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Acceptability and viscosity of low cost home processed supplementary foods developed for preschool children

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Abstract. Four supplement mixtures using whole wheat, pearl millet, bengal gram, green gram, groundnuts and amaranth leaves were developed employing roasting and malting techniques. Malting used in the formation of the supplements reduced significantly hot paste viscosity of all the four supplements and increased their nutrient density per unit volume. The organoleptic trials conducted on rural mothers revealed that taste, texture, colour, aroma, appearance and overall acceptability of all the four supplements were found to be excellent with mean overall acceptability. Children did not develop any GIT disorders after consuming the products. Trained panelists found all the four supplements acceptable as indicated by a nine point hedonic scale.

Introduction

Although breast feeding is beneficial for the optimum growth of the children, prolonged breast feeding without appropriate complementary feeding is crucial contributory factor for malnutrition among young children. Therefore, supplementation has to be instituted after four to six months to overcome malnutrition and related complications due to infection. Although a number of commercial formulae which provide a balanced weaning foods are available in the market, these are too expensive and are not within the reach of the poor. Hence, development of weaning and supplementary food based on inexpensive locally available cereals and pulses has been one of the strategies suggested to combat PEM among children of low socio-economic group. Traditional processing methods need to be practiced for such foods as they have the potential of being easily adoptable at home or village level [1].

Malted mixes have been found to be superior with respect to protein digestibility and mineral bioavailability and are far less viscous in hot paste slurry solutions making the food more nutrient densed [2]. The development and processing of the newly evolved supplements demand their acceptability and ensure products of good keeping quality so as to promote good growth among children on supplementation.

This paper reports the development of blends of cereal, pulse and nuts using simple domestic methods of processing and an attempt made to study their acceptability on rural preschool children.

Materials and methods

Development of supplementary foods. The concept of multimixes and four food square system [3] was adopted for selecting the staple, protein and energy supplement. A number of permutations and combinations with the locally grown and commonly consumed food stuffs of Haryana were calculated for protein content, essential amino acid profile and chemical score. Four were selected for the present study.

Materials. Among pulses, bengal gram and green gram were used as protein supplements to the staple foods. Groundnut was also included as it is a rich source of energy and protein and is locally available in rural areas of Haryana. Jaggery was added to increase the energy density of the supplements and also to provide iron. Amaranth leaves (*Amaranthus gangeticus*) were included because of its advantage of providing minerals.

The grains of wheat (WH-283), bajra (CJ-104), green gram (K-851), bengal gram (G-130) were obtained from the Directorate of Farms, Haryana Agricultural University, Hisar in a single lot. Jaggery, groundnuts and amaranth leaves were produced in single lots from local market of Hisar. The grains were cleaned for dust and other extraneous materials and stored at room temperature in plastic containers.

Based on the fact that essential amino acid contents of the supplements should be similar to that of egg protein (Standard reference protein source) and the supplements satisfy fully the young child supplementary feeding guidelines of providing at least, one-third of recommended dietary allowances of nutrients, the proportions of adding cereal, pulse and oilseeds in the ratio of 4:1:1 were decided for the development of supplements.

The following four home processed supplements were developed in the nutrition laboratory.

Supplement I: Roasted wheat, malted bengal gram, roasted groundnuts, dried amaranth leaves and jaggery

Supplement II: Roasted wheat, malted green gram, roasted groundnuts, dried amaranth and jaggery

Supplement III: Roasted bajra, malted bengal gram, roasted groundnuts, dried amaranth and jaggery

Supplement IV: Roasted bajra, malted green gram, roasted groundnuts, dried amaranth and jaggery

Processing methods. Simple home scale processing methods were used in the preparation of supplements so that mothers could easily follow these tech-

niques at household level. Roasting and malting of the grains (traditional methods commonly employed in rural families) were employed in processing different ingredients. Roasting was used as it reduces significantly most of the antinutrients and improves the taste, flavour and nutritional quality of the products [3, 4]. Malting was practised with a view that it increases the digestibility, lowers the paste viscosity and increases the nutrient density [5]. The following main steps in the malting process were involved: (1) Steeping, (2) Germination, (3) Roasting, and (4) Milling.

