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THE EFFECT OF SUPPLEMENTING A BASAL RICE DIET WITH WILD GREEN LEAFY VEGETABLES ON THE RETENTION OF NITROGEN, CALCIUM AND PHOSPHORUS IN ADOLESCENT GIRLS

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Diets based predominantly on rice and containing only small amounts of milk and other protective foods are being consumed by a vast majority of the population in different parts of India.[1] Aykroyd and Krishnan[2] showed in experiments with albino rats that poor Indian rice diets are deficient in calcium, vitamin A, certain vitamins of the B complex group and proteins. They found that among the different supplements tested, milk was highly effective and green leafy vegetables moderately effective in supplementing poor Indian rice diet. Wild green leafy vegetables are an important and inexpensive source of calcium and carotenes in the diets of the low income groups of the population in South India

In earlier publication from this laboratory, Devadas *et al*[3] reported that a mixture of wild green leafy vegetables supplemented effectively poor Indian rice diet as judged by the growth rate and retention of calcium in albino rats.

The present paper deals with studies on the effect of supplementing a poor rice diet with a mixture of wild green leafy vegetables on the retention of nitrogen, calcium and phosphorus in adolescent girls.

Experimental

Subjects: The metabolism study was carried out on six adolescent girls (College students) aged 19 to 21 years. Data regarding the age, height and weight of the subjects are given in Table I. They were clinically examined and were found to be in good health.

Experimental diets and the feeding of the subjects: The experiment consisted of four periods: Period I: Basal rice diet (B1) Period II—Experimental diet I (E1) containing a supplement of 100g of green leafy vegetables to the basal diet; Period III Basal rice diet (B2) which was the same as the diet given in the first period and Period IV: Experimental diet II (E2) containing a supplement of 35g of skim milk powder to the basal diet. The composition of the experimental and basal diets is given in Table II. The nutrients supplied by the supplements daily to the basal diet are presented in Table III. The nutritive value of the diets analysed and calculated from the figures given by Aykroyd *et al.*[4] is given in Table IV as compared with recommended dietary allowances for young women of this age group.

The composition of the basal rice diet was similar to that consumed by the low income groups in urban areas in South India with rice as the staple food. It also contained some wheat flour. The subjects were fed four times daily at breakfast, lunch, tea and dinner. Breakfast consisted of 'idli' or 'dosai' prepared from a mixture of rice and blackgram dhal or uppuma prepared out of wheat semolina and a cup of coffee. Lunch and dinner consisted of cooked rice, unleavened bread from wheat flour, vegetable *kootu* (a preparation containing cooked vegetables, dhal, spices and salt,) 'sambar' (a preparation containing tamarind fruit extract, cooked dhal, salt, spices and vegetables) and butter milk (prepared by churning sour curd and diluting with water.) During the first experimental period (E1), the subjects received daily 100 g of fresh green leafy vegetables cooked and served in two equal portions along with lunch and dinner. At

the second experimental period (E_2) they received 35 g of skim milk powder as reconstituted milk supplying the same amount of calcium (about 480 mg) as 100g green leafy vegetable, along with lunch and dinner.

Table I *Age, height and weight of the experimental subjects*

Subjects	Age	Height (cm)	Weight (kg)
1	20	155.2	48.7
2	21	153.5	44.8
3	20	156.5	46.8
4	20	155.9	46.9
5	20	154.5	47.4
6	20	156.5	49.4

Table II *The composition of the basal and experimental diets*

Basal diet common to all the groups[1]	Quantity (g)
Rice parboiled milled	250
Wheat flour (white soft variety)	100
Red gram dhal (*Cajanus cajan*)	30
Black gram dhal (*Phaseolus mungo*)	10
Bengalgram dhal flour	50
Cabbage	50
Potato	50
Tomato	100
Onion (small)	25
Carrot	10
Banana fruit	50
Appalam	10
Sesame oil	30
Cane sugar	40
Skim milk powder	5
Supplements to experimental groups	
Experimental group I (E 1)	
Wild green leafy vegetables	100
Experimental group II (E 2)	
Skim milk powder	35

[1] To render the diet isocaloric, rice 10g, banana fruit. 50 g and cane sugar 5g were reduced in the basal diet given to experimental group II.

Table III *Nutrients supplied by the daily supplements of green leafy vegetables and skim milk powder*

Nutrients	Wild green leafy vegetables (100g)	Skim milk powder (35g)
Protein (N x 6.25)	3.5	11.4
Calcium (mg)	485	487
Phosphorus (mg)	119	470
Iron (mg)	14	0.2
Vitamin A value (I.U.)	3100	nil
Thiamine (mg)	0.1	0.08
Riboflavin (mg)	0.15	0.56
Ascorbic acid (mg)	74	—

Table IV *The nutritive value of the Basal and Experimental diets*

Nutrients*	Basal diet	Experimental diet with wild green vegetables	Experimental diet with skim milk powder	Recommended daily allowance
Calories (KCal)	2098	2104	2109	2000
Protein (N x 6.25)g	65.3	68.6	75.3	96.0
Calcium (mg)	218	703	705	1000
Phosphorus (mg)	346	465	816	—
Iron (mg)	18	32	17	20.0
Vitamin A value (I.U.)	2544	5644	2544	4000
Thiamine (mg)	1.21	1.21	1.29	1.0
Riboflavin (mg)	0.97	1.12	1.51	1.5
Ascorbic acid (mg)	158	232	158	50

* Values for protein, calcium and phosphorus were determined by actual analysis of the diets; other values were calculated using the figures of Aykroyd *et al*,[4]

Careful records of the food consumed daily by the subjects were maintained throughout the experiment. Duplicates of all dishes consumed daily by each subject were collected, dried in air oven at 90-95°C and weighed. They were powdered and analysed for N, Ca and P.

