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Development of nutrient dense supplementary products for children by using locally available cereals, soy flour, bengal gram leaves and cow pea leaves

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ABSTRACT

Malnourished children are often victim of various infections like weight loss, iron deficiency, iodine deficiency, vitamin A deficiency etc. As with underweight, the prevalence of different micronutrient deficiencies varies widely across states. Prevention of malnutrition can be started by providing nutrient dense supplementary foods to the children. So present study was designed to develop low cost nutrient dense supplementary products for children by using locally available cereals, soy flour, bengal gram leaves and cow pea leaves. Different types of ten supplementary food were developed and their sensory evaluation, nutrient evaluation and cost analysis was done. It was found that all the products were organoleptically acceptable and overall acceptability scores revealed that malted (B) and fermented (C) products were more acceptable as compared to the unprocessed variant (A). Nutritionally products were containing higher percentage of energy, protein, calcium and iron in comparison to standard with a cost of Rs 1.4 – 5.0.

Keywords Supplementary food, cowpea leaves, Bengal gram leaves, soyflour, malting, wheat flour, fermentation.

INTRODUCTION

India is home to 40 percent of the world's malnourished children and 35 percent of the developing world's low – birth - weight infants; every year 2.5 million children die in India, accounting for one in five deaths in the world. More than half of these deaths could be prevented if children were well nourished. India's progress in reducing child malnutrition has been slow. The prevalence of child malnutrition in India deviates further from the expected level at the country's per capita income than in any other large developing country [1].

Malnutrition in children occurs in weaning stage when babies need more than just breast milk and weaning towards the normal family diet must begin. At this time to fulfill the nutrient requirement of baby it is necessary that weaning and supplementary food should be nutrient dense so it can fulfill the increased requirements of babies. Supplementary Food is any food other than breast milk which can fulfill and correct the nutritional deficiencies in growing children and is nutrient dense. Supplementary food should be introduced at the age of six months. But in India where a large population is below poverty line, illiterate and ignorant don't have a proper knowledge and attitude towards the child malnutrition and supplementary feeding. Cereal based food items are generally given to the child which have low energy density, high fiber content and high anti nutrients. Commercially available supplementary foods are expensive and out of reach of poor and rural population [2]. Effective supplementary feeding can improve the nutritional status of moderately malnourished children . According to a review of supplementary feeding trials, supplementary

feeding, when given in adequate amounts to malnourished children, has a positive effect on growth [3]. So, it is necessary that supplementary food should contain a staple as the main ingredient (i.e, preferable a cereal), a protein supplement from a plant or animal food source (e.g. beans, groundnut, milk, meat, chicken, fish, eggs, etc), a vitamin and mineral supplement (e.g. a vegetable or a fruit), an energy supplement to increase the energy density of the mix (e.g. fat, oil or sugar etc). When these four ingredients are used together in suitable proportions, they form a complete meal [2].

Rice contributes to 43% of total food grain production and 46% of total cereal production. Rice flour is one of the main foods consumed by most Asian countries. It has versatile uses, from baby foods, pancake mix and baked snacks to coatings for fried foods. It is a starchy food that provides vegetable proteins and contains complex carbohydrates. The protein content of rice is 7% and the carbohydrate content is 72-75% [4]. These carbohydrates are gradually released into the body and supply energy as and when needed. Rice flour is low in saturated fat, cholesterol and sodium. It also contains almost the same amount of calories as its counterpart, wheat. It is a combination of complex carbohydrates and nutrients.

Another most common cereal available all over the world and today is even more in demand for its abundant health benefits is wheat. Through decades, wheat has been one of the major cereals crops in the world. The protein content of wheat is 11.8 g per 100 g and the energy content is 346 kcal per 100 g [5]. Wheat is rich in catalytic elements, mineral salts, calcium, magnesium, potassium, sulfur, chlorine, arsenic, silicon, manganese, zinc, iodide, copper, vitamin B, vitamin E and ferments. Thereby, you can call wheat as the base foundation of nourishment. Issues like anemia, demineralization, gallstones, breast cancer, chronic inflammation, obesity, asthenia, tuberculosis, pregnancy problems and breastfeeding problems are smartly dealt by whole wheat.

