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Processing and Assessment of Quality Characteristics of Composite Baby Foods

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Abstract**—**The usefulness of weaning foods to meet the nutrient needs of children is well recognized, and most of them are precooked roller dried mixtures of cereal and/or legume flours which posses a high viscosity and bulk when reconstituted. The objective of this study was to formulate composite weaning foods using cereals, malted legumes and vegetable powders and analyze them for nutrients, functional properties and sensory attributes. Selected legumes (green gram and lentil) were germinated, dried and dehulled. Roasted wheat, rice, carrot powder and skim milk powder also were used. All the ingredients were mixed in different proportions to get four formulations, made into 30% slurry and dried in roller drier. The products were analyzed for proximate principles, mineral content, functional and sensory qualities. The results of analysis showed following range of constituents per 100g of formulations on dry weight basis, protein, 18.1-18.9 g ; fat, 0.78-1.36 g ; iron, 5.09-6.53 mg; calcium, 265-310 mg. The lowest water absorption capacity was in case of wheat green gram based and the highest was in rice lentil based sample. Overall sensory qualities of all foods were graded as "good" and "very good" with no significant differences. The results confirm that formulated weaning foods were nutritionally superior, functionally appropriate and organoleptically acceptable.

Keywords**—**malted legumes, weaning foods, nutrition, functional properties

I. Introduction

ALTHOUGH breast milk is adequate to meet the energy and nutrient requirements of an infant up to four to six months of age, thereafter it is insufficient to sustain normal growth and needs to be supplemented with other foods, such as weaning foods. However, the capacity of a weaning diet to meet the protein and energy requirements of infants depends on its nutritional quality as well as its dietary bulk. This can be achieved through legume supplementation of cereal-based weaning foods. However, their role appears to be limited because of several factors including low protein and starch digestibility, poor mineral bioavailability and high antinutritional factors [1,2,3]. It has been reported that protein and thiamin [4] mineral bioavailability [5] and protein and starch digestibility [6] increased, whereas phytic acid [4] and tannin [3] decreased during germination of legumes.

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Legumes are known to contain lysine in a quantity that exceeds the requirements for human but with the low content of sulphur amino acids. Cereals, on the other hand, are high in the sulphur amino acids but deficient in lysine. A mutual complementation of amino acids and consequent improvement in protein quality is therefore achieved when legumes are blended with cereals in the right proportions.

II. Materials and Methods

Green gram (*Phaseolus aureus*) and lentil (*Lens culinaris*) were obtained from local market. Legume seeds were cleaned, washed and soaked in 4-5 volumes of water (22-25 ºC) for 12 h under ambient laboratory conditions. At the end of the period, the water was drained and the seed samples were allowed to germinate under a wet muslin cloth for 24 h and then dried in a cabinet dryer at 50 ± 5 ºC for 16-18 h. Germinated samples were dehulled in a dehusker. Samples of wheat (Triticum aestivum), rice (Oryza sativa), Skim milk and carrot powders were procured from local market. Dehulled (after germination) green gram and lentil flours were milled to flour in plate mill. Whole wheat was roasted in a cylindrical roaster for 10 min at 110 ºC and milled in plate mill. Rice also was milled in plate mill. Four weaning foods were formulated with 60% roasted wheat flour or rice flour, 25% germinated and dehulled green gram or lentil flour, 10% skim milk powder and 5% carrot powder. They were called (WG) wheat and green gram based, (RG) rice and green gram based, (WL) wheat and lentil based, (RL) rice and lentil based. The formulated weaning foods were made to 30% slurry, homogenized in colloidal mill and then roller dried in double drum drier. The products were milled in hammer mill and packed in LDPE and metalized polyester bags. The bags were stored at room temperature till further analysis.

Moisture, fat and ash contents were estimated by standard AOAC methods [7]. The nitrogen content was estimated by Kjeldhal method, based on that plant proteins contain 16 % nitrogen, protein content was calculated using the formula, protein= nitrogen x 6.25 [7]. Carbohydrate content was calculated by difference. The samples were ashed in a muffle furnace and ash solution was prepared by dry ashing. Iron was estimated colorimetrically by α-α- dipyridyl method [7]. Calcium was analysed by precipitation as calcium oxalate and subsequent titration by potassium permanganate [7]. Phosphorous was estimated colorimetrically [8]. Insoluble and soluble dietary fiber was analyzed by separation of non-starch polysaccharides by enzymatic gravimetric method [9].

