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Formulation and quality evaluation of protein rich supplementary food

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Abstract
Protein rich supplementary foods were formulated from locally available foods such as wheat flour, soybean flour and chick pea flour using household technologies like blending and roasting. The proximate composition of product used for preparation of supplementary food fortified with 10% skimmed milk powder contained higher amount of protein and other nutrients. They contained proteins (16.2 to 21.1%), fat (1.9 to 4.5%), fiber (1.28 to 1.78%), ash (0.7 to 1.40%) and carbohydrates (67.66 to 77.2%). Also showed that soy flour / chickpea flour alone or in combination, both increased the amount of protein significantly. Soy flour fortification was considered the best because it is rich in protein with good product acceptability. The total energy expressed in terms of Kcal per 100 g of product varied from 350.7 to 395.8. The various minerals viz., calcium, phosphorus and iron were found to increase on supplementation 10% skimmed milk powder. Different kinds of products were made with and without fortification of 10% skimmed milk powder and subjected to sensory evaluation for various sensory attributes. The present investigation was carried out to formulate a product for poor people to fulfill their nutritional requirements at lower cost.

Keywords: protein rich, supplementary food, malnutrition, Nutritional quality, mineral value, sensory value

Introduction
Human childhood may be divided in to three stages Infancy, Weaning and Pre-school stage. 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 implemented after four to six months to overcome malnutrition and related complications. These supplementary foods are worked as balanced diet for pre-school children. When the child is 1 to 1-1/2 years old, breast milk may not be available to it or milk is no longer sufficient to meet its nutritional requirements. It needs some more calories and other nutrients as supplement to milk till it is ready to eat fully the adult foods. This is the post weaning stage of a child. In this stage proper nutritional care of the child is essential to ensure normal growth. It helps to avoid malnutrition in pre-school children (Mahgoub 1999) [11].

Problem of malnutrition in children continues to be critical in most underdeveloped and developing countries like India. This problem associated with inadequate protein and amino acids supply to the growing child. Malnutrition and poor growth during infancy affect a large portion of the world's population; more than 800 million children under 5 years of age suffer from malnutrition and growth failure. Such morbidity is responsible for more than 10 million deaths per year in this age group. Malnutrition accounts for the higher infant mortality rate in India (95/1000 live births) compared to that in developed countries (Greco L. 2006) [8].

Several types of supplementary foods are being marketed in India. Some are Balamul, Farex, Cerelac and Nustem. They contain about 14% protein and are nutritionally balanced. Most of these baby foods being nutritious blends of cereals, legumes and milk, are excellent supplements to child milk food and they are convenient to feed also. But they are quite expensive and are beyond the purchasing power of the parents belonging to middle and lower income groups. Due to this, parents belonging to lower income strata feed their own children with foods that the adults eat (Joshi Neena and Vaidehi, M.P. 1998) [10].

The cereals commonly used are wheat, rice maize etc. cereals in general provide about 350 calories per 100 g. They are however, relatively poor source of protein, the content varying from 7.7 in rice to about 12% in wheat.

Pulses are good source of protein (17-24%) (Gupta C 1992). They also provide vitamins, minerals and fibers. Pulses being rich in lysine and threonine, they complement the amino acid of cereals based diet. Soybean being rich in protein and lysine can play an important role in the enhancement of protein quality of cereal based diet which may help in the reduction of malnutrition of the community and easily available to anyone (George A. 1991) [6].

Objectives

The present investigations were carried out to formulate and develop low cost and protein rich supplementary food for children, to evaluate the nutritional quality characteristics of the product and to evaluate the sensory quality characteristics of the product.

Methods

Food Commodities: Wheat, chickpea, soybean, sugar, skimmed milk powder, polythene bags and laminated pouches etc. were procured from the local market, Aurangabad

Cleaning: The above food commodities were taken and cleaned to remove the stones, dust, woods and any other foreign materials from the grains.

Preparation of wheat flour: Wheat grains were thoroughly cleaned to remove dirt, dust, insect excreta/ feathers and admixture of other food grains. The clean graded materials were ground in the electric grinder to make fine flour and sieved by 80 - 100 mesh sieves. The flour samples obtained were roasted and then kept in airtight container before use.

Preparation of chickpea flour: Chickpea grains were cleaned to remove the foreign materials and then dehulled in a hand-operated chakki for removal of husk. The dehulled grains were ground in an electric grinder to make fine powder and sieved by 80 – 100 mesh sieve. The obtained flours were roasted on low flame and then stored in airtight container before use.

