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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

IV. EFFECT OF SUPPLEMENTARY PROTEIN FOOD ON THE GROWTH AND NUTRITIONAL STATUS OF SCHOOL CHILDREN

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The diets consumed by a great majority of the population in many of the developing countries in the world contain negligible amounts of protein-rich and protective foods[1]. In view of the shortage in the production of milk and other protective foods in these countries, studies have been carried out by several workers on the use of protein-rich foods of vegetable origin as effective supplements to the diets of the vulnerable groups of the population[2-4]. In the earlier papers, the results of studies on the preparation and nutritive value of a protein food based on a 1:1 blend of full-fat soya flour and edible groundnut flour and fortified with 1% each of l-lysine and dl-methionine and adequate amounts of calcium salts, vitamins A and D, thiamine and riboflavin, have been reported.[5,6] The present paper describes the results of studies on the effect of supplementing the diets of school children with the protein food on their growth and nutritional status.

Experimental

Protein food: The protein food based on a 1 : 1 blend of full-fat soya flour and edible groundnut flour and fortified with l-lysine, dl-methionine, certain vitamins and minerals, used in the present study was prepared according to Narayana Rao *et al*[5]. The nutrients supplied by a daily supplement of 40 g of protein food are given in Table I.

Table I. *Nutrients supplied by a daily supplement of 40g of protein food*

Nutrients	*Amount*
Protein (N x 6.25) (g)	19.8
Fat (g)	6.2
Carbohydrate (g)	7.4
Calcium (mg)	392
Phosphorus (mg)	300
Iron (mg)	2.5
Thiamine (mg)	0.92
Riboflavin (mg)	1.32
Nicotinic acid (mg)	4.8
Vitamin A	
as vitamin A (i.u.)	1200
as carotene (i.u.)	140
Vitamin D (i. u.)	120
Calories (k. cal)	165

Subjects: A local boarding home in Mysore having about 100 girls as inmates was chosen as the venue for conducting the present experiment. Forty girls aged 5-11 years and free from diseases likely to interfere with the experiment were selected as experimental subjects for the study.

Physical measurements and assessment of nutritional status: Height, weight, RBC count and haemoglobin content of the blood of the subjects were determined according to Reddy *et al.*[7] Height was recorded to the nearest 1/4 cm and weight to the nearest 1/20 kg. Nutritional status was determined according to the score card devised by the Nutritional Advisory Committee of the Indian Council of Medical Research[8]. On the basis of initial height, weight and nutritional status, the children were paired and the members of each pair allotted at random to two groups.

Composition of the experimental diets and feeding of the children: The two groups

of children received the boarding home diet which consisted mainly of cereals (rice and wheat) and contained only small amounts of pulses, vegetables and skim-milk powder. In addition to the usual diet, the children in the experimental group received daily, a supplement of 40 g of protein food, given in the form of chutney, along with lunch and dinner. In order to equalise the calorie intake, each child in the control group received a daily supplement of 40 g rice. The pattern of the diets consumed by the children is given in Table II.

Table II. *Pattern of diets consumed by the children*

Foodstuff	*Intake (g/child/day)*
Basal diet common to both groups :	
Rice, raw milled	200
Wheat flour (as white bread)	80
Pulses : Bengalgram dhal (*Cicer arietinum*) and horsegram(*Dolichos biflorus*)	19.8
Peanut oil	40
Common salt	10.0
Tamarind (*Tamarindus indicus*) pulp from the fruit	4.0
Condiments (Coriander red chillies, garlic, turmeric)	2.8
Meat	14.2
Vegetables (Brinjal, French beans, green plantain)	38.4
Roots and tubers, (Radish, Onion)	13.0
Jaggery	20.0
Skim milk powder	7.1
Banana, ripe	25 0
Supplement	
Control group : Rice raw, milled	40.0
Experimental group : Protein food	40.0

The mean consumption unit for both the groups calculated from the international scale of family co-efficients, League of Nations Health Organization 1932, was found to be 0 8.