Soy is truly seems to be a wonder food. Soy is an excellent source of dietary fiber and protein (43%). It is rich in vitamin B6 - important in building amino acids and in the formation of neurotransmitters. As a high-quality, complete protein, soy protein is comparable in protein quality to the protein found in animal sources, such as meat, milk and eggs. Soy protein products can be good substitutes for animal products because, unlike some other beans, soy offers a 'complete' protein profile [6]. Soybean also contain Omega-3 fatty acids, for example, alpha-linolenic acid) which are special fat components that benefit many body functions. Some beneficial effects are associated mainly with the longer-chain fatty acids eicosapentaenoic acid (20:5n-3, EPA) and docosahexaenoic acid (22:6n-3, DHA) found in some algae and oily fish.

Green leafy vegetables are rich sources of mainly provitamin A and vitamin C, iron and calcium. They are almost always cooked before consumption whereby they shrink in volume and become more nutrient dense. However, cooking may affect the bioavailability and activity of the nutrients. Consumption of green leafy vegetables improves the nutrient quality of cereal based diets, although the bioavailability of vitamin A as well as iron is low [7]. Cow pea leaves are consumed in at least 18 countries in Africa, and 7 countries in Asia and the pacific. In many parts of Africa, cowpeas are among the top three or four leaf vegetables marketed and consumed [8]. Cow pea leaves are a good source of some vitamins and minerals. Their protein content range from 29% to 43% on a dry weight basis, with the higher nitrogen content in younger leaves. The iron content of cow pea leaves is 20.1 mg per 100 g and calcium content is 290 mg per 100 g. Similarly, Bengal gram leaves are a very rich source of iron (23.8 mg). It is therefore highly beneficial in the treatment of iron deficiency anemia. Young Bengal gram leaves are also eaten as a cooked vegetable green in certain parts of the world and could be a useful source of dietary nutrients, especially in malnourished populations [9].

But all these foodstuff contain anti nutritional factors i.e. soy contains tannins, wheat contain phytic acid, and leaves contain high amount of oxalic acid etc. These anti nutritional content hinder the absorption of many nutrients. So, different processing techniques are required to decrease the anti nutritional content of these ingredients and to increase the availability of nutrients. Malting is a process in which grains are allowed to germinate and then quickly dried in a kiln before the plant has a chance to fully develop. In this malting process some of the starch in the grains is degraded into sugars, protein quality and digestibility is improved and the content of riboflavin, niacin, and vitamin C is increased and the content of anti nutrients is reduced [7]. It enhances riboflavin, niacin and ascorbic acid content of wheat [10]. As judged by an in vitro method, the availability of iron and zinc improved several fold on malting by reduction in phytin phosphorus on malting [11]. Another processing treatment, fermentation influences the nutritional quality of foods in a number of ways, e.g. increase in energy density and increase in the amount and bioavailability of nutrients. Fermentation of cereal gruels can improve protein digestibility [7].

Fermented foods improve digestion, they restore the proper balance of bacteria in the gut. Fermenting foods increases the vitamin content and also helps to absorb the nutrients.

So the persist study for developing Supplementary foods with the mixing of Wheat, Rice, Soy and Green leafy vegetables was planned by keeping certain basic parameters in mind like developed products should have high nutrient content, high bio availability and low cost. The objectives of study were as follows:

1. To conduct nutrient analysis of cow pea leaves and Bengal gram leaves.
2. To reduce the fiber content of Bengal gram leaves and Cow pea leaves by using different processing techniques.
3. To develop supplementary foods by mixing of cereal + Soya flour + Bengal gram leaves and Cow pea leaves.
4. To conduct the sensory evaluation and nutrient analysis of developed recipes.
5. To evaluate nutrient density, nutrient content and cost of the developed foods.

MATERIALS AND METHODS

Procurement of material Cowpea leaves was procured from Durgapura Agricultural institute, Jaipur and Bengal leaves was cultivated in K.V.K, Banasthali University. Rice, wheat and Soya were procured from local market of Banasthali.

Processing of soy, rice and wheat

Soy Firstly Blanching of soy was done to remove anti nutritional factor and the unpleasant flavor of soy. Then sun drying was done and after than flour was made.

Rice Whole rice was grind finely.

Wheat Malting of wheat was done by as follows:

Collection of raw wheat

⇩

Washing of wheat

⇩

Wheat was soaked in water for 24 hrs

⇩

Water was changed in every 6 hrs

⇩

Wheat was kept in muslin cloth for 3-5 days

⇩

Water was sprinkled after every 4 hrs

⇩

After germination drying was done in sun

⇩

Wheat was milled in fine flour

Cowpea and Bengal gram leaves Both types of leaves were blanched in hot water for 15 minutes and then they were sieved through filter to reduce its fiber content. As high fiber content increases the bulk to diet and thus decrease the intake of supplementary food.