Preparation of full fat soy flour: Soybean grains were thoroughly cleaned to remove the dust and other foreign materials. The clean grains were tempered with water to 20-25 per cent moisture content and then autoclaved for 25 min in a pressure cooker. They were removed and dried directly in the sun for 3-4 days till the material was completely dried having 6 – 8 per cent moisture content. Soybean was then ground to make fine flour and sieved through 80 – 100 mesh sieves. The flour samples obtained were roasted and then stored in airtight container before use.

Roasting: The prepared flours were roasted before storage in airtight container. Roasting was done at 70-80 °C on a low flame to avoid burning of flour. Roasting gave a pleasant flavor to flour.

Treatment combinations

Table 1: Different combination of wheat flour and soybean flour

S. No	Treatments	Symbol
1	100%WF+ 0% SF	Control
2	90% WF + 10% SF	TS_1
3	85% WF + 15% SF	TS_2
4	80% WF + 20% SF	TS_3
5	75% WF + 25% SF	TS_4

WF= Wheat flour, SF= Soybean flour

Table 2: Different combination of wheat flour and chick pea flour

Sr. No.	Treatments	Symbol
1	100%WF+ 0% CF	Control
2	90% WF + 10% CF	TC_1
3	85% WF + 15% CF	TC_2
4	80% WF+ 20% CF	TC_3
5	75% WF+ 25% CF	TC_4

WF= Wheat flour, CF= Chick pea flour

Table 3: Different combination of wheat flour, soya flour and chick pea flour

S. No	Treatments	Symbol
1	100%WF+ 0% SF+ 0% CF	Control
1	90% WF + 5% SF + 5% CF	TSC_1
2	80% WF + 10% SF + 10% CF	TSC_2
3	70% WF + 15% SF + 15% CF	TSC_3
4	60% WF + 20% SF + 20% CF	TSC_4

WF= Wheat flour, SF= Soybean flour, CF= Chick pea flour

Formulation of protein rich supplementary foods

Different types of supplementary foods were prepared from roasted flours of wheat, soybean and chick pea flour using above different combinations. After mixing properly, 35% sugar and 10% skimmed milk powder is added to each treatment and then they were subjected to sensory as well as nutritional evaluations.

Nutritional analysis

The nutritional evaluation of protein rich supplementary foods i.e. moisture content, fat content, protein content, ash content, crude fiber, fatty acid was carried out by A.O.A.C (1984) methods.

Minerals Analysis

Calcium, phosphorus and iron analyzed by a manual of laboratory techniques (1983) methods.

Sensory evaluation of products

The sensory quality characteristics of the products such as colour, taste, texture, flavor and overall acceptability were evaluated by panel of judges using nine point hedonic scales as described by

Results and Discussion

Nutritional composition of protein rich supplementary foods

It is evident from table 4 that moisture content varied from 1.5 to 2.3 per cent with the lowest T_0 (1.55%) and highest in TS_3 (2.33%). Fortification of 10% skimmed milk powder did not affect the moisture content of supplementary food. The protein content in various products ranged from 12.20 to 17.1%. The highest amount of protein was recorded in TS_3 (17.1%) and lowest in the control T_0 (12.20%). On supplementation of 10% skimmed milk powder, the protein content increased from 16.2 to 21.2%. The highest amount was recorded in TS_3 (21.2%).The product with and without fortification of 10% skimmed milk powder did not change the fat content of supplementary foods. It varied from 1.9 to 4.5% with the lowest in T_0 (1.9%) and highest in TS_3 (4.5%).The highest amount of crude fibre was present in TS_3 (1.78) and lowest in T_0 (1.30%). There were no affect on crude fibre content on fortification of milk powder (Ashturkar, P. B *et al.* 1992) [2].

The ash content varied from 0.7 to 1.40 %. The lowest value was observed in T_0 (1.02%) and highest in TS_3 (1.40%).

Supplementation of 10% skimmed milk powder increased the ash content of the supplementary food (Baskran V. *et al.* 1999) [3]. The carbohydrate content in the supplementary food of all the products was less (61.6 to 71.2) as compared products fortified with 10% skimmed milk powder (67.6 to 77.2). It is observed that addition of 10 % skimmed milk powder increased the carbohydrate content of the products. The maximum amount of carbohydrates were recorded in T_0 (77.2%) and lowest in TS_3 (67.6%). Finally It is observed that addition of 10 % skimmed milk powder increased the total energy of the products. The calculated total energy ranged from 390.8 to 395.8 Kcal/100 g in all milk fortified products as compared to 350.7 to 358.8 Kcal/100 g in normal products (Gimbi, D.M 1997).

