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PREPARATION AND NUTRITIONAL EVALUATION OF WEANING FOOD BASED ON WHEAT, RICE AND SOYBEAN (*SOYLAC*)

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A weaning food (brand name, *Soylac)* based on a blend of wheat, rice, trypsin inhibitor free soybeen meal and fortified with essential vitamins and minerals was prepared. Chemical and biological evaluation of food showed that it was of high nutritive value and conformed to FAO/WHO/Protein Advisory Group's specification for weaning foods. It is cheaper to produce and has a better nutritive value than that of *Protofex* [1] and *Protolac* [2].

INTRODUCTION

There is a need at this time to produce infant food because a large amount of baby food is being imported in Pakistan and the demand for it is increasing every year. There is a great shortage of protein rich cheap food to meet the energy and nutrient requirements of growing infants. An average Pakistani family cannot afford the imported infant food and the quantity of breast milk supplied by the mother is not sufficient to meet the requirement of a six-month old baby. Consequently, starchy food is usually given to the babies and that too in a unhygienic manner, with the result that the infant may contract diarrhoea. Investigations are therefore being made to minimise protein calories malnutrition and to develop a cheap weaning food from both conventional and non-conventional sources.

In earlier reports [1, 2], we have described the preparation and nutritional evaluation of a weaning food based on a mixture of cereals, skim milk powder and legumes named as *Protofex* and *Protolac.* Prices of legumes (chick pea) and skim milk have gone up three times and twice respectively over the last two years in Pakistan. Attempts have been made to reduce the quantity of skim milk protein to about half of that present in *Protofex.* The chick pea as a protein source in *Protolac* has been replaced by a non-conventional source of protein viz protein from soybean cake. As reported by R. Brocher [3], the trypsin inhibitor can be removed from soybean and brought down to a safe level, but we have modified the procedure and the trypsin inhibitor from oil expelled cake has been completely removed. Oil expelled cake thus prepared was used in the recently developed baby food named *Soylac* which contains wheat, broken rice, skim milk and trypsin inhibitor free soybean meal.

The protein content of *Soylac* is 20%. It is cheaper to produce and has a better nutritive value than *Protofex* and *Protolac.*

The present investigation deals with the preparation and the biochemical, biological and clinical evaluation of *Soylac.*

MATERIAL AND METHODS

Preparation of Trypsin Inhibitor Free Soyflour: Soybean seeds obtained from the Seed Division of Pakistan Ghee Corporation contained 22% oil. The oil was extracted from the cleaned and dehulled seeds by means of an oil expeller. The oil expelled cake, containing 7-8% oil, was ground into a 20-22 mesh size.

Four litres of water were added to 1 kg of flour and a slurry was made. It was autoclaved at 20 lb presssure for 30 min. The moisture of this prepared flour was evaporated in a cabinet dryer and the dry material stored for the production of baby food. Trypsin inhibitor units of soybean, oil expelled cake and soyflour were determined according to the method of R. Brocher [3]. The results are shown in Table 1.

Table 1.

Sr. No.	Material	Inhibition (%)	Trypsin inhibition unit ($\times 10^{-3}$)
1.	Raw soybean	54.5	2.4
2.	Soy cake from oil expeller	30.0	1.3
3.	Autoclaved soy cake	7.0	0.32
4.	Soylac	nil	nil

Flour prepared as mentioned above was almost free from trypsin inhibitor and was used as a cheap source of protein in baby food.

Preparation of Soylac: Cereals such as wheat and broken rice were purchased from the local market. They were thoroughly cleaned, and flours were made and stored separately. Skim milk was also purchased from the local market. ' Soybean meal free from trypsin inhibitor was prepared as described earlier.

A mixture of soybean meal, wheat, rice, milk, minerals and water was cooked for 25 min. and the cooked slurry dried in thin flakes on a twin cylinder-roller dryer at 40 lb psi. The flakes were milled and vitamins were added and mixed to meet the requirement of FAO/WHO/UNICEF Protein Advisory Group for Weaning Food [4].

Biological Evaluation: Net Protein Utilization Operative (NPU_{op}) was determined according to the method of Platt *et at* [5] using albino rats weighing 40-45 g. NPU standardized (NPU st) was calculated using the formula [6]:

$$NPU_{st} = \frac{NPU_{op} \times 54}{54 - P} = 8, \text{ where P is protein cals (\%)}$$

Net Dietary Protein Calories (NDP cals %) were calculated by the formula [5]:

$$\text{NDP cals \%} = NPU_{op} \times \text{protein calories (\%)}$$

Protein Efficiency Ratio: Soylac and maize starch were mixed in 1:1 ratio to make up 10% protein level of the diet. PER was determined at 10% protein level according to the method of Chambell [6] using albino rats. In addition to the test group a reference standard group of rats on skim milk diet at 10% protein level was also maintained. Feeding was continued for a period of 4 weeks and records of weight gain and food intake were maintained. PER was calculated by dividing the weight gain with the protein intake during the experimental diets as shown in Table 2.

Table 2. Protein Values of Diet

Diet	Protein calories (%)	NPU_{op} (%)	NPU_{st} (%)	NDP cals %	PER
Skim milk	10.0	76.1	85.4	7.6	3.1
Soylac	20.7	60.5	90.0	12.5	2.7

Chemical Analysis: The food was analysed for moisture, protein, fat, crude fibre, ash, iron and vitamin C according to the AOAC methods [7]. Iron was determined according to the method described by Andrew and Fell [8]. Vitamin A, thiamine and riboflavin were estimated according to methods given in vitamin assays [9]. Total bacterial count and coliform count were determined according to the method given in the *Hand Book of Practical Bacteriology* [10]. The results are given in Table 3.