The nutritive value of the diets consumed by the subjects in the control and experimental groups were calculated using the data given by Aykroyd *et al.*[6], for the nutritive value of different foodstuffs The results together with the dietary requirements suggested by the Indian Council of Medical Research, Nutritional Advisory Committee for children of similar age group are given in Table III.

All the children relished the supplement and none complained of any digestive trouble. The experiment lasted for a period of 5½ months at the end of which, height, weight, nutritional status, red blood cell count and haemoglobin content of the blood of the children were determined.

Table III. *Mean daily intake of different nutrients by the children as compared to recommended allowances*

Nutrient	Control group	Experimental group	N. A. C Standard*
Calories	1520	1521	2000
Protein (N x 6·25)g	39.9	57.1	57.0
Fat (g)	9 9	15.9	—
Carbohydrate (g)	317 6	287.3	—
Calcium (g)	0 27	0.65	1 0-1.5
Phosphorus (g)	0.88	1.14	—
Iron (mg)	8.7	10.6	10-30
Vitamin A			
as vitamin A (i.u.)	9	1209	3000-4000
as carotene (i u.)	873	1013	
Thiamine (mg)	0 71	1 60	0.5-1.0
Riboflavin (mg)	0.56	1.9	1.8‡
Nicotinic acid (mg)	5.1	9.4	12 0‡
Ascorbic acid (mg)	32.0	32 0	30-50
Vitamin D (i.u.)	—	30	400

*Recommendation of the Indian Council of Medical Research : Nutrition Advisory Committee (1944)

‡ Recommendation of the (U S A.) National Research Council : Food and Nutrition Board (1948)

Results

The initial and final values for height, weight, haemoglobin level and red blood cell count of the subjects in the two groups are given in Table IV and for nutritional status in Table V. For the purpose of statistical analysis, the various measurements during the experimental period were obtained for each subject and the mean for each group calculated. The difference in the mean increase between the two groups were tested by the 't' test appropriate for paired comparison. The results (Table IV) show that the mean increases in height, weight, haemoglobin level and red blood cell count of blood in the experimental group were higher than those observed in the control group, the difference in each character being highly ($P < 0.001$) significant. Sixteen children in the experimental group improved in their nutritional status as compared with only

Table IV. *Mean values for the initial and final measurements of the children in the control and experimental groups (Twenty girls in each group)*

Characters	Control group (a)			Experimental group (b)			Differences in increase b-a *	Significance of difference
	Initial value	Final value	Increase	Initial value	Final value	Increase		
Height (cm)	118.82	119.86	1.04	118.59	120.80	2.21	1.17±0.20	*Sig at 0 1%* level
Weight (kg)	20.05	20.71	0.66	19.91	21 83	1.92	1.26±0.07	,,
Haemoglobin (g/100 ml)	11 93	12.38	0.45	12.17	13.38	1.21	0.76±0 10	,,
Red blood cell count (10^6/mm^3)	3.84	4.03	0 19	3.78	4.16	0.38	0.19±0.05	,,

*Value with standard error based on 19 degrees of freedom

Table V. *Nutritional status of children in the control and experimental groups*

Nutritional Score*	Initial nutritional status of children		Changes in the nutritional status of children					
			Control group (no of children)			Experimental group (no of children)		
	Control group (no of children)	Experimental group (no. of children)	Improved	Stationary	Deterio-rated	Improved	Stationary	Deterio-rated
0	0	0	0	0	0	0	0	0
1	2	1	1	1	0	0	1	0
2	2	2	0	1	1	1	1	0
3	3	5	2	1	0	4	1	0
4	10	6	1	7	2	6	0	0
5	3	6	1	1	1	5	1	0
Total	20	20	5	11	4	16	4	0

* According to the recommendation of the Indian Council of Medical Research: Nutrition Advisory Committee (1948)

five children in the control group. Further, four children in the control group deteriorated in their nutritional status while none in the experimental group showed any deterioration.

