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# Production, quality evaluation and storage stability of vegetable protein-based baby foods

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**Abstract**

Studies on the preparation of highly nutritious, soy-based baby food have been carried out. Soymilk was prepared and different formulations of baby food, based on soymilk and cereals, such as rice, wheat and corn, were finalized. Physico-chemical characteristics, biological, microbiological and shelf-life studies of the prepared products were carried out. Baby foods prepared from soymilk with corn, soymilk with rice and soymilk with wheat, contain protein 28.5, 25.0, and 26.0%, fat 9.50, 9.00 and 10.0% and carbohydrates 54.9, 58.5 and 56.0%, respectively. Protein efficiency ratios of the three formulations were comparable with casein. The products prepared were of cream-white colour, possessed good taste and fluffy texture and contained all nutrients known to be essential for babies and preschool children.


*Keywords:* Soymilk; Cereals; Baby food

## 1. Introduction

Childhood malnutrition, in the form of protein energy malnutrition, is the most common deficiency disease in the world, especially in developing countries (WHO, 1998). This is related to poor food quality, insufficient food intake and infections (Onis & Blossner, 1997). The traditional complementary foods for infants are mainly based on cereals, such as maize, rice and wheat which do not satisfy the energy needs of infants (Sanni, Onilude, & Ibidapo, 1999). Cereal grains are rich in carbohydrates but deficient in essential amino acids such as lysine, thus making their protein quality poorer than that of animals (Horn & Schwartz, 1961). Soybean is an excellent source of protein and is used in weaning foods, hypoallergenic food and vegetable mixtures mainly because of its good protein quality (Wolf, 1973). Addition of soy proteins to cereal proteins is advantageous, with the purpose of improving their nutritional values, by supplying lysine, which is abundant in soy but limiting in cereal proteins (Bornstein & Lipstein, 1962; Bressani & Mareno, 1963; Del-Velle & Montemayor, 1976; Del-Velle & Villasenor, 1974; Hayward & Diser, 1961). Fortification of cereal protein with soy protein is complimentary; when blended in correct ratios, the mixtures are nutritionally superior to either protein source by itself. Soy-based foods for feeding infants are used primarily to replace milk or milk-based formulae in the diets of children who are allergic or intolerant to milk. These products have good potential in feeding children from birth to adolescence and seem to satisfy the needs for total nitrogen and essential amino acids when ingested in adequate amounts (Torun, 1981).

There is a need for nutritionally balanced, energy-dense, easily digestible weaning foods, especially for the first six months in the case of infants who cannot be breast-fed or when breast-feeding alone becomes insufficient (Hansen, Hosek, Callan, & Jones, 1981; Weisberg, 1974). Malnutrition in developing countries is very serious for the small child, particularly after weaning, because the child enters the family eating pattern and eats not only small amounts of foods, but foods unsuitable for weaning purposes (Bressani, 1981).

Blended foods, e.g. corn soy blend (CSB), wheat soy blend (WSB) and rice soy blend (RSB) have been specially developed as nutritional supplements for the diets