Steeping. Cleaned and picked grains of bengal gram and green gram were steeped in double amount of water at ambient temperature (25–30 °C) and relative humidity (70%) for 12 hours.

Germination. The soaked pulses were wrapped in damp muslin cloth to stimulate germination. The bengal gram seeds were allowed to sprout for 48 hours and green gram for 24 hours. The sprouts were dried overnight at room temperature by keeping under a fan.

Roasting. Sprouted pulses were roasted in oven at 70 °C for two hours each to develop characteristic malt aroma. Wheat, bajra and groundnuts were separately roasted in oven at 70 °C for 2, 1 and 2 hours, respectively.

Drying. Amaranth leaves were cleaned, washed, sundried and finally powdered.

Milling. The malted and roasted ingredients except jaggery were milled in grinding machine separately according to the supplement composition.

Blending. The milled product and powdered jaggery were blended thoroughly. Composition and cost per serving of each product is given in Table 1.

Physico-chemical properties. Physico-chemical parameters such as density, viscosity, etc. are important parameters which ultimately play an important role in the behaviour for cooking and processing. The developed supplements were analysed for density and viscosity in particular.

Density and viscosity. Density and viscosity of supplements were determined by Viscometer [6]. Gruels for viscosity measurements were prepared by measuring out the required amount (2 g) of the supplement. Water was added to make up the volume to 100 ml in a beaker. The slurry was heated in a boiling water bath till maximum gelatinization of supplement mixtures took place. The gruel was cooled to room temperature and triplicate readings in centipoise units (cps) were taken in viscometer.

Acceptability trials. Two sets of criteria were used to determine the acceptability of the supplements. The criteria recommended by ICMR [7] was followed for judging the acceptability of the supplements which is as follows:

1. *Liking by mothers*: The mothers liked the taste, colour and texture. This was judged by using score card method.

Table 1. Composition and cost of developed supplements

Ingredients	Amount (g)	Cost (paise)	Processing method
Supplement I			
Whole wheat	40	11	Roasting
Bengal gram	10	8	Malting
Groundnuts	10	19	Roasting
Amaranth leaves	10	4	Sun drying
Jaggery	40	26	
Total (per day intake)	110	68	
Supplement II			
Whole wheat	40	11	Roasting
Green gram	10	12	Malting
Groundnuts	10	19	Roasting
Amaranth leaves	10	4	Sun drying
Jaggery	40	26	
Total (per day intake)	110	72	
Supplement III			
Whole bajra	40	9	Roasting
Bengal gram	10	9	Malting
Groundnuts	10	19	Roasting
Amaranth leaves	10	4	Sun drying
Jaggery	40	26	
Total (per day intake)	110	67	
Supplement IV			
Whole bajra	40	9	Roasting
Green gram	10	12	Malting
Groundnuts	10	19	Roasting
Amaranth leaves	10	4	Sun drying
Jaggery	40	26	
Total (per day intake)	110	70	

2. *Sample preparation*: The method of preparing the supplements was simple and did not take more than 15 min.
3. *Storability*: The supplements kept well at least 12 hours after preparation without any deleterious effect on taste and they did not develop any off-flavour.

Acceptability trials among preschool children was assessed using the following creteria.

1. The percentage of children who refuse the supplement should not exceed 25.
2. The child should be able to consume the supplement in amount which would provide about 300 kcal and 8–9 g protein, this being the extent of

calorie deficit in their diets. This amount should be consumed in addition to their intake of home's diet.

3. The child should not develop any side effects like diarrhoea and vomitting after consuming the preparation.

Organoleptic evaluation. The 4 supplement mixtures were subjected to sensory evaluation by a trained ten member panel of teaching staff of Department of Foods and Nutrition. The fresh and stored supplements drawn at an interval of 10 days were evaluated for colour, appearance, aroma, texture, taste and overall acceptability. Samples stored in all containers for different periods along with fresh samples were served at a time. The judges were instructed to sip water before and after testing each product. The judges recorded quality characteristics of each sample on the nine-point Hedonic Rating Scale, for like extremely (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2), and dislike extremely (1). The characteristics with mean score obtained by different products for different periods were calculated and statistically analysed. The characteristics with mean scores of 5 or more were considered acceptable.

