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Nutritional evaluation of home-processed weaning foods based on low cost locally available foods

Saroj Dahiya & Amin C. Kapoor*

Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar — 125 004, India

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Four supplements were developed from locally available least expensive food items, using home-processing methods of roasting and malting. The supplement mixtures developed were: (i) roasted wheat, malted bengal gram, roasted groundnuts, jaggery and dried amaranth leaves, (ii) roasted wheat, malted green gram, roasted groundnuts, jaggery and dried amaranth leaves, (iii) roasted pearl millet, malted bengal gram, roasted groundnuts, jaggery and dried amaranth leaves, and (iv) roasted pearl millet, malted green gram, roasted groundnuts, jaggery and dried amaranth leaves. The ingredients were mixed in the ratio of 4:1:1:4:1 in all the four formulae. Nutritional evaluation of the developed supplements indicated that moisture, protein, energy, ash, fibre, iron and calcium contents of all the developed supplements were within the ranges prescribed by the Indian Standard Institute for processed weaning foods and could meet, satisfactorily, one third of the RDA (Recommended Dietary Allowances) of these nutrients per day for children of 1 to 3 years of age.

INTRODUCTION

Since commercial preparations are expensive there is a need to develop weaning foods from low cost local foods by methods suitable at village level or at home (Devadas *et al.*, 1984).

The present investigation was undertaken to develop low cost food formulations, using local foods to explore the feasibility of producing the supplementary foods using household technology and an attempt was made to evaluate them nutritionally.

MATERIALS AND METHODS

Development of supplementary foods

The concept of multimixes and a four food square system (PAG, 1977) was adopted for selecting the staple, protein and energy supplement. A number of permutations and combinations with the locally grown and commonly consumed foodstuffs of Haryana were theoretically calculated for protein content, essential amino acid profile and chemical score.

* To whom correspondence should be addressed.

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Materials

Four supplements using blends of cereals, pulse and oil seeds were formulated, taking into consideration cost, availability and acceptability. Wheat and bajra were selected as the staple foods which provide good amounts of energy. 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 iron content and energy density of the supplements. Amaranth leaves (*Amaranthus gangeticus*) were also added with the advantage of providing minerals.

The wheat grais (WH-283), bajra (CJ-104), green gram (K-851) and 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 procured in one lot from a local market of Hisar. The grains were cleaned from 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 that the supplements satisfy, fully, one-third of the recommended dietary allowances of nutrients for children of 1 to 3 years of age, cereals, pulses and oilseeds were mixed in ratios of

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	

4:1:1. This proportion was kept deliberately simple so that this technology could be easily transferred to the household or village level.

Supplements I and II were prepared by roasting of wheat and malting of pulses, and supplements III and IV by roasting of bajra and malting of pulses. The compositional analysis and cost of the supplements (per serving) is given in Table 1.

Processing methods

Roasting and malting of the grains were employed in the processing of different ingredients as these are the traditional methods commonly used in Indian rural families. Roasting was used as it significantly reduces most of the antinutrients and improves the taste, flavour and nutritional quality of the products (Khan *et al.*, 1988). Malting was practised because it increases the digestibility, lowers the paste viscosity and increases the nutrient density (Taragopaldas, 1988). The following steps were involved in the malting process.

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

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

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

Drying
Amaranth leaves were cleaned, washed, sun-dried and finally powdered.

Milling
The malted and roasted ingredients, except jaggery, were milled in a grinding machine, separately, according to the composition of the supplements.

Blending
The milled product and powdered jaggery were blended thoroughly.

Analytical methods

The fresh samples of supplements were analysed for moisture, total nitrogen, crude fibre, crude fat, ash, carbohydrates and calories by employing standard methods (AOAC, 1980). A factor of 6·25 was applied to convert N into crude protein. Calcium and iron (AOAC, 1982) and phosphorus (Fiske & Subba Rao, 1925) were determined, using standard methods.