Clinical Evaluation: The food was tested on infant ranging in age from 4 to 12 months. Studies were made with 8 children in each group selected at random from those admitted to the Nutrition Unit of the Department of Child Health, Mayo Hospital, Lahore. All of these were suffering from protein-caloric malnutrition (marasmus). The food was prepared by adding 6 spoons of *Soylac* to 160 ml of boiled, luke-warm water or milk and a teaspoon (5 g) sugar was also added to each feed. Food was given to infants at 4 hourly intervals and each infant was given 5 feeds a day. The unused portions of each feed were collected together and its weight was deducted from the total food given in a day. A second group of 8 infants was given *Soylac* mixed with cow's milk instead of lukewarm water. Changes in body weight, length, blood haemoglobin, serum protein of each infant as shown in Table 4 were determined weekly. The experiment was designed to last for 8 weeks, but as in many cases mothers refused to keep their babies in the hospital for such a long time, the various measurements were recorded until the children left the hospital.

RESULTS AND DISCUSSION

Bacteriological and biochemical analyses of *Soylac* as shown in Table 3 are compared with the Pakistan Standard Institte (PSI) and Protein Advisory Group, specifications for weaning food/mixtures and the recommended daily allowances by FAO/WHO for infants. From the above mentioned table it can be observed that *Soylac* conform to

Table 3. Composition of *Soylac* compared with Pakistan Standard Institute and Protein Advisory Group (PAG) Specification for Cereals Infant Foods

	Soylac	PSI specification	PAG specification	Daily recommended allowances FAO/WHO
1. Moisture (%)	6.5	Max. 6.0	5-10	
2. Protein (%)	19.4	Min. 14.0	Min. 20.0	2.3-1.2/kg
3. Fat (%)	3.81	Max. 7.0	Max. 10.0	–
4. Ash (%)	4.2	Max. 5.0	5-10	–
5. Crude Fibre (%)	1.25	Max. 1.0	Max. 5.0	–
6. Carbohydrates (%)	64.9	–	–	–
7. Calcium (%)	1.1	Max. 1.0	Min. 0.3	1.0 gm
8. Iron mg/100 g	14.0	Min. 10.0	Min. 10.0	6.0 mg
9. Vitamin A IU/100 g.	1550	Min. 1500	Min. 1400	1100
10. Thiamine mg/100 g	1.2	Min. 0.5	Min. 0.3	0.4
11. Riboflavin mg/100 g	1.3	Min. 0.6	Min. 0.4	0.6
12. Niacin mg/100 g	5.8	Min. 5.0	Min. 5.0	4.0
13. Vitamin C mg/100 g	25	Min. 25.0	Min. 20.0	30
14. Vitamin D IU/100 g.	400	Min. 300	Min. 400	–
15. Calories/100 g	372	–	–	110/kg
16. Total bacterial count/g	5000	Max. 50000	–	–
17. Coliform count/g	nil	Max. 10	–	–

Table 4. Experiment period 4 weeks, 8 infants per group

	Soylac water	*Soylac* with milk
Average wt. in kg of 8 infants	4.5	4.7
Average food intake in g/day	151	146
Protein intake in g/kg body wt.	6.4	7.0
Calories intake per kg body wt.	125	123
Gain in wt. in kg in 4 weeks	1.3	1.3
Increase in height in cm in 4 weeks	4.4	4.3
Serum protein at the start of experiment	4.4	4.8
Serum protein at the end of experiment	6.3	6.4
Haemoglobin % at the start of experiment	10.8	10.5
Haemoglobin % at the end of experiment	11.2	11.0

Reference protein gm/kg body wt. NPU_{st} x protein intake

g/kg body wt. $\frac{90 \times 6.4}{100} = 5.7$

PAG and PSI specifications and only 100 g of *Soylac* are required to meet the vitamins and minerals requirement of 0 to 1 year old infants. In fact some of the nutrients are in higher amounts than the daily recommended allowances.

Bacteriological analysis of *Soylac* showed that food is safe for infant feeding. It was free from coliforms and the total count/g was 5000 which was much less than the maximum prescribed for weaning food.

Biological Evaluation: As a shown in Table 2, the NPU operative of *Soylac* was found to be 60.5 whereas NPU standardized is 90.0 which eliminates the effect of protein concentration. From the results it is also observed that the NPU_{op} and NPU_{st} of *Soylac* are higher than those of the previous roducts, *Protofex* and *Protolac*. According to an FAO/WHO report [11] and Platt *et al* [6]. Food combinations having NDP cals % less than 8 are incapable of meeting the protein requirement of infants. The NDP cals % of *Soylac* was found to be 12.5 as shown in Table 2. The PER of *Soylac* was 2.7 which also indicates that the protein quality of *Soylac* is similar to that of milk. Our observations have shown increase in length, height, serum protein and haemoglobin contents of infants fed on *Soylac* with or

without milk. It was also observed (Tabl 4) that infants fed on *Soylac* with water and *Soylac* with milk gave similar results. Thus milk is not required by infants on this formula. Hence *Soylac* with water can be given to infants.

It can be also observed from the Table 4 that reference protein intake was 5.7 g/kg which was three times the bodily needs of infants.

According to an F.A.O. [11] report, safe levels of intakes of egg or milk protein (NPU = 100) for infants are 1.7 g/kg body weight which indicates that infants fed on *Soylac,* ven when mixed with water, receive their full daily calories and protein requirements. Thus it can be concluded that *Soylac* is a complete semi-solid weaning food. It is better than cow's milk, and it also contains adequate quantities of iron and vitamin C, which are deficient in cow's milk. *Soylac* can be administer as a better substitute for milk.

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