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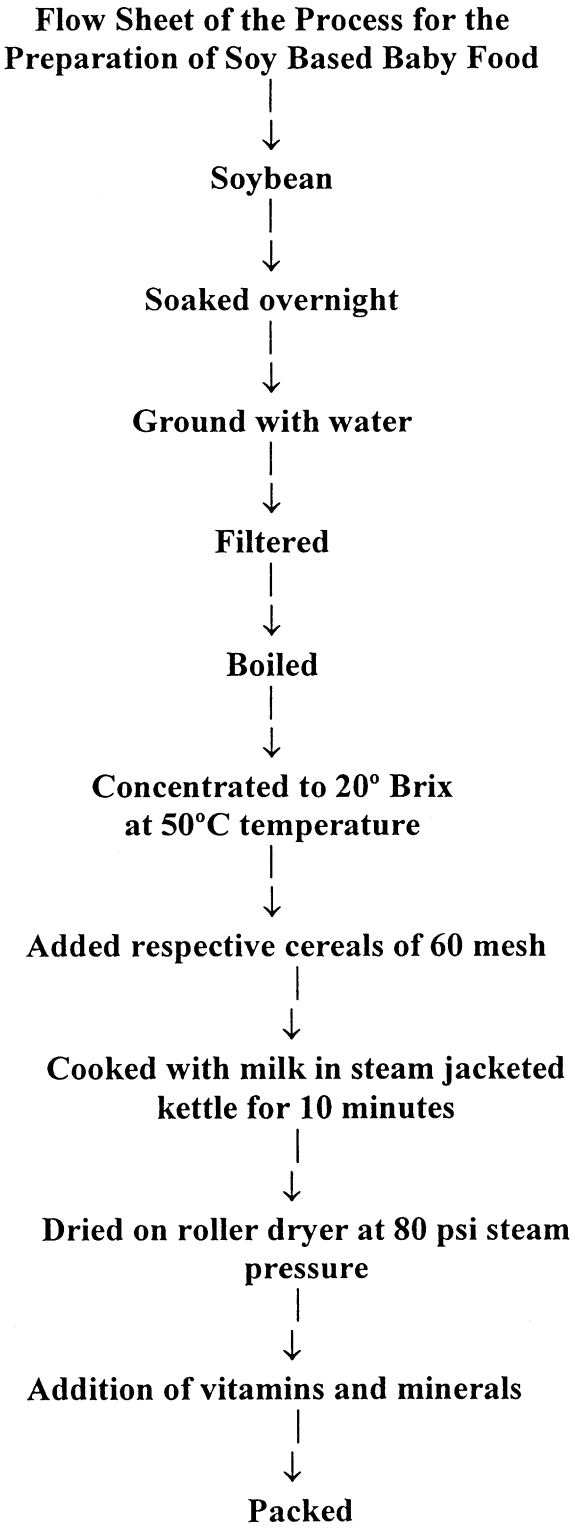
of weaning infants, preschool children, pregnant and lactating mothers in many countries of the world (Aguilera & Lusas, 1981).




Pakistan has little in the way of an organized dairy industry; often production of cow's milk is limited. The microbiological quality is poor and necessary facilities for collection, processing and bottling of milk are virtually non- existent. Under these conditions the need for infant and weaning food, at reasonable cost, based on non-dairy food ingredients, seems imperative. The main objective of the present work was to prepare soy-based baby food of high nutritional quality at reasonable cost.

## 2. Materials and methods

### 2.1. Materials

Good quality wheat, corn and rice were procured from the local market, while soybean of Lee variety (1998) Tarnab Farm, Peshawar, was used for the preparation of soymilk. Soymilk was prepared (Wadud, Kosar, Ava, & Durrani, 1987) and used in all the experiments on baby food.

The milk was concentrated under vacuum at 50 °C to 20° Brix. Rice, wheat and corn were ground to 60 mesh size and cooked with concentrated milk in a steam-jacketed kettle for 10 min until these were turned into a thick slurry. The slurry was dried on a roller dryer at 80 psi steam pressure. The products prepared were in the form of white fluffy flakes. The flow sheet of the process for the production of soybean based baby foods is presented below. The products prepared in these experiments were fortified with vitamins and minerals by dry mixing (Table 1).

Table 1
Vitamins and minerals added (per 100 g food)

| Additive | Quantity |
|---|---|
| Vitamin A (I. U.) | 1500 |
| Vitamin D (I.U.) | 300 |
| Vitamin C (mg) | 1.50 |
| Vitamin E (mg) | 28.00 |
| Vitamin B12 (mg) | 2.50 |
| Riboflavin (mg) | 1.50 |
| Pyridoxine (mg) | 0.50 |
| Nicotinic acid (mg) | 5.50 |
| Pantothenic acid (mg) | 3.50 |
| Thiamine (mg) | 0.70 |
| Iron (mg) | 6.50 |

Table 2
Chemical composition of soymilk

| Constituent | Quantity (%)[a] |
|---|---|
| Water | 90.0 |
| Protein | 3.5 |
| Fats | 2.8 |
| Carbohydrates | 3.1 |
| Ash | 0.5 |
| TSS[b] | 4.5 |

[a] Average of triplicate determinations.
[b] Total soluble solids.