The water absorption capacities (WAC) of the samples were determined by the centrifuge technique described by [10]. Bulk densities of the samples were determined [11]. Percent dispersibility was determined [12].

The four formulated weaning foods were evaluated for color, smoothness, stickiness (easy to swallow), aroma, taste

and overall quality using following scale; excellent (9-10); very good (7-8); good (5-6); fair (3-4); and poor (1-2). The score card developed for this purpose was given to a panel consisting of 30 panelists (semi trained). The different products were ranked for individual quality attributes and also to score for overall quality on a 10 point scale.

The analysis was carried out in four replicates for all determinations. The mean and standard deviation of means were calculated. The data were analyzed by one-way analysis of variance (ANOVA). A multiple comparison procedure of the treatment means was performed by Duncan's New Multiple Range Test [13]. The correlation coefficients were computed and regression equations were made. Significance of the differences was defined as $P<0.05$.

III. Results and Discussion

The nutritional characteristics of the formulated weaning foods are presented in Table 1. The moisture content of foods ranged from 4.2 to 4.3 g% and their protein content ranged from 18.1 to 19.0 g%. There were significant ($P< 0.05$) differences between moisture and protein contents of wheat and rice based weaning foods. Fat and ash contents ranged from 0.78 to 1.36 g% and 1.73 to 2.43 g% respectively. WG had the highest fat and ash contents and RL had the lowest ones. The differences of fat and ash contents between the foods were significant ($P< 0.05$). These values are in the same range of foods developed by other researchers, as reported for malted cowpea, sorghum weaning food and malted ragi and green gram weaning food, respectively [14]. Carbohydrate contents of rice based weaning foods were significantly ($P< 0.05$) higher than wheat based weaning foods. It could be due to higher level of carbohydrate in rice than wheat. Iron, calcium and phosphorous contents were the highest in WG and lowest in RL. The dietary fiber fractions of all the weaning foods were comparatively low, which could be due to incorporation of dehulled legume flours. The total dietary fiber contents were in range of 3.45 to 7.49 g%. Statistical analysis confirms the significant ($P< 0.05$) differences between dietary fiber fractions of the formulated weaning foods.

Water absorption capacity gives an indication of the amount of water available for gelatinization. Lower absorption capacity is desirable for making thinner gruels. The experimental formulations had absorption capacities in the range of 465 to 530 g of water absorbed by 100 g of sample (Table 2). The lowest WAC was in case of WG and the highest was in RL sample. The bulk density values of WG, WL, RG and RL weaning foods were 60, 62, 59 and 61g/100 ml (Table II). These values are in agreement with the results reported for malted sorghum and cowpea (57 g/100 ml) [14] and for malted chickpea based weaning food (72 g/100 ml) [15]. The dispersibility of a mixture in water indicates its reconstituability. The higher dispersibility, the better the reconstitution property. The percentage dispersibility of the weaning food formulations were 74, 72, 72 and 78% for WG, WL, RG and RL samples, respectively (Table 2). Reference [12] studied the percent dispersibility of the sorghum malt based weaning food formulations and a commercial weaning food. They reported 63 to 79% dispersibility for their formulations with different proportion of ingredients and a very poor dispersibility of only 40% in case of commercial preparation.The formulated weaning foods were evaluated for sensory attributes and results are presented in Table 3. All the weaning foods were graded as "good" and "very good". There were significant ($P< 0.05$) differences between overall quality of WG and RL with WL and RG. The overall qualities of WG and RL formulations were superior and graded as "very good" compared to WL and RG, which were graded "good".

IV. Conclusion

The four types of weaning foods, which were formulated based on rice, wheat, lentil and green gram also had desirable nutritional quality as well as functional and sensory properties. Hence, it can be recommended that germinated dehusked legumes can be used in combination with cereals and vegetables for producing composite weaning mixes, which will prove to be of immense benefit especially for young children in developing countries, because of their low cost and ease of preparation.

