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STUDIES ON A PROCESSED PROTEIN FOOD BASED ON A BLEND OF GROUNDNUT FLOUR AND FULL-FAT SOYA FLOUR FORTIFIED WITH ESSENTIAL AMINO ACIDS, VITAMINS AND MINERALS

V. EFFECT OF SUPPLEMENTARY PROTEIN FOOD ON THE METABOLISM OF NITROGEN, CALCIUM AND PHOSPHORUS IN UNDERNOURISHED CHILDREN SUBSISTING ON A RICE DIET

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In earlier publications from this laboratory, Joseph *et al.*,[1,2] and Kurien *et al.*,[3,4] have reported that undernourished children subsisting on poor Indian diets based mainly on rice, jowar (*Sorghum vulgare*), ragi (*Eleucine coracana*) and bajra (*Pennisetum typhoideum*) maintained on an average, slight positive nitrogen and calcium balances, which were inadequate for promoting optimum growth of the children. Supplementation of a poor rice diet daily with 2 oz of a processed protein food based on a 2 : 1 : 1 blend of groundnut flour, Bengalgram flour and low-fat coconut meal or with 50g of fortified groundnut flour, made up the deficiencies in the diet, and brought about a significant increase in the growth and nutritional status and also in the retention of nitrogen, calcium and phosphorus in children.[5,6] In an earlier paper, it has been reported that supplementation of the diet of undernourished children, daily with 40g of protein food based on a 1 : 1 blend of groundnut flour and full-fat soya flour fortified with l-lysine, dl-methionine and adequate quantities of calcium salts and vitamins A and D, thiamine and riboflavin brought about a marked improvement in their growth and nutritional status.[9] The present paper describes the results of studies on the effect of the protein food on the metabolism of nitrogen, calcium and phosphorus in the children.

Experimental

Subjects: The metabolism studies were carried out, when the feeding trials with the protein food based on a 1 : 1 blend of groundnut flour and full-fat soya flour had been in progress for a period of 3 months. The feeding trial was started in July 1962 and the metabolism study was carried out in October 1962. Eight pairs of girls aged 9-10 years were selected for the study, from among the subjects of the feeding trial. The age, height and weight of the experimental children, at the time of the metabolic study are given in Table I. The girls of each pair were similar in age, height and weight. They were clinically examined and found free from ailments likely to interfere with the study.

Table I. *Age, height and weight of the children at the beginning of the metabolic experiment*

Subject No	Age (years)	Height (cm)	Weight (kg)
	Rice diet (Control)		
1	10	132	25.9
2	10	129	22.7
3	9	122	23.1
4	9	122	21.3
5	9	121	19.1
6	9	118	18.3
7	9	122	21.5
8	9	111	17.7
	Rice + protein food diet (Experimental)		
1	10	130	23.2
2	10	127	22.9
3	9	126	22.9
4	9	121	21.4
5	9	120	20.9
6	9	118	18.7
7	9	122	21.1
8	9	109	17.0

Experimental diets and feeding of children: The procedure adopted for the metabolic study was similar to that of Parthasarathy *et al.*[8] The composition of diets consumed by the subjects during the metabolic experiment was the same as that consumed by the subjects during the feeding study.[9] The pattern of breakfast, lunch and dinner was also the same. Duplicates of all dishes consumed by each subject were collected daily, dried in an air oven at 80-90°C, and analysed for nitrogen, calcium and phosphorus.

Plan of study: The experimental period lasted for seven days. During the first two days, the children were left to get accustomed to the equipment used for the collection of urine and faeces which were collected only during the last 5 days. The methods used for collection and preservation of urine and faeces were the same as those of Murthy *et al.*[10]

Analytical methods: The methods for the estimation of nitrogen, calcium and phosphorus in diet, urine and faeces were the same as those of Murthy *et al.*[10] The different analyses were carried out in duplicate.

Results

The results for nitrogen metabolism are given in Table II; those of calcium and phosphorus metabolism are given in Table III.

The mean daily intake of calories, protein, calcium and vitamins on the control rice diet fell short of the recommended allowances suggested by the Indian Council of Medical Research, Nutrition Advisory Committee.[11] Supplementation of the control diet daily with 40g of protein food supplement made up to a certain extent the deficiencies of protein, calcium and vitamins in the diet.

Nitrogen metabolism: The mean daily intakes of nitrogen by the children on the rice diet (control) and rice-protein food diet (experimental) were 6·35 and 9·13g respectively. The mean daily excretion of nitrogen in urine of children receiving rice diet (3·23g) was less than that (5·28g) of children receiving the rice-protein food diet. The apparent digestibility of the proteins in the rice-protein food diet (85·7%) was significantly ($P < 0·001$) higher than that (74.3%) of the proteins in the rice diet. The mean daily retention of nitrogen on the rice diet and rice-protein food diet were 1·49 and 2·54g respectively, the difference being significant at 0·1% level. All the children on the two diets were on positive nitrogen balance.