Table 4: Nutritional composition of protein rich supplementary foods with and without 10% skimmed milk powder.

Constituents (%)	Products								Average mean
	T_0		TS_3		TC_3		TSC_2		
	A	B	A	B	A	B	A	B	
Moisture	1.52	1.50	2.22	2.31	1.84	1.95	1.85	1.84	2.16
Protein	12.2	16.2	17.1	21.1	13.2	17.2	15.2	19.6	18.6
Fat	1.91	2.01	4.41	4.51	2.52	2.6	3.81	3.92	3.74
Fibre	1.31	1.32	1.73	1.71	1.22	1.2	1.51	1.51	1.74
Ash	0.72	1.30	0.81	1.42	0.42	1.0	0.71	1.21	1.02
Carbohydrates	71.2	77.2	61.6	67.6	69.5	75.5	65.7	71.7	77.7
Total energy K cal.	350.7	390.8	354.4	394.5	354.1	394.5	358.5	395.8	374.4

(Results are average of three replications)
T0 : Roasted wheat flour (100:00)
TS3 : Roasted wheat flour: soy flour (80:20)
TC3 : Roasted wheat flour: chickpea flour (80:20)
TSC2 : Roasted wheat flour: chickpea soy flour (80: 10: 10)

A: Without skimmed milk powder.
B: With 10 % skimmed milk powder.
*Analysis of products without sugar

Mineral content in protein rich supplementary food

The values presented in Table 5 showed that calcium content ranged from 50 to 202 mg/100g in the different kinds of products. The highest calcium content was recorded in TSC_2 (202 mg/100g) and lowest in T_0 (50 mg/100g). The addition of 10% skimmed milk powder showed a remarkable increase in calcium content. The phosphorus content varied from 111 to 388 mg/100g in different kinds of products. The highest phosphorus content was recorded in TSC_2 (354mg/100g) and lowest in T_0 (111mg/100g). The addition of 10% skimmed milk powder showed a remarkable increase in phosphorus content. The iron content varied from 2.6 to 6.5 mg/100g. The highest amount was recorded in TSC_2 (6.5 mg/100g) and lowest in T_0 (2.6mg/100g). The addition of 10% skimmed milk powder did not change the iron content of food products (Gahlawat, P. and Sehgal, S. 1993) [5].

Table 5: Mineral composition of supplementary foods made from roasted wheat flour, soy flour and chick pea flours fortified with and without 10% skimmed milk powder.

Constituents (mg/100g)	Treatments								Average mean
	T_0		TS_3		TC_3		TSC_2		
	A	B	A	B	A	B	A	B	
Calcium	50	180	68	198	55	175	70	202	115
Phosphorus	111	221	210	320	277	388	285	354	235
Iron	2.6	2.6	5.6	5.6	4.5	4.5	6.5	6.5	4.0

(Results are average of three replications)
T0 : Roasted wheat flour (100)
TS3 : Roasted wheat flour: soy flour (80:20)
TC3 : Roasted wheat flour: chickpea flour (80:20)
TSC2 : Roasted wheat flour: chickpea soy flour (80: 10: 10)

Analysis of products without sugar
A: Without skimmed milk powder.
B: With 10 % skimmed milk powder.

Sensory quality characteristics of protein rich supplementary food

Different kinds of roasted flour were used to develop the supplementary food from wheat, chickpea and soy flours with and without mixing of 10% skimmed milk powder and appropriate sugar (35%). The sensory quality characteristics of the products revealed that the mean score values for various sensory attributes viz; colour, flavour, taste, texture and overall acceptability varied from 6.0 to 8.8 (Table 6). It is observed that supplementary food fortified with 10% skimmed milk powder did not affect the sensory quality characteristics of the products. The values remained more or less the same (Table 7).

The supplementation of soy flour in wheat flour at different levels (10 to 25%) revealed that the values of various sensory attributes ranged in between 6.0 to 8.6 (Table 6 and Table 7). They were highest in TS_3 ranging in between 7.5 to 8.8. However, lower values were observed in TS_4 (6.0 to 7.6). This indicates that higher amount of soy flour decreased the sensory quality characteristics of the product. On the basis of these observations, the supplementation of soy flour at the level of 20 per cent could be considered the best from sensory points of view. Thus, TS_3 blend consisting of 80:20 (wheat flour: soy flour) could be used to develop the product with high nutritional quality (Ereifej K.I. *et al.* 1993) [4].