Statistical analysis. The data thus obtained were subjected to statistical analysis for analysis of variance in a completely randomized design using standard methods [8].

Results and discussion

The compositional analysis and cost per serving of each developed supplement is given in Table 1.

The viscosity of unprocessed supplements was the highest (3.50 cps) in supplement I and the lowest (3.35 cps) in supplement IV (Table 2). There were significant differences in viscosity between unprocessed wheat based and bajra (pearl millet) based supplements. However, the supplements based upon same type of raw ingredients (I, II, III and IV) did not differ significantly among themselves. The viscosity of processed supplements based on wheat was significantly ($p<0.05$) higher than that of bajra based supplements. All the malted and roasted processed supplements had significantly ($p<0.05$) lower viscosity as compared to their raw unmalted counterparts. The percent reduction in viscosity after processing ranged from 8.69 to 11.17 being the highest reduction in bajra based supplement III and the lowest in wheat based supplement (II). The highest reduction in viscosity observed in supplement III might be due to the addition of malted bengal gram flour in that supplement.

The density also decreased on processing but the effect was opposite to that of viscocity (Table 2). The results of the present study are in close agreement with those reported by earlier workers [9] who also observed significant

Table 2. Effect of processing (roasting and malting) on viscosity and density measurement of supplements

Supplements	Viscosity (cps units) (Conc. of gruel in 2 per cent slurry)			Density (g/ml)		
	Raw (unprocessed)	Developed (processed)	Decrease (%)	Raw (unprocessed)	Developed (processed)	Decrease (%)
I	3.50 ± 0.06	3.15 ± 0.04	10.00	0.75 ± 0.01	0.68 ± 0.02	9.33
II	3.45 ± 0.05	3.15 ± 0.03	8.69	0.73 ± 0.02	0.70 ± 0.03	10.25
III	3.40 ± 0.06	3.02 ± 0.02	11.17	0.78 ± 0.00	0.71 ± 0.01	8.97
IV	3.35 ± 0.03	3.05 ± 0.05	8.75	0.80 ± 0.02	0.72 ± 0.01	10.00

	Viscosity	Density
Raw	SE(m) 0.02 ($p<0.05$) 0.07	SE(m) 0.006 ($p<0.05$) 0.02
Developed	SE(m) 0.03 ($p<0.05$) 0.09	SE(m) 0.006 ($p<0.05$) 0.02
Raw × Developed	SE(m) 0.08 ($p<0.05$) 0.25	SE(m) 0.006 ($p<0.05$) 0.02

Values are mean ±SD of three independent determinations.

reduction in the paste viscosity of roller dried weaning foods on addition of barley malt flour. Malting has also been used in the formulation of supplements of low hot paste viscosity [9].

Organoleptic evaluation

All the developed supplements were evaluated for organoleptic characteristics by twenty rural women of village Gavar, District Hisar.

Organoleptic characteristics, taste, texture, aroma, colour, overall acceptability were expressed with scores 10, 8, 6, 4, 2 for excellent, good, very fair, fair and poor, respectively according to the criteria given by ICMR [10]. The mean scores for colour, appearance and texture for all the supplements did not differ significantly among themselves. However, the mean scores of aroma of supplement III and IV was significantly lower than that of supplement I. The mean scores of taste and overall acceptability for supplement I were significantly higher than that of supplement IV but non significantly higher than that of supplement II and III (Table 3).

Wheat based supplements I and II did not differ significantly in all the organoleptic characteristics. Same trends, were observed in case of bajra based supplements III and IV.

Supplement III differed significantly ($p < 0.05$) from supplement I in aroma, but did not differ significantly from supplement I and II in texture, taste and overall acceptability. Similarly, supplement IV differed significantly ($p < 0.05$) from supplement I and II with respect to aroma, texture and overall acceptability but differed non-significantly with supplement III in aroma, texture, taste and overall acceptability. All the supplements were acceptable to rural women with a higher preference for supplement I followed by supplement II, III and IV.

Acceptability trial on children revealed that out of twenty children only three refused to take the supplement. All the children liked the taste and enjoyed a sufficient amount. None of the children liked the taste and enjoyed a sufficient amount. None of the children developed any side effect like diarrhoea and vomiting after consuming the preparation.

