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STUDIES ON DEVELOPMENT OF LOW COST NUTRITIONALLY BALANCED SUPPLEMENTARY FOOD FOR CHILDREN

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Abstract: *The present investigation concludes 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 Flour: Soy Flour) 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. The shelf life of the product was good in both the packaging materials for the period of 03 months at room temperature. Hence, it was concluded that low cost nutritionally balanced supplementary food for children could be developed with 10% skimmed milk powder.*

Keywords*: Low Cost Food, Supplementary Food, Nutritionally Balanced Food, Food for Children.*

Introduction

Human childhood may be divided in to three stages a) Infancy b) Weaning c) 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. Supplementary foods are the foods which are supplemented in place of milk. These supplementary foods are worked as balanced diet for pre-school children.

Several types of supplementary foods are being marketed in India. 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 lower income groups.

Mehta and Shah (2000) conducted a study on a home-made fermented weaning food for malted rice with Bengal gram and Red gram (66:27:7 w/v) and referred to as RBR mix and was analyzed for physico-chemical parameters. A significant improvement in IPVD (61.54 – 77.43%) and IVSD (34.50 – 48.38) were observed with increase in period of fermented mix as compared to unfermented one.

Shrivastavas *et al.* (2001) studies on two convenience mixes suitable for five different types of baby food based on prosomillet were developed. Malting and popping were used as processing techniques and malted convenience mix was further used as multipurpose flour for development of different baby foods. These food products were sweet gruel, salty gruel, halwa, burfi and biscuit.

Smita and Pavunny (2003) studied the infant feeding practices among 150 agricultural laboures families of the Thrissur district Kerla and reported that most of the women breast feed their infants for a period of 1-3 years and most of them gave weaning food to them between the periods of 2-5 months after birth. The commonly given weaning food was boiled and mashed banana. About 48.66% of mothers gave cow's milk, suji, ragi, rava and raw banana powder were also in the form of porridges.

Greco *et al.,* (2006) studied development of nutritious foods that prevents and treats

malnutrition. They studied that children who received porridges did better than those given only milk feeding.

Materials and Methods

Raw Materials

Wheat, chickpea, soybean, sugar, skimmed milk powder, polythene bags and laminated pouches etc were procured from the local market, Aurangabad. Wheat grains & Chickpea 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. Soybean grains were thoroughly cleaned to remove the dust and other foreign materials. The clean grains were tempered with water to 20-25 % 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 % 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. The prepared flours were roasted before storage in airtight container. Roasting was done at 70-80 $^{\circ}$C on a low flame to avoid burning of flour.

Formulation of Supplementary Foods

Different types of supplementary foods were prepared from roasted flours of wheat, soybean and chick pea flour using following 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.

Table 1: Different combination of Wheat Flour (WF), Soybean Flour (SF) & Chick-pea Flour (CF)

Sr. No.	Treatment 1	Treatment 2	Treatment 3
1	100%WF+ 0% SF (Control)	100%WF+ 0% CF (Control)	100%WF+ 0% SF+ 0% CF (Control)
2	90% WF + 10% SF (S_1)	90% WF + 10% CF (C_1)	90% WF + 5% SF + 5% CF (SC_1)
3	85% WF + 15% SF (S_2)	85% WF + 15% CF (C_2)	80% WF + 10% SF + 10% CF (SC_2)
4	80% WF + 20% SF (S_3)	80% WF + 20% CF (C_3)	70% WF + 15% SF + 15% CF (SC_3)
5	75% WF + 25% SF (S_4)	75% WF + 25% CF (C_4)	60% WF + 20% SF + 20% CF (SC_4)

Nutritional Evaluation & Sensory Evaluation

The moisture content, total carbohydrates, fat, protein, crude fibers, fatty acids & ash in the sample was estimated according to the method of AOAC (1984).

Calcium in the acid digested sample was determined by the "Versenate Titration Method". Phosphorus content in the tri-acid digested samples determined by "Vanado Molybdate Method". Iron content in the sample was determined colorimetrically as described in "A Manual of Laboratory Techniques" (1983).