Calcium metabolism: The mean daily intakes of calcium on the rice diet and rice-protein food diet were 267 and 634 mg respectively. The mean daily calcium retentions were 33 and 183 mg respectively, the difference being significant at 0.1% level. All the children on the two diets were on positive calcium balance.

Phosphorus balance: All the subjects on the two diets were on positive phosphorus balance. The mean daily intakes of phosphorus on a rice diet and rice-protein food diet were 826 and 1180 mg respectively. The mean daily phosphorus retention on the rice-protein food diet (388 mg) was significantly higher than that (155 mg) observed on rice diet, the difference being significant at 0·1% level.

Discussion

It is evident from the results (Tables II and III) that supplementation of a rice diet daily with 40g of a processed protein food based on a 1 : 1 blend of groundnut flour and full-fat soya flour fortified with 1% each of l-lysine and dl-methionine and adequate amounts of calcium salts, vitamins A and D, thiamine and riboflavin brought about a significant increase in the retention of nitrogen, calcium and phosphorus in children. In spite of the inadequate calorie intake (1520 Kcal) which fell short of the recommended allowances of the Nutrition Advisory Committee, consumption of extra protein resulted in a significant increase in the retention of nitrogen. This confirms the earlier observations of Tasker *et al.*,[7] and Parthasarathy *et al.*,[8] in their studies with a protein food containing coconut meal or based on fortified groundnut flour. The results obtained in the present and preceding paper[9] of this series have demonstrated the possibilities of using a processed protein food based on groundnut flour and

Table II. *Mean daily intake, excretion and balance[1] of nitrogen of girls on rice and rice-protein food diets*

Diet	Intake (g)	Excretion (g)			Apparent digesti-bility (%)	Balance (g)
		Urinary	Faecal	Total		
Rice diet[2]	6.35	3.23	1.63	4.86	74.3	1.49
Rice-protein food diet[3]	9.13	5.28	1.31	6.59	85.7	2.54
Difference	2.78	2.05	−0.32	1.73	11.4±2.18[4]	1.05±0.20[4]

[1] Average of 8 girls aged 9-10 years per group
[2] Calorie intake, 1520 Kcal/child/day
[3] Calorie intake, 1521 Kcal/child/day
[4] Standard error based on 7 df

Table III. *Mean daily intake, excretion and balance[1] of calcium and phosphorus of girls on rice and rice-protein food diets*

Diet	Intake (mg)	Excretion (mg)			Balance (mg)
		Urinary	Faecal	Total	
		Calcium			
Rice diet[2]	267	24	210	234	33
Rice-protein food diet[3]	634	65	386	451	183
Difference	367	41	176	217	150±25.7[4]
		Phosphorus			
Rice diet[2]	826	314	357	671	155
Rice-protein food diet[3]	1180	263	529	792	388
Difference	354	−51	172	121	233±52.2[4]

[1] Average of 8 girls aged 9-10 years per group
[2] Calorie intake, 1520 Kcal/child/day
[3] Calorie intake, 1521 Kcal/child/day
[4] Standard error based on 7 df

full-fat soya flour and fortified with essential amino acids and adequate amounts of calcium salts and vitamins, as an effective supplement to the poor dietary of the vulnerable groups of the population in regions where protein-rich and protective foods like milk, eggs, meat etc., are not available in adequate quantities.

Summary

1. The metabolism of N, Ca and P was studied in 8 pairs of girls aged 9-10 years similar in height and weight and fed on a diet based on rice or the same supplemented daily with 40g of processed protein food based on a blend of groundnut flour and full-fat soya flour fortified with lysine and methionine and adequate quantities of essential vitamins and minerals.

2. The mean daily N intakes on the rice diet and rice-protein food diet were 6.35 and 9.13g respectively. The apparent digestibility coefficients of the protein in the above diets were 74·3 and 85·7% respectively. The mean daily N retention on rice-protein food (2.54g) was significantly ($P<0·001$) higher than that on the rice diet (1·49g).

3. The mean daily intakes of Ca on the rice diet and rice-protein food diet were 267 and 634 mg. respectively. The mean daily calcium retention on the rice-protein food diet (183 mg) was significantly ($P < 0.001$) higher than that (33 mg) obtained on the rice diet.

4. The mean daily intakes of P on the rice diet and rice-protein food diets were 826 and 1180 mg respectively. The mean daily phosphorus retentions were 155 and 388 mg respectively, the difference being significant at 0·1% level.

5. All the children on the control rice diet and experimental rice-protein food diet were on positive N, Ca and P balance.

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