The rural women preferred supplements containing wheat to the supplements having bajra. Roasted bengal gram gave better taste and flavour than roasted green gram. So, the supplements containing bengal gram were preferred to that of having green gram.

This shows that in spite of slight variations in taste, aroma and overall acceptability, all the supplements were liked by children and rural mothers. Also, method of preparing the feed was simple and did not take more than 15 minutes. Children relished the supplements prepared from local foods (bengal gram, groundnut and jaggery) more than corn soya milk (CSM) because supplements were fresh [11].

All the four supplements were also evaluated by trained panelists of Department of Foods and Nutrition. The score for colour and appearance of

Table 3. Mean scores of organoleptic characteristics of fresh supplements by rural women

Supplements	Organoleptic characteristics					
	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
I	9.55 ± 0.52	9.50 ± 0.51	9.64 ± 0.21	9.73 ± 0.63	9.68 ± 0.40	9.77 ± 0.18
II	9.24 ± 0.48	9.46 ± 0.42	9.20 ± 0.18	8.80 ± 0.58	9.06 ± 0.35	9.33 ± 0.25
III	9.33 ± 0.61	9.37 ± 0.48	8.62 ± 0.25	8.33 ± 0.57	8.73 ± 0.32	9.11 ± 0.32
IV	8.53 ± 0.37	8.31 ± 0.40	8.75 ± 0.20	7.91 ± 0.60	8.04 ± 0.45	8.75 ± 0.12
SE(m)	0.35	0.45	0.22	0.60	0.37	0.23
CD($p<0.05$)	1.08	1.36	0.69	1.82	1.10	0.70

Values are mean of sixty scores.

Table 4. Mean scores of organoleptic characteristics of fresh supplements

Supplements	Organoleptic characteristics					
	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
I	7.4 ± 0.58	7.3 ± 0.30	7.0 ± 1.00	7.0 ± 0.86	7.2 ± 0.76	7.2 ± 0.76
II	7.2 ± 0.61	7.2 ± 0.29	6.8 ± 0.76	6.9 ± 0.79	7.0 ± 0.78	7.0 ± 1.00
III	7.1 ± 0.57	7.1 ± 0.63	6.6 ± 0.21	7.1 ± 1.12	6.9 ± 0.92	7.0 ± 0.94
IV	7.0 ± 0.63	7.0 ± 0.48	6.5 ± 0.98	7.0 ± 0.87	6.7 ± 0.65	6.8 ± 0.86
SE(m)	0.40	0.52	0.42	0.48	0.50	0.49
CD($p<0.05$)	1.20	1.57	1.26	1.46	1.55	1.50

Values are mean scores of ten panelists.

supplement I, II, III and IV were almost the same (Table 4). Aroma, texture and taste were liked moderately. All the supplements were overall acceptable. Mean scores of all the four supplements for the organoleptic characteristics showed non-significant differences among themselves. This shows that in spite of different cereals and pulses added to the supplement mixtures, all the fresh supplements were liked by trained panelists.

Effect of storage on organoleptic charcteristics

On storing the supplements, it was found that all the supplements stored in plastic containers had a non-significant variation in colour and appearance up to 30 days (Table 5). The mean scores for colour, appearance and texture of stored supplements were similar to that of the fresh supplements, except supplement III, for which mean score for texture differed significantly from fresh on day 30 of storage. Mean scores of supplements I and III for aroma differed significantly till day 30 of storage. Mean scores for taste of supplements I and II were close to fresh supplements and differed non-significantly in all periods of storage but in case of supplements III and IV, on day 20 and day 30 of storage, significant differences ($p<0.05$) in taste of the supplements were observed. On day 30, the taste of the supplements III and IV was found to be slightly bitter. Therefore, mean scores for taste were the lowest in supplement III and IV and varied significantly ($p<0.05$) from supplement I and II on day 20 and day 30 of storage.