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TABLE I
NUTRITIONAL COMPOSITION OF FORMULATED WEANING FOODS (PER 100G ON DRY WEIGHT BASIS) *

Parameter	Formulated weaning foods			
	Wheat+ Green gram	*Wheat+ Lentil*	*Rice+ Green gram*	*Rice+ Lentil*
Moisture (g)	4.2 ±0.01 [a]	4.2 ±0.01 [a]	4.3 ±0.01 [b]	4.3 ±0.02 [b]
Protein (g)	19.0 ±0.3 [a]	18.8 ±0.1 [a]	18.3 ±0.2 [b]	18.1 ±0.1 [b]
Fat (g)	1.36 ±0.01 [a]	1.27 ±0.01 [b]	0.87 ±0.02 [c]	0.78 ±0.02 [d]
Ash (g)	2.43 ±0.03 [a]	2.17 ±0.08 [b]	1.94 ±0.11 [c]	1.73 ±0.07 [d]
Carbohydrate(g)**	73.01 ±1.2 [a]	73.56 ±1.4 [a]	74.59 ±1.5 [b]	75.09 ±1.3 [b]
Iron (mg)	6.53 ±0.21 [a]	5.22 ±0.21[bc]	5.48 ±0.21[b]	5.1 ±0.15 [c]
Calcium (mg)	310 ±12.9 [a]	292 ±8.1 [b]	272 ±7.9 [c]	265 ±7.1 [c]
Phosphorous (mg)	403 ±10.4 [a]	385 ±6.9 [b]	338 ±7.3 [c]	295 ±8.6 [d]
Soluble dietary fiber (g)	1.52 ±0.01 [a]	0.24 ±0.01 [b]	0.1 ±0.01 [c]	0.14 ±0.01 [d]
Insoluble dietary fiber (g)	5.97 ±0.03[a]	6.56 ±0.06 [b]	3.52 ±0.03 [c]	3.31 ±0.01[d]
Total dietary fiber (g)	7.49 ±0.04[a]	6.8 ±0.06 [b]	3.62 ±0.03 [c]	3.45 ±0.01 [d]

* Values are expressed as mean ± standard deviation (n =4)
** by difference
All mean scores bearing different superscripts in rows are significantly different on application of Duncan's New Multiple Range Test (P< 0.05).

TABLE II
FUNCTINAL PROPERTIES OF FORMULATED WEANING FOODS

Parameter	Formulated weaning foods			
	Wheat+ Green gram	*Wheat+ Lentil*	*Rice+ Green gram*	*Rice+ Lentil*
Color	5.96 ±1.97 [a]	5.84 ±1.04 [a]	6.66 ±1.71 [a]	6.64 ±1.25 [a]
Texture (Smoothness)	6.93 ±1.63 [a]	6.04 ±1.95 [a]	6.96 ±1.62 [a]	8.14 ±1.75 [b]
Texture (Stickiness)	7.28 ±1.43 [a]	6.12 ±1.9 [b]	7.32 ±1.34 [a]	6.8 ±1.98 [ab]
Aroma	6.44 ±1.92 [a]	5.64 ±1.6 [a]	5.64 ±1.5 [a]	5.42 ±2.03 [a]
Taste	5.82 ±1.42 [a]	5.0 ±1.15 [a]	5.5 ±1.82 [a]	5.7 ±1.84 [a]
Overall quality	6.62 ±1.38 [a]	5.74 ±1.11 [b]	6.36 ±1.44[b]	6.54 ±1.77 [a]

TABLE III
SENSORY EVALUATION OF FORMULATED WEANING FOODS

Parameter	Formulated weaning foods			
	Wheat+ Green gram	*Wheat+ Lentil*	*Rice+ Green gram*	*Rice+ Lentil*
Water absorption capacity (g/100 g)	465	485	500	530
Bulk density (g/100 ml)	60	62.5	59.4	61.8
Dispesibility (%)	74	72	72	78