Food Product Development Home based recipes were selected which could be enriched suitably to meet the objective of this experimentation. The criteria of selection were easily availability of ingredients, commonly consumed by local people, low in cost. Keeping all the consideration in mind ten products viz - Bhakar wadi, Bhakri, Halwa, Namakpara, Pua, Rings, Vegetable pakodi, Chana murmura premix, Murmura moong dhal premix, Suji groundnut premix, Suji ki kheer premix were standardized and developed in food laboratory of Food Science and Nutrition of Banasthali university and their compositions are shown in table no 1. Four variant of different recipes were prepared i.e standard, variant A, variant B, variant C. In all the variants, Rice flour (10 g), wheat flour (10 g), Soy flour (10 g), Cow pea leaves (5 g), Bengal gram leaves (5 g) incorporated except standard but in variant A ingredients were incorporated in unprocessed form, in variant B instead of raw wheat flour malted wheat flour was incorporated, and in variant C fermentation of wheat flour dough was done by adding curd at 37˚C for 6 hours.

Sensory evaluation The sensory evaluation of different recipes were carried out by using nine-point Hedonic rating scale through 15 semi- trained panel members selected by triangle difference test. Appearance, taste, texture, odour and overall acceptability were different attributes considered for evaluation. The scale for different attributes were: Liked Extremely (9), Liked very much (8), Liked moderately (7), Liked slightly (6), Neither liked nor disliked (5), Disliked slightly (4), Disliked moderately (3), Disliked very much (2), Disliked extremely (1).

Nutrient analysis Nutrient analysis was done using standard methods of AOAC [12]. Moisture content was determined by drying flour of raw leaves in an oven at 80℃ for 24 h and is expressed in percentage basis. Crude protein was determined by the MicroKjeldahl method using 6.25 as the conversion factor. Iron was estimated by Wong's method as given by Ranganna [13]. Calcium by titrametric estimation was determined by following the AOAC methods (1980).

Statistical Analysis Data were expressed as mean (X), standard deviation (σ). The database was created in Microsofts Excel. Data analysis was by SPSS version 16.0 (SPSS Inc.).

RESULTS AND DISCUSSION

Nutrient analysis of cowpea and bengal gram leaves were shown in table no 1. The results indicate that the moisture content in cowpea leaves was 88.24 g/100g and in Bengal gram leaves was 72.20 g/100g. Whereas, protein content in cowpea leaves was found 3.15g/100g and in Bengal gram leaves was 5.80g/100g. On the other hand, micronutrient analysis revealed that calcium content in cow pea leaves and Bengal leaves were 287.62mg/100g and 337.56mg/100g respectively. Whereas, iron content in cow pea leaves was 19.74mg/100g and of Bengal gram leaves was 22.34mg/100g.

Table: 1 Nutrient content of fresh Cow pea leaves and Bengal gram leaves

	Moisture (g/100g)	Protein (g/100g)	Calcium (mg/100g)	Iron (mg/100g)
Cow pea leaves	88.24±0.70	3.20±0.22	287.33±6.09	19.53±0.54
Bengal gram leaves	72.20±0.26	5.87±0.21	337.81±2.22	22.23±0.65

Sensory evaluation The mean scores of different sensory parameters of various recipes developed by incorporating rice, wheat, soya, cowpea leaves and Bengal gram leaves are shown in table no 2. On the basis of overall acceptability scores of different recipe it was found that standard scored highest and among the three variants, variant B (incorporated with malted wheat flour) was most acceptable and variant A (incorporated with unprocessed flour) was least acceptable. It was observed that Vegetable pakodi was most acceptable recipe followed by Pua, Namakpara, Suji ki kheer, Chana murmura premix, Bhakra badi, Bhakri, Rings, Murmura moong dal premix, Suji ka halwa in terms of mean score of overall acceptability. On the basis of sensory evaluation none of the incorporated product was disliked by the panel members. Thus, it can be said that the entire product can be given readily.

