleic acid and Thepla mix from 0.30 to 1.93 per cent of oleic acid from zero to 180 days of storage. A perusal of Fig. 4 indicates that, the per cent increase in FFA in Laddu mix was higher (from 25 to 87.21%) compared to Thepla mix (from 22.45 to 80.31%), however, the mixes were acceptable after 180 days of storage. As Laddu mix contained additional five per cent of roasted groundnut pieces that had led to an increase in FFA. Lowered increase observed in Thepla mix might be due to the inclusion of spices. Similar result was observed in Itagi *et al.* (2011) study. Free fatty acids are results of secondary degradation of flours, of hydroperoxides or due to hydrolysis of triglycerides during storage (Thakur and Arya, 1990).

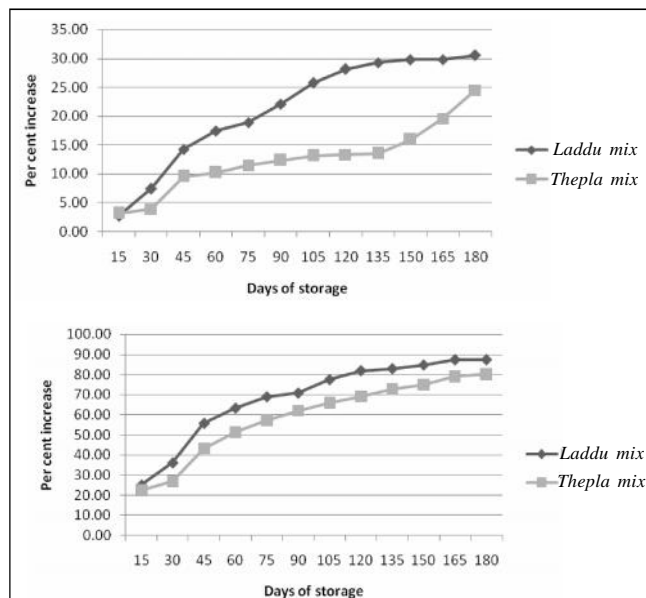


Fig. 4 : Per cent increase in moisture and free fatty acid content of Laddu and Thepla mix on storage

### Conclusion:

The multigrain mix formulated in the present study was based on locally available low cost food materials that can also be affordable by people of low economic status. The developed mix has promising nutritional attributes. They contain reasonable quantities of most nutrients, significantly increased levels of protein, iron, calcium and vitamins, in accordance with BIS standards. Multigrain mix can be stored for a period of six months with better sensory scores. The processing techniques are affordable at the household level. Hence, such foods can be promoted for improving the health and nutritional status of children, thereby preventing the occurrence of PEM and episodes of morbidity.

### Authors' affiliations:

**SHILPA GUDDAD**, Department of Food Science and Nutrition, College of Rural Home Science, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA  
(Email: guddadshilpa@gmail.com)

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