Table 3
Chemical composition of soy-based baby foods[a]

| Sample | Moisture (%) | Protein (%) | Fat (%) | Carbohydrate (%) | Ash (%) |
|---|---|---|---|---|---|
| Corn soy blend | 3.00 | 28.5 | 9.5 | 54.9 | 4.10 |
| Rice soy blend | 3.20 | 25.0 | 9.0 | 58.5 | 4.30 |
| Wheat soy blend | 3.50 | 26.0 | 10.0 | 56.0 | 4.50 |

[a] Average of triplicate readings.

Table 4
Determination of net protein utilization (NPU) of soy-based baby foods

| Source of protein diet | Total protein intake (g) | Protein excreted (faeces)[a] | NPU (%) |
|---|---|---|---|
| Corn soy blend | 25 | 4.30 | 84.3 |
| Rice soy blend | 25 | 4.68 | 83.8 |
| Wheat soy blend | 25 | 5.00 | 83.0 |
| Pure casein | 25 | 3.70 | 85.0 |

[a] Average of triplicate readings.

### 2.2. Analytical work

The products prepared were analyzed for moisture and total protein content according to AACC (1995); pH and acidity were determined by the method of Atherton and Newlander (1982). Ash and carbohydrates were determined by AOAC (1990) methods. Total viable count was carried out as described by Robinson (1990) and the American Public Health Association (1978). Trypsin inhibitor was determined by the method of Nelson, Steiberg, and Wei (1976), while proximate composition of the samples was done by the method of Koniecko (1985).

### 2.3. Determination of protein efficiency ratio (PER) of soy-based baby food

For the PER value determination, 20 albino rats, weighing 120±2 g, were divided into four groups. One was a control, given casein and the other three groups were fed on soy-based baby food, i.e. corn soy blend, wheat soy blend and rice soy blend, respectively, along with their normal diet. Feeding was continued for a period of 40 days and a record of feed intake and weight gain was maintained. PER was calculated by dividing the weight gain by the protein intake during the experimental period.

### 2.4. Determination of net protein utilization (NPU)

Net protein utilization of various formulations of soy-based baby foods was determined (Miller & Bender, 1955) using 16 albino rats. For this purpose four groups of albino rats, of 200±2 g each, were selected. One group received casein and the other three groups received soy-based baby foods along with their normal diets. After every 24 h, faeces were collected, mixed thoroughly, and nitrogen was determined by the Kjeldahl method. Approximate nitrogen assimilation was calculated as follows:

$$\frac{(\text{Food N} - \text{faeces N}) \times 100}{\text{Food Nitrogen}} = \%\ \text{Nitrogen Assimilated.}$$

### 2.5. Sensory evaluation

The samples of baby foods, prepared from soymilk with cereals, were organoleptically evaluated according to the Larmond (1977) method. Baby food available in the market was used as a reference. The products were served to a panel of 12 judges on three separate days and mean score of every product was determined.

### 2.6. Bacteriological condition

The product was examined microbiologically for total viable bacterial count, yeast and mould, total coliform, salmonella and shigella. Total count was determined by using nutrient agar; yeast and mould counts were carried out on malt extract agar, coliform on lactose broth, salmonella on bismuth sulphite agar and shigella on MacConkey's and desoxycholate agar.

Table 5
Protein efficiency ratio (PER) of soy-based baby foods

| Source of protein | Protein intake (g) | Weight gain[a] (g) | PER |
|---|---|---|---|
| Corn soy blend | 16 | 51 | 3.18 |
| Rice soy blend | 16 | 50 | 3.12 |
| Wheat soy blend | 16 | 48 | 3.00 |
| Pure casein | 16 | 52 | 3.25 |

[a] Average of triplicate readings.

### 2.7. Shelf life studies

The soy-based baby foods were packed in polyethylene bags (200 g each), sealed and kept at two temperatures (ambient and 37 °C). Two samples from each lot were examined at monthly intervals for peroxide value and moisture content up to a storage period of 180 days.