Trace elements (zinc, copper and manganese) were estimated by the atomic absorption spectrophotometer AA-120 (Perkin Elmer Norwalk, CT, USA), according to the method of Lindsey & Norwell (1969).

Statistical analysis

The data thus obtained were subjected to analysis of variance in a completely randomized design, using standard methods (Snedecor & Cochran, 1967).

Cost of product

The cost of production of different food supplement mixtures was computed, according to the price of each ingredient in the local market, and was compared with the cost of commercial weaning food available in the market.

RESULTS AND DISCUSSION

Proximate analysis

The contents of moisture, crude fat, crude fibre and ash of bajra-based supplements (III and IV) were

Table 2. Chemical composition of developed supplements (g/100 g, on dry matter basis)

Supplements	Moisture	Protein	Crude fat	Crude fibre	Ash	Carbo-hydrates	Energy (kcal)
I	5·37 ± 0·20	12·5 ± 0·25	5·28 ± 0·25	1·26 ± 0·09	1·91 ± 0·06	73·7 ± 3·95	392 ± 4·75
II	5·51 ± 0·35	12·8 ± 0·30	5·08 ± 0·18	1·30 ± 0·15	2·00 ± 0·10	73·2 ± 2·10	390 ± 6·92
III	6·09 ± 0·28	11·7 ± 0·49	5·98 ± 0·30	1·51 ± 0·10	2·18 ± 0·08	72·9 ± 3·93	392 ± 2·82
IV	6·16 ± 0·18	11·8 ± 0·52	5·75 ± 0·42	1·61 ± 0·08	2·20 ± 0·12	72·5 ± 4·87	389 ± 3·61
Cerelac	2·50	15·5	9·00	1·40	2·70	68·9	419
SE (m)	0·18	0·30	0·21	0·06	0·05	2·00	3·37
CD ($P < 0·05$)	0·55	0·90	0·65	0·20	0·17	6·03	10·12

Values are mean (± SD) of three independent determinations.

significantly ($P < 0·05$) higher than those of wheat-based supplements (I and II). Supplements prepared from the same types of food items, i.e. I and II, and III and IV, did not differ significantly ($P < 0·05$) between themselves with respect to these parameters (Table 2).

On the other hand, the protein content of wheat-based supplements (I and II) was significantly ($P < 0·05$) higher than that of bajra-based supplements (III and IV) except in the case of the supplements I and IV.

Energy and carbohydrate contents of all the developed supplements were almost the same. Shulk *et al.* (1986) also reported 6·5% moisture and 19·4% protein in the developed soybean weaning mixtures. Chandrasekhar *et al.* (1988) developed mixtures from malted ragi and horse gram and roasted groundnuts, which also contributed 412 kcal energy and 13 g of protein.

All the supplements were found to meet one-third requirements of children for protein and calories. The values for moisture, crude fibre, crude fat and ash reported in the present study fall within the ranges prescribed by the Indian Standard Institute Prevention of Food Adulteration Act for processed foods. The recommended dietary intakes of nutrients for children of 1 to 3 years of age are 1220 kcal and 22 g of protein. Developed supplements of the present study provide 11·7 to 12·8 g of protein and 388 to 392 kcal and thus meet, satisfactorily, one-third of the requirements of these nutrients for children of 1 to 3 years of age.

Mineral composition

The calcium and phosphorus contents of developed supplements varied from 153 ± 6·3 mg to 184 ± 10·2 mg and 260 ± 10·2 to 295 ± 13 mg/100 g, respectively (Table 3). The wheat-based supplements (I and II) had significantly ($P < 0·05$) lower calcium, but significantly ($P < 0·05$) higher phosphorus contents than those of bajra-based supplements (III and IV). However, non-significant differences in calcium and phosphorus contents were observed between supplements I and II, and between supplements III and IV.

Iron contents of all four supplements varied from 16·5 ± 0·48 to 17·7 ± 0·55 mg/100 g, respectively. Bajra-based supplement (III) having the highest amount and wheat-based supplement (II) the lowest amount. The iron contents of wheat-based supplements were significantly ($P < 0·05$) lower than those of bajra-based supplements.