The sensory quality characteristics of the products such as colour, taste, texture, flavor and overall acceptability were evaluated by panel of judges using "09 Point Hedonic Scale".

Storage studies:

The shelf-life studies of supplementary foods were carried out in "Polyethylene and Laminated Pouches" for a period of 03 months at ambient temperature. 100 gms of each sample were packed and kept at room temp. for 90 days. All samples were drawn periodically after 0, 30, 60, 90, days and analyzed for fatty acid acidity contents according to the standard procedures.

Results & Discussions

Sensory Quality Characteristics of Product

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 2). 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 3).

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 2 and Table 3). They were highest in S_3 ranging in between 7.5 to 8.8. However, lower values were observed in S_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 % could be considered the best from sensory points of view. Thus, S_3 blend consisting of 80:20 (wheat flour: soy flour) could be used to develop the product with high nutritional quality.

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 2 and Table 3). The values were highest in C_1, C_2 and C_3 ranging in between 7.2 to 8.8. Thus, the supplementation of chickpea flour at the level of 20 % 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 (C_4). This indicates that higher amount of chickpea flour beyond 20% affected the sensory quality characteristics of the products. Thus, C_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 % each) revealed that the scores of various sensory attributes ranged in between 6.2 to 7.8 (Table 2 and Table 3). They were highest in SC_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.

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 3). This indicates that 10 % skimmed milk powder did not affect the sensory quality characteristics of the products.

Table 2: Sensory evaluations 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	C_0	100:00	8.1	8.3	8.2	8.6	8.1
WF:SF	S_1	90:10	8.0	7.6	8.2	6.9	8.0
	S_2	85:15	8.2	8.0	8.5	8.5	8.2
	S_3	**80:20**	**8.4**	**8.0**	**8.6**	**8.2**	**8.2**
	S_4	75:25	6.5	7.5	6.0	7.5	6.9
WF:CF	C_1	90:10	7.2	7.8	7.9	7.5	8.2
	C_2	85:15	8.4	8.2	8.0	6.9	8.2
	C_3	**80:20**	**8.8**	**8.5**	**8.0**	**8.2**	**8.0**
	C_4	75:25	6.6	6.2	6.3	6.3	6.5
WF:SF:CF	SC_1	90:05:05	7.2	7.3	7.6	7.4	7.5
	SC_2	**80:10:10**	**7.6**	**7.4**	**7.8**	**7.5**	**7.6**
	SC_3	70:15:15	6.9	6.2	7.2	6.8	7.2
	SC_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

Table 3: Sensory evaluations 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	C_0	100:00	8.1	8.3	8.2	8.6	8.1
WF:SF	S_1	90:10	8.2	7.8	8.2	6.9	8.0
	S_2	85:15	8.2	8.0	8.5	8.5	8.2
	S_3	**80:20**	**8.5**	**8.2**	**8.8**	**8.5**	**8.5**
	S_4	75:25	6.5	7.5	6.0	7.5	6.9
WF:CF	C_1	90:10	8.2	8.8	8.9	8.5	8.2
	C_2	85:15	8.4	8.2	8.0	7.9	8.0
	C_3	**80:20**	**8.8**	**8.5**	**8.0**	**8.2**	**8.0**
	C_4	75:25	6.3	6.2	6.3	6.6	6.5
WF:SF:CF	SC_1	90:05:05	7.2	7.3	7.6	7.4	7.5
	SC_2	**80:10:10**	**7.6**	**7.4**	**7.8**	**7.5**	**7.6**
	SC_3	70:15:15	6.9	6.2	7.2	6.8	7.2
	SC_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

Proximate composition of supplementary foods

It is evident from Table 4 that moisture content varied from 1.5 to 2.3 % with the lowest C_0 (1.55%) and highest in S_3 (2.33%). Fortification of 10% skimmed milk powder did not affect the moisture content of supplementary food.

It is evident from Table 4, that the protein content in various products ranged from 12.20 to 17.1%. The highest amount of protein was recorded in S_3 (17.1%) and lowest in the control C_0 (12.20%). On supplementation of 10% skimmed milk powder, the protein content increased from 16.2 to 21.2% (Table 4). The highest amount was recorded in S_3 (21.2%).