The reason for lower score for taste and aroma in bajra supplements (III and IV) than wheat supplements may be that bajra contains more fat which might have undergone oxidation. Fat rancidity during storage could have caused change in the taste of the bajra based supplements. Non-significant differences in overall acceptability of supplements I, II and III were observed on all periods of storage. However, supplement IV showed significant ($p<0.05$) differences in overall acceptability on day 30 of storage. The mean scores for overall acceptability of supplement IV were significantly ($p<0.05$) lower than those of supplements I, II and III.

Thus, it may be concluded that organoleptic characteristics of all the supplements were not affected till one month of storage. Supplement IV was exception which showed a change in taste on day 30. A weaning food based on wheat, bengal gram: groundnut (WBG) formulation was satisfactorily acceptable to mothers [12]. They preferred malted multimix for taste and arome over roasted mixes. Young children had significantly higher intake of malted multimix over roasted ones. Weaning mixture prepared from wheat, green gram, groundnut, jaggery was also found to be acceptable by mothers and children and did not cause any gastro-intestinal disorders [13]. Acceptability of malted ragi mixtures and mothers' opinion about the daily supplement provided to children was studied by another worker [14]. They also reported that malted mixtures were quite acceptable to mothers and children.

Table 5. Mean scores of organoleptic characteristics of supplements as affected by storage period

	Colour				Appearance				Aroma				Texture				Taste				Overall acceptability			
	0	10	20	30	0	10	20	30	0	10	20	30	0	10	20	30	0	10	20	30	0	10	20	30
	7.4	7.4	7.3	7.2	7.3	7.3	7.2	7.1	7.0	7.0	6.8	6.8	7.0	7.0	7.0	6.9	7.2	7.1	7.1	7.1	7.2	7.3	7.3	7.2
	7.2	7.2	7.1	7.1	7.2	7.2	7.1	7.1	6.8	6.7	6.6	6.5	6.9	7.0	6.9	6.8	7.0	7.1	7.0	6.9	7.0	7.0	6.9	7.1
	7.1	7.1	7.0	7.0	7.1	6.9	7.0	6.7	6.6	6.3	6.4	6.3	7.1	7.0	7.0	6.9	6.9	6.7	6.3	6.1	7.0	6.9	6.5	6.2
	7.0	7.1	6.9	7.0	7.0	6.9	7.0	7.0	6.5	6.5	6.3	5.9	7.0	7.0	6.9	6.9	6.7	6.6	6.2	6.0	6.8	6.7	6.5	6.0
Supplement	SE(m)			0.37	0.30				0.28				0.10				0.14				0.20			
	CD($p<0.05$)			NS	NS				NS				NS				0.42				0.80			
Period	SE(m)			0.15	0.14				0.31				0.16				0.24				0.31			
	CD($p<0.05$)			NS	NS				NS				NS				0.72				NS			
Supplement	SE(m)			0.16	0.17				0.16				0.06				0.16				0.33			
× period	CD($p<0.05$)			0.48	0.52				0.50				0.18				0.48				1.10			

Values are mean scores of ten panelists.

Conclusion

The present study was conducted to develop supplementary foods from locally available food stuffs and to investigate its acceptability and viscosity.

Low cost supplement mixtures were prepared by mixing (1) roasted wheat, malted bengal gram, roasted groundnuts and dried amaranth leaves, (2) roasted wheat, malted green gram, roasted groundnuts, dried amaranth, (3) roasted pearl millet, malted bengal gram, roasted groundnuts, and dried amaranth leaves, and (4) roasted pearl millet, malted green gram, roasted groundnuts and dried amaranth leaves. Jaggery (40%) was added in all the preparations. The ingredients were mixed in the proportion of 4:1:1:1.

Overall, all the supplements were acceptable. Mean scores of all the four supplements for the organoleptic characteristics showed non-significant differences among themselves. Organoleptic characteristics of all the supplements were not affected till one month of storage. All the supplements were acceptable to trained panelists, Anganwadi children and rural mothers. None of the children developed any GIT disorders after consuming the supplements.

Thus, it can be concluded that developed supplements were nutritious, least expensive, and well acceptable, and tolerable to young children and rural mothers. These supplements can be prepared easily at home by rural mothers in bulk from locally available foods using simple domestic methods. Thus, nutritional status of young children can be improved if children are fed these nutritious supplements in their home diets.

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