Discussion

It will be of interest to compare the results obtained in the present study, with those obtained in similar studies carried out earlier with protein-rich foods of vegetable origin. Doraiswamy *et al.*,[10] and Subrahmanyan *et al.*,[11] reported that supplementation of the diets of school children with 50 g of a protein food based on fortified groundnut flour or 2 oz of a protein food based on a 3 : 1 blend of groundnut flour and Bengalgram flour daily brought about a significant improvement in their growth and nutritional status The improvement in the growth and nutritional status observed in the present investigation with a 40g daily supplement of protein food based on a 1 : 1 blend of full-fat soya flour and groundnut flour fortified with 1% each of lysine and methionine and adequate quantities of calcium salts and essential vitamins is higher than that observed in earlier experiments with other vegetable protein foods.[10,11] This may be due to the higher nutritive value of the protein food used in the present study[6]. It may be concluded from the results obtained in this

experiment that processed protein foods based on a blend of full-fat soya flour and groundnut flour and fortified with lysine, methionine and adequate amounts of vitamins and minerals could be used as effective supplements in regions where milk and other protective foods of animal origin are costly and are not available in adequate quantities.

Summary

1. A feeding experiment extending over a period of 5½ months was carried out on two groups of girls aged 5-11 years (20 girls in each group) to assess the value of supplementing their diets daily with 40g of a supplementary protein food based on a blend of full-fat soya flour and groundnut flour and fortified with lysine, methionine and adequate amounts of vitamins and minerals.

2. The children were paired according to initial height and weight and the members of each pair allotted at random to the control and experimental groups. Values for height, weight, red blood cell count and haemoglobin level of blood were determined at the beginning and end of the experiment for subjects in the control and experimental groups.

3. A highly significant ($P < 0.001$) increase in the height, weight, red blood cell count and haemoglobin level of the subjects receiving a 40 g daily supplement of the protein food was observed as compared with the control group. Sixteen children in the experimental group improved in their nutritional status as compared with only five children in the control group. Further four children in the control group deteriorated in their nutritional status while none in the experimental group showed any deterioration.

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REFERENCES

1. FAO. (1959), Production year book, Vol 13. Food and Agriculture Organization, Rome.
2. Subrahmanyan, V., Narayana Rao, M. and Swaminathan, M. (1960), *Proc. Nat. Inst. Sci.* (India)., **26A** (Suppl 1), 99.
3. Scrimshaw, N. S. and Bressani, R. (1961), *Fed. Proc.*, **20** (Suppl 7), 80.
4. Autret, M. and van Veen, A. G. (1955) *Amer. J. clin. Nutr.*, **3**, 234.
5. Narayana Rao, M., Ananthachar, T. K., Kurup, K. R., Rajagopalan, R., Swaminathan, M., Sreenivasan, A. and Subrahmanyan, V. (1954), *J. Nutr. Dietet.*, **1**, 1
6. Panemangalore, M., Balaji Rao, M., Narayana Rao, M., Rajagopalan, R., Chandrasekhar, B.S., Swaminathn, M., Sreenivasan, A. and Subrahmanayn, V. (1964), *J Nutr. Dietet.*, **1**, 4.
7. Reddy, S. K., Doraiswamy, T. R., Sankaran, A. N., Swaminathan, M. and Subrahmanyan, V. (1954), *Brit J. Nutr.*, **8**, 17.
8. I. C. M. R., Nutrition Advisory Committee. (1944), *Report of the ScientificAdvisory Board for the year 1944*, Indian Council of Medical Research, Delhi.
9. Aykroyd, W. R., Patwardhan, V. N. and Ranganathan, S. (1956), *The Nutritive value of Indian Foods and the Planning of Satisfactory Diets*, 5th Ed., Manager of Publications, Delhi.
10. Doraiswamy, T. R., Parthasarathy, H. N., Tasker, P. K., Sankaran, A. N., Rajagopalan, R., Swaminathan, M., Sreenivasan, A. and Subrahmanyan, V. (1962), *Food Science*, **11**, 186.
11. Subrahmanyan, V., Joseph, K., Doraiswamy, T. R., Narayana Rao, M., Sankaran, A. N. and Swaminathan, M. (1957), *Brit. J. Nutr.*, **11**, 382.