## 3. Results and discussion

Present studies have been conducted for the preparation of soy-based baby foods. In this regard, soymilk has been prepared with bland taste and free of beany flavour and trypsin inhibitor (Table 2). Soymilk was mixed with different cereals, i.e. wheat, rice and corn under similar conditions. Three products of soy-based baby food, i.e. wheat soy, rice soy and corn soy blends, were prepared (Table 3). Protein content of the products varied from 25.0 to 28.5% whereas fat ranged between 9 and 10%. Corn soy blend had higher protein content than the other two formulations. Results showed that there was a slight difference between NPU of the three formulations as compared with casein (Table 4). The PER of the three formulations were calculated to be 3.18, 3.12, 3.00 and 3.25 and the differences between growth rates of the rats fed on corn soy blend, wheat soy blend, rice soy blend and casein were non-significant, while the gains in weight during 40 days were 51, 50, 48 and 52 g, respectively. These results indicated that nutritional qualities of the three products of soy-based baby food were almost equal to pure casein (Table 5).

All three samples of baby foods were organoleptically evaluated by 12 judges on three separate days and mean scores for colour, flavour, taste, texture and acceptability were recorded. The organoleptic evaluation (Table 6) showed that overall acceptabilities of all three samples were almost equal and similar to control. Shelf-life studies showed that moisture content had increased from 0.7 to 1.3% which indicates that rate of absorption of water in these samples was insignificant. Baby food, when prepared, had a peroxide value of 0.69–0.81 meq/kg of sample (Table 7). After six months of storage, a negligible increase in peroxide value was observed. This indicated that the product remained acceptable for six months. All the products were analyzed bacteriologically for total viable bacterial count, coliform bacteria, yeast, mould, salmonella and shigella. The overall bacteriological status of the product was observed to be satisfactory. Total bacterial counts of the foods were: rice-soy-based food $80 \pm 2.78$, corn-soy-based food $82 \pm 1.89$, wheat-soy-based food $105 \pm 3.15$; however, yeast/mould, coliform, salmonella and shigella

Table 6
Organoleptic results of soy-based baby foods (mean score of 12 judges on three separate days)

| Sample | Colour (10) | Flavour (10) | Taste (10) | Texture (10) | Acceptability (10) |
|---|---|---|---|---|---|
| Corn soy blend | 8.00 | 7.50 | 8.50 | 9.00 | 8.50 |
| Rice soy blend | 7.50 | 7.50 | 8.00 | 8.50 | 8.50 |
| Wheat soy blend | 7.50 | 7.50 | 8.00 | 8.50 | 8.00 |
| Control | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 |

Table 7
Shelf-life studies on baby foods

| Product | Storage Time (days) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 30 | | 90 | | 180 | |
| | RT[a] | RT | 37 °C | RT | 37 °C | RT | 37 °C |
| *Corn soy blend* | | | | | | | |
| Moisture (%) | 3.00[b] | 3.10 | 3.15 | 3.20 | 3.35 | 3.60 | 3.70 |
| Peroxide value meq/kg of sample | 0.75 | 8.83 | 0.90 | 1.19 | 1.25 | 2.75 | 2.90 |
| *Rice soy blend* | | | | | | | |
| Moisture (%) | 3.50 | 3.60 | 3.66 | 3.80 | 4.01 | 4.20 | 4.31 |
| Peroxide value meq/kg of sample | 0.69 | 0.72 | 0.79 | 1.75 | 1.85 | 2.70 | 2.79 |
| *Wheat soy blend* | | | | | | | |
| Moisture (%) | 3.50 | 3.60 | 3.66 | 3.80 | 4.01 | 4.20 | 4.31 |
| Peroxide value meq/kg of sample | 0.69 | 0.72 | 0.79 | 1.75 | 1.85 | 2.70 | 2.79 |

[a] RT = room temperature.
[b] Average of triplicate readings.

were found to be absent in all the foods. Low total count indicated that suitable sanitary conditions were maintained throughout the process. Chemical, microbial, biological and organoleptic observations suggested that the foods prepared were nutritious and suitable for babies and preschool children.

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