Table: 2 Sensory evaluation scores of different recipes

	Appearance	Taste	Texture	Odour	Overall acceptability
Bhakar wadi					
Standard	8.10±0.91	8.15±0.87	8.10±1.02	8.10±0.91	8.35±0.74
A	6.60±1.78	6.50±1.90	6.50±1.84	6.30±1.89	6.40±1.84
B	6.95±1.82	6.55±1.73	6.70±1.86	6.65±1.87	6.85±2.08
C	7.20±1.43	7.50±1.43	7.25±1.40	7.15±1.89	7.15±1.84
Bhakri					
Standard	8.20±0.83	8.30±0.86	8.05±0.82	8.15±0.93	8.25±0.85
A	6.55±1.66	6.25±1.65	6.50±1.67	6.20±1.82	6.20±1.90
B	6.55±1.09	6.45±1.09	6.50±0.88	6.40±1.18	6.55±0.99
C	6.75±1.06	6.55±1.09	6.75±1.33	6.60±1.09	6.85±1.13
Namakpara					
Standard	8.20±0.61	8.10±0.91	8.10±0.71	8.10±0.85	8.15±0.74
A	7.20±1.54	7.05±1.39	7.15±1.75	7.15±1.78	7.35±1.38
B	7.15±1.46	7.10±1.11	7.15±1.81	7.00±1.48	7.35±1.13
C	7.35±1.38	7.45±1.19	7.25±1.61	7.50±1.27	7.70±1.08
Pua					
Standard	8.45±0.68	8.45±0.75	8.50±0.76	8.50±0.76	8.40±0.75
A	7.65±0.87	7.60±1.04	7.60±0.99	7.60±1.04	7.60±0.99
B	7.35±1.03	7.35±1.18	7.30±1.12	7.30±1.17	7.30±1.12
C	7.35±1.18	7.40±1.23	7.45±1.31	7.25±1.25	7.45±1.31
Rings					
Standard	8.15±0.93	7.90±1.02	8.05±0.88	7.65±1.46	8.05±0.75
A	6.85±1.46	6.10±1.55	6.35±1.66	6.10±1.71	6.45±1.53
B	6.75±1.71	6.10±1.61	6.65±1.49	6.40±1.60	6.55±1.46
C	6.20±1.88	6.10±1.61	6.20±1.73	6.15±1.92	6.25±1.71
Suji ka Halwa					
Standard	8.70±0.47	8.50±0.94	8.55±0.82	8.60±0.82	8.70±0.57
A	6.20±1.70	5.80±1.60	6.10±1.74	5.95±1.76	6.10±1.68
B	6.35±1.22	5.85±0.98	6.40±1.23	6.35±1.42	6.40±1.23
C	6.30±1.68	5.60±1.53	6.10±1.94	6.15±1.98	6.00±1.83
Vegetable pakodi					
Standard	8.30±0.73	8.35±0.78	8.20±0.76	8.25±0.78	8.35±0.74
A	7.50±1.05	7.45±1.05	7.40±1.14	7.40±0.99	7.40±1.04
B	7.70±1.03	7.75±1.06	7.75±1.06	7.75±1.01	7.80±1.05
C	8.00±1.12	7.75±1.01	7.80±1.10	7.80±1.15	7.85±1.13
Chana murmura premix					
Standard	8.30±0.65	8.20±0.69	8.10±0.64	8.05±0.68	8.15±0.74
A	7.10±0.78	7.00±0.91	7.10±0.85	6.95±0.82	7.05±0.75
B	7.45±0.75	7.35±0.87	7.15±0.98	7.25±0.85	7.30±0.80
C	7.30±0.57	7.20±0.89	7.10±0.78	7.15±0.74	7.10±0.85
Murmura moong dhal premix					
Standard	8.10±0.96	7.70±1.03	7.65±1.38	7.65±1.18	7.70±1.26
A	6.65±1.30	6.65±0.87	6.80±1.10	6.90±0.96	6.75±1.11
B	6.45±1.35	6.35±0.93	6.65±0.98	6.85±0.93	6.45±1.05
C	6.50±1.27	6.35±1.18	6.65±1.03	6.95±0.82	6.40±1.56
Suji ki kheer premix					
Standard	8.55±0.51	8.45±0.51	8.40±0.68	8.55±0.51	8.55±0.51
A	7.60±0.68	7.00±0.72	7.15±0.58	7.15±0.58	7.20±0.52
B	7.65±0.58	7.25±0.71	7.45±0.60	7.35±0.74	7.45±0.54
C	7.50±0.68	7.05±0.68	7.20±0.69	7.15±0.74	7.15±0.58

Cost analysis The costs per serving for different recipes were shown in table no. 3. Cost of all the products were with in the range of Rs 1.50 for Chana murmura premix to Rs 4.78 for Suji ka halwa. So it can be concluded that the entire developed product were low in cost with a punch of energy and nutrient.