Shulk *et al.* (1986) reported 1·1% calcium and 14 mg of iron in 100 g of the developed weaning food Soylac. On the other hand, lower amounts of calcium (290 mg) and iron (7·6 mg) have been found in another mixture (Chandrasekhar *et al.*, 1988). Higher contents of iron in developed supplements in the present study may be due to the addition of jaggery.

Zinc and copper contents of all four supplements varied from 2·70 ± 0·01 to 2·80 ± 0·01 mg/100 g and from 0·75 ± 0·02 to 0·84 ± 0·01 mg/100 g, respectively (Table 3). Bajra-based supplements (III and IV) had significantly ($P < 0·05$) higher values for zinc and copper than wheat-based supplements (I and II). However, wheat- and bajra-based supplements (I and II, III and IV) did not differ significantly between themselves with regard to their zinc and copper contents.

Manganese content was found to vary from 2·37 ± 0·10 to 2·65 ± 0·07 mg/100 g. Bajra-containing supplements (III and IV) showed significantly ($P < 0·05$) higher values of manganese than those of wheat-containing

Table 3. Mineral composition of developed supplements (mg/100 g, on dry matter basis)

Supplements	Calcium	Phosphorus	Iron	Zinc	Copper	Manganese
I	162 ± 6·30	291 ± 9·50	16·7 ± 0·30	2·73 ± 0·01	0·77 ± 0·01	2·40 ± 0·08
II	153 ± 8·32	295 ± 12·95	16·5 ± 0·48	2·70 ± 0·00	0·75 ± 0·02	2·37 ± 0·10
III	175 ± 7·10	260 ± 10·20	17·7 ± 0·55	2·80 ± 0·01	0·84 ± 0·01	2·65 ± 0·07
IV	184 ± 10·18	264 ± 8·80	17·4 ± 0·62	2·76 ± 0·00	0·81 ± 0·02	2·60 ± 0·12
Cerelac	410	330	7·5	—	—	—
SE (m)	4·30	8·55	0·23	0·006	0·01	0·05
CD ($P < 0·05$)	13·04	25·75	0·70	0·02	0·03	0·18

Values are mean (± SD) of three independent determinations.

Table 4. Cost of the developed supplements and commercial formulae

Name of the product	Cost	
	Rs	P
Supplement I	0	68
Supplement II	0	72
Supplement III	0	67
Supplement IV	0	70
Cerelac	7	50
Farex	7	45
Amulspray	7	10
Lactogen	11	60
Sapan	5	2

Rs = rupees, P = paise (100 paise = 1 rupee).

supplements (I and II), but wheat-based supplements (I and II) did not differ significantly between themselves. Similarly, bajra-based supplements (III and IV) also did not differ significantly between themselves in their manganese contents. The differences in chemical composition of all developed supplements may be ascribed to their different compositional make up.

An attempt was made to compare the nutrient contribution made by the formulation with that of the most popular processed food (Cerelac) available in the market, and the values are given in Table 4. The moisture content was high in the developed formulations compared to the commercial foods. As far as the other parameters (energy, protein, fibre and ash) are concerned, they are equally good, and calcium and phosphorus contents of commercial foods are high due to enrichment and fortification. The comparative cost of the formulations developed, and the commercial weaning foods as purchased from the market, are given in Table 4.

It is evident from Table 4 that the processed foods are nearly five to six times costlier than the home-processed low cost formulations. A low income family cannot afford to buy the commercially processed foods and for such families low-cost formulations are helpful. This supports the case that home-processed supplementary foods based on local low cost foods can easily be adopted as they are culturally acceptable customary foods.

Thus, it may be concluded that the developed supplements were nutritious, inexpensive and can be prepared easily from locally available inexpensive food ingredients by rural mothers using simple domestic processing techniques. They can be incorporated in children's diet as good supplements for improving the nutritional status of low income group pre-school children.

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