Similarly, the supplementation of chickpea flour in wheat flour was used to develop supplementary food. The results revealed that the score values for various sensory attributes ranged in between 6.2 to 8.8 (Table 6 and Table 7). The values were highest in TC_1, TC_2 and TC_3 ranging in between 7.2 to 8.8. Thus, the supplementation of chickpea flour at the level of 20 per cent could be considered the best from sensory points of view. However, at the level of 25 %, there were a decrease in the values of sensory quality parameters and overall acceptability of the product (TC_4). This indicates that higher amount of chickpea flour beyond 20% affected the sensory quality characteristics of the products. Thus, TC_3 blend consisting of 80:20 (wheat: chickpea flours) could be used to develop the product with high nutritional quality.

The supplementation of both chickpea and soy flour (5 to 20 per cent each) revealed that the scores of various sensory

attributes ranged in between 6.2 to 7.8 (Table 6 and Table 7).They were highest in TSC_2. Thus, supplementation chickpea and soy flour both at the level of 10% each could also be considered the best from sensory points of view (Idowu, M. A *et al.* 1992).

The supplementation of 10 % skimmed milk powder in each products showed that the values of different sensory attributes were more or less same with or without fortification of 10% skimmed milk powder (Table 7). This indicates that 10 per cent skimmed milk powder did not affect the sensory quality characteristics of the products.

Table 6: Sensory evaluation of supplementary foods made from roasted wheat, soybean and chickpea flours in different combinations.

Group	Treatments	Blended ratio	Colour	Flavour	Taste	Texture	Overall acceptability
Control	T_0	100:00	8.1	8.3	8.2	8.6	8.1
Wheat: soybean flour	TS_1	90:10	8.0	7.6	8.2	6.9	8.0
	TS_2	85:15	8.2	8.0	8.5	8.5	8.2
	TS_3	80:20	8.4	8.0	8.6	8.2	8.2
	TS_4	75:25	6.5	7.5	6.0	7.5	6.9
Wheat:chick pea flour	TC_1	90:10	7.2	7.8	7.9	7.5	8.2
	TC_2	85:15	8.4	8.2	8.0	6.9	8.2
	TC_3	80:20	8.8	8.5	8.0	8.2	8.0
	TC_4	75:25	6.6	6.2	6.3	6.3	6.5
Wheat: soybean: chick pea flour	TSC_1	90:05:05	7.2	7.3	7.6	7.4	7.5
	TSC_2	80:10:10	7.6	7.4	7.8	7.5	7.6
	TSC_3	70:15:15	6.9	6.2	7.2	6.8	7.2
	TSC_4	60:20:20	6.4	6.3	6.2	6.3	6.2
	Average Mean		7.6	7.5	7.6	7.4	7.6

Control (T_0) – Roasted wheat flour (100: 00)
*Product evaluated after mixing with 35% sugar.

Table 7: Sensory evaluation of supplementary foods made from roasted wheat, soybean and chickpea flours in combinations with 10% skimmed milk powder.

Group	Treatments	Blended ratio	Colour	Flavour	Taste	Texture	Overall acceptability
Control	T_0	100:00	8.1	8.3	8.2	8.6	8.1
Wheat: soybean flour	TS_1	90:10	8.2	7.8	8.2	6.9	8.0
	TS_2	85:15	8.2	8.0	8.5	8.5	8.2
	TS_3	80:20	8.5	8.2	8.8	8.5	8.5
	TS_4	75:25	6.5	7.5	6.0	7.5	6.9
Wheat:chick pea flour	TC_1	90:10	8.2	8.8	8.9	8.5	8.2
	TC_2	85:15	8.4	8.2	8.0	7.9	8.0
	TC_3	80:20	8.8	8.5	8.0	8.2	8.0
	TC_4	75:25	6.3	6.2	6.3	6.6	6.5
Wheat: soybean: chick pea flour	TSC_1	90:05:05	7.2	7.3	7.6	7.4	7.5
	TSC_2	80:10:10	7.6	7.4	7.8	7.5	7.6
	TSC_3	70:15:15	6.9	6.2	7.2	6.8	7.2
	TSC_4	60:20:20	6.4	6.3	6.2	6.3	6.2
	Average Mean		7.6	7.6	7.7	7.6	7.6

Control – roasted wheat flour (100: 00)
*Product evaluated after mixing with 35% sugar.

Conclusion

The present investigation was carried out to formulate a product for poor people to fulfill their nutritional requirements at lower cost. On the basis of above observation it was concluded that soy blended products could be considered the best from both nutritional and sensory points of view. The product made in the ratio of 80:20 (wheat: soy flours) was good in terms of proteins and minerals. Supplementation of 10 % skimmed milk powder further increased the amount of calcium, phosphorus and high quality proteins.

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