Table: 3 Cost analyses of different modified recipes

Products	Bhakar Wadi	Bhakri	Namakpara	Pua	Rings	Suji ka Halwa	Vegetable Pakodi	Chana Murmura Premix	Murmura Moong Dal Premix	Suji ki Kheer Premix
Cost (INR)/ Serving	3.12	3.01	2.08	2.60	2.93	4.78	2.98	1.50	1.98	3.2

Table: 4 Nutritive value of different recipes

	Energy (Kcal)	Protein (g)	Calcium (mg)	Iron (mg)
Bhakar wadi				
Standard	373.94	4.56	109.77	8.90
A	461.84	9.60	185.47	8.96
B	463.74	8.96	194.77	14.55
C	469.74	9.91	209.67	14.57
Bhakri				
Standard	310.21	6.27	43.82	2.61
A	402.61	10.59	141.72	8.71
B	410.55	10.50	145.72	11.71
C	418.61	10.90	156.62	12.73
Namakpara				
Standard	349.45	8.98	41.77	2.04
A	394.45	12.52	145.42	8.79
B	439.75	13.01	148.57	9.01
C	446.45	13.36	160.27	8.81
Pua				
Standard	211.45	4.97	21.84	2.02
A	303.85	9.29	119.74	8.12
B	306.50	9.20	129.74	10.12
C	309.81	9.60	134.64	12.14
Rings				
Standard	382.35	5.79	15.89	1.88
A	473.25	7.70	121.09	8.37
B	475.61	10.70	112.31	8.65
C	478.34	10.77	135.99	11.39
Suji ka Halwa				
Standard	243.70	3.02	6.80	0.47
A	334.70	7.68	111.10	7.23
B	337.48	7.87	114.46	7.58
C	340.70	7.99	126.00	7.25
Vegetable pakodi				
Standard	153.34	7.18	90.80	2.07
A	240.04	9.91	142.50	8.24
B	241.94	10.50	157.90	8.21
C	247.94	10.81	172.80	8.23
Chana murmura premix				
Standard	149.30	5.02	42.34	2.53
A	241.40	9.30	127.34	8.49
B	243.00	9.67	129.84	8.32
C	247.40	9.61	142.24	8.50
Murmura moong dhal premix				
Standard	169.06	6.46	17.56	1.76
A	262.36	8.90	115.26	7.79
B	266.98	9.18	129.35	7.73
C	268.36	9.03	130.16	7.81
Suji ki kheer premix				
Standard	162.48	2.71	6.32	0.43
A	250.32	7.37	110.62	7.19
B	259.02	7.87	113.98	7.59
C	287.52	7.68	125.52	7.70

Nutritive value

Nutritive value of different recipes prepared by incorporating rice, wheat, soyflour and Bengal gram, cowpea leaves at various levels were shown in table 4. Energy content of all the food preparations of standard varied from 149.30 Kcal of *Chana murmura* premix to 382.35 Kcal per serving of *rings*. Protein content of standards was highest in *namakpara* (8.98 g/ serving) and lowest in *suji ki kheer* premix (2.71 g/serving). Calcium content in standards ranged between 6.32 g in *suji ki kheer premix* to 109.77 g per serving in *bhakar wadi*. In standards, highest iron content was found in *bhakar wadi* (8.90 g/ serving) and minimum in *suji ki kheer* (0.43 g/ serving). After incorporating unprocessed and processed forms of rice, wheat, soy flours and Bengal gram, cowpea leaves, it was found that energy content was increased maximum in *bhakar wadi* i.e. 469.74 kcal/serving (variant C) and minimum in vegetable *pakodi* i.e. 240.04 Kcal/serving (variant A). Protein content was increased highest in *namakpara* i.e.

13.36 g/serving (variant C) and lowest in *suji ki kheer* premix i.e. 7.37 g/serving (variant A). Whereas, micronutrients were also increased i.e. calcium and iron content was highest in *bhakar wadi* i.e. 7.37 mg/serving and 14.57 mg/serving respectively in variant C but lowest calcium and iron content was found in *suji ki kheer* premix i.e 110.62 mg/serving and 7.19 mg/serving respectively in variant A. So it can be concluded that fermented flour increased energy, protein and micronutrients content of different recipes in comparison to malted ones and lowest content of these nutrients were prevalent in variant A i.e in unprocessed forms of flour.

CONCLUSION

It can be concluded that developed products would be helpful for local population because Bengal gram leaves and Cow pea leaves are available easily and also very cheap. Product development by Bengal gram leaves and Cow pea leaves through mixing them with Soy flour and with staple cereals like Wheat and Rice may be beneficial to prevent PEM due to its higher nutritive value and it can be beneficial for children to prevent them from malnutrition. As all the products were organoleptically acceptable, nutrient dense and low in cost. Thus it can act as a panacea in combating the various problems prevalent during early period of life.

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