A perusal of Table 4, in case of 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 C_0 (1.9%) and highest in S_3 (4.5%)

The values presented in table 4.2 showed that highest amount of crude fibre was present in S_3 (1.78) and lowest in C_0 (1.30%). There were no affect on crude fibre content on fortification of milk powder.

It is obvious from the Table 4, the ash content varied from 0.7 to 1.40 %. The lowest value was observed in C_0 (1.02%) and highest in S_3 (1.40%). Supplementation of 10% skimmed milk powder increased the ash content of the supplementary food (Table 4).

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 (Table 4). The maximum amount of carbohydrates were recorded in C_0 (77.2%) and lowest in S_3 (67.6%).

It is observed that addition of 10 % skimmed milk powder increased the total energy of the products (Table 4). 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.

Table 4: Proximate composition of supplementary foods with skim milk (A) and without 10% skim milk powder (B)

Constituents	Products								Average Mean
	C_0		S_3		C_3		SC_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 (Kcal)	350.7	390.8	354.4	394.5	354.1	394.5	358.5	395.8	374.4
Calcium (mg/100g)	50	180	68	198	55	175	70	202	115
Phosphorus (mg/100g)	111	221	210	320	277	388	285	354	235
Iron (mg/100g)	2.6	2.6	5.6	5.6	4.5	4.5	6.5	6.5	4.0

The values presented in Table 4 showed that calcium content ranged from 50 to 202 mg/100g in the different kinds of products. The highest calcium content was recorded in SC_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.

An appraisal of the Table 4 showed that the phosphorus content varied from 111 to 388 mg/100g in different kinds of products. The highest phosphorus content was recorded in SC_2 (354mg/100g) and lowest in C_0 (111mg/100g). The addition of 10% skimmed milk powder showed a remarkable increase in phosphorus content.

A perusal of Table 4 showed that the iron content varied from 2.6 to 6.5 mg/100g. The highest amount was recorded in SC_2 (6.5 mg/100g) and lowest in C_0 (2.6mg/100g). The addition of 10% skimmed milk powder did not change the iron content of food products.

Changes in fatty acid acidity during storage

The storage of different kinds of blended products with and without 10% skimmed milk powder stored in polyethylene bags and laminated pouches for the period of 90 days at ambient temperature revealed that the average value of fatty acid acidity was minimum (0.115) in the control having wheat flour only. However, the soybean and chickpea blended flours contained higher values for fatty acid acidity (0.161 to 0.201). During storage there was a gradual increase in the fatty acid acidity in all the blends. The values were more or less the same in both the packaging materials (laminated pouches and polyethylene bags). This indicates that both the packaging materials could be considered the safest for storage of products. Fortification of 10% skimmed milk powder did not affect the free fatty acid acidity of the products (Table 5 and Table 6).

Table 5: Changes in fatty acid acidity (mg of KOH/100 g of flour) of different kinds of products in polyethylene bags during storage

Treatments	Period of storage (Days)								Average Mean
	0		30		60		90		
	A	B	A	B	A	B	A	B	
C_0	0.110	0.112	0.108	0.115	0.115	0.118	0.118	0.120	0.115
S_3	0.178	0.188	0.188	0.190	0.189	0.196	0.235	0.240	0.201
C_3	0.160	0.161	0.162	0.165	0.158	0.161	0.160	0.162	0.161
SC_2	0.150	0.152	0.166	0.164	0.180	0.182	0.218	0.220	0.179

Table 6: Changes in fatty acid acidity (mg of KOH/100 g of flour) of different kinds of products in laminated pouches during storage

Treatments	Period of storage (Days)								Average Mean
	0		30		60		90		
	A	B	A	B	A	B	A	B	
C_0	0.110	0.112	0.112	0.115	0.114	0.118	0.118	0.120	0.115
S_3	0.182	0.187	0.185	0.189	0.198	0.197	0.240	0.244	0.203
C_3	0.166	0.162	0.162	0.168	0.160	0.164	0.160	0.165	0.163
SC_2	0.150	0.152	0.162	0.166	0.180	0.184	0.215	0.218	0.178

Conclusion

The results showed that wheat flour having 20 %, soy flour had similar values as control and hence it could be considered the best. At higher amount of soy fortification, there were slight decreases in the sensory quality parameters. This indicates that higher concentration of soybean adversely affected the quality of product.

The supplementation of chickpea flour for product development revealed that 20 % chickpea flour was the best without affecting the sensory attributes. However, at higher concentration of chickpea the values of sensory scores were found to decrease.

The supplementation of soy flour in combination of chickpea in equal quantities i.e. 10 % each did not change the sensory quality characteristics of product as observed in the present study. Thus, the benefits of both grains (chickpea and soy flour) could be included in the same supplementary food.

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%), fibre (1.28 to 1.78%), ash (0.7 to 1.40%) and carbohydrates (67.66 to 77.2%). These results 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 as observed in the present investigation.

The supplementation of 10% skimmed milk powder increased the amount of protein, calcium and phosphorus in the supplementary foods. The carbohydrate content decreased slightly due to increase in the protein content. The ash, fat and iron contents were remained more or less the same. However, significant enhancement in the quantity of calcium content was observed on fortification of 10% skimmed milk powder. The calcium content increased three times and phosphorus double in the product. It has been reported that milk powder is a good source of protein, calcium and phosphorus having 38.8 g of protein, 6.8 g of ash, 1370 mg of calcium and 1000 mg phosphorus per 100 g on dry weight basis (Gopalan *et al.,* 1980). Thus, addition of skimmed milk powder could be recommended for nutritional improvement of the product especially from mineral points of view.

The storage of supplementary foods in laminated pouches and polyethylene bags revealed that there were no changes in fatty acid acidity of the flours during storage periods. Fatty acid acidity ranged in between 0.111 to 0.244. This indicates that packaging materials maintained the quality of the product safely.

Thus, it was concluded that supplementary foods having high nutritional quality could be developed from wheat flour with 20% soy flour which was comparatively rich in protein and calcium as either chickpea alone or combination with both. The supplementation of 10% skimmed milk powder was able to enhance the nutritional quality of the

product particularly in minerals and high quality proteins.

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. The shelf life of the product was good in both the packaging materials for the period of 03 months at room temperature. Hence, it was concluded that low cost nutritionally balanced supplementary food for children could be developed with 10% skimmed milk powder.

References

A.O.A.C. (1984) Official methods of analysis 23rd edition. Association of the Official Analytical Chemist, Washington, D. C.

Baskran, V. Mahadevamma,N. G. Malleshi, R. Shankara and B. R. Lokesh (1999) Acceptability of supplementary foods based on popped cereals and legumes suitable for rural mothers and children. *Plant foods for human nutrition* 53: 237-247.

Gopalan, C., B. V. Ranasastri and S. C. Balasubramanian (1980). Nutritive value of Indian foods, National Institute of Nutrition ICMR, Hyderabad, India.

Greco, L. (2006) Effect of a low cost food on the recovery and death rate of malnourished children. *J.Pediatr.Gastroenterol.Nutr.* 43: 512-517

Griffith, L.D., M. E. Castell-Perez and M. E. Griffith (1998) Effects of blend and processing method on the nutritional quality of weaning foods made from selected cereals and legumes. Cereals chemistry 75(1): 105-112

Mehta, P. and Shah, N. (2000) A study on fermentation of selected cereals pulse mix (RBR) for young child feeding with reference to nutritional properties. *Indian J. Nutr. Diet* 37:208

Shrivastava, S., Thathola, A. and Batra, A. (2001). Development and nutritional evaluation of prosomillet based convenience mix for infants and childrens. J. *Food. Sci. Technol. (India)* 38950: 480-483.

Smita, M. E. and Pavunny,O. (2003). Infant feeding practices among agriculture laboures families. 5th International Food Convention, 5-8 Dec. 2003, Mysore. Poster abstract, NU- 17, pp-29.