Collection and preservation of urine and faeces: The procedure for the collection and preservation of urine and faeces was the same as that of Murthy *et al*[5]. Carmine was used as a marker for the collection of faeces. A check on the complete collection of urine was maintained by determining the daily excretion of creatinine.

Analytical methods: Nitrogen content of the diet, urine and faeces was determined by macro Kjeldhal method; calcium content by McCrudden's method[6] and phosphorus content by the method of Fiske and Subbarow[7]. All the analyses were carried out in duplicate.

Results

The results of nitrogen metabolism are given in Tables V and VI, calcium metabolism in Tables VII and VIII and phosphorus metabolism in Table IX and X respectively.

Table V *Nitrogen metabolism in adolescent girls on basal rice diet supplemented with wild green leafy vegetables or skim milk powder*
(Mean values per day per subject ; No. of subjects, 6)

Diet No.	Diet	Calorie intake (KCal)	Nitrogen (g)				Retention	
			Intake	Excretion			(g)	as % of intake
				Urinary	Faecal	Total		
B_1	Basal rice diet (BRD)	2098	10.43	4.86	3.57	8.43	2.00	19.2±0.60
E_1	BRD+wild green leafy vegetables	2104	10.98	5.02	3.67	8.69	2.29	20.8±2.4
B_2	Basal rice diet (BRD)	2099	10.42	5.21	3.51	8.72	1.70	16.7±1.5
E_2	BRD+skim milk powder	2109	12.03	5.21	3.76	8.97	3.06	25.4±5.4

Table VII *Calcium metabolism in adolescent girls on a basal rice diet supplemented with wild green leafy vegetables or skim milk powder*
(Mean values per day per subject : No. of subjects 6)

Diet No.	Diet	Calorie intake (KCal)	Calcium (mg)				Retention	
			Intake	Excretion			(mg)	as % of intake
				Urinary	Faecal	Total		
B_1	Basal rice diet (BRD)	2098	217.8	55.1	160.1	215.2	2.6	1.2±0.14
E_1	(BRD)+wild green leafy vegetables	2104	702.9	104.0	291.9	395.9	307.0	45.7±3.4
B_2	Basal rice diet	2099	217.6	53.7	156.7	210.4	7.2	3.3±0.16
E_2	BRD+skim milk powder	2109	704.6	87.3	221.2	308.5	396.1	56.2±2.54

Table IX *Phosphorus metabolism in adolescent girls on a basal rice diet supplemented with wild green leafy vegetables or skim milk powder*
(Mean values per day per subject : No. of subjects-6)

Sl. No.	Diet	Calorie intake (KCal)	Phosphorus (mg)				Retention	
			Intake	Excretion			(mg)	as % of intake
				Urine	Faeces	Total		
B_1	Basal rice diet (BRD)	2098	345.9	134.5	162.3	296.8	49.1	12.3±3.7
E_1	BRD+wild green leafy vegetables	2104	465.2	120.0	134.5	254.5	210.7	44.9±4.5
B_2	Basal rice diet (BRD)	2099	345.7	130.3	169.2	299.5	46.2	11.6±4.3
E_2	BRD +skim milk powder	2109	815.7	310.4	273.6	584.0	231.7	28.1±7.8

Table VI *Results of analysis of variance of nitrogen retention in adolescent girls on the different diets*

Diets	F-ratio	Standard error	Significance level
B_1—B_2	2.8	0.57	not significant
B_1—E_1	89.8	0.10	1 % level
B_2—E_2	98.5	0.37	1 % level
E_1—E_2	22.6	0.40	1 % level

Table VIII *Results of analysis of variance for the retention of calcium in adolescent girls on different diets*

Diets	F-ratio	Standard error	Significance level
B_1—B_2	3.6	5.95	Not significant
B_1—E_1	1219.0	30.78	1 % level
B_2—E_2	8600.0	13.31	1 % level
E_1—E_2	9.3	29.9	5 % level

Table X *Results of analysis of variance for the retention of phosphorus in adolescent girls on different diets*

Diets	F-ratio	Standard error	Significance level
B_1—B_2	0.92	0.89	Not significant
B_1—E_1	9.20	4.21	5% level
B_2—E_2	42.10	7.50	1% level
E_1—E_2	1.63	9.83	not significant

Nitrogen metabolism: (Tables V and VI) The N intakes on the different diets were as follows: Basal rice diet I (B_1); 10.43 g; Experimental diet I (E_1), 10.98 g; Basal rice diet II (B_2) 10.42 g and Experimental diet II (E_2) 12.03 g and the N retentions on above diets were as foilows :- B_1—2.0g; E_1—2.29 g; B_2—1.70 and E_2, 3.06 g.

Calcium metabolism: (Tables VII and VIII) The Ca intakes on the different diets were as follows: Basal diet I—217.8 mg; Experimental diet I (E_1) 702.9 mg; Basal diet, II (E_2) 217.6 mg and Experimental diet II (E_2), 704.6 mg. The Ca retentions on the above diets were as follows: B_1—2.6 mg; E_1—307.0 mg; B_2—7.2 mg and E_2—396.1 mg.

Phosphorus metabolism: (Tables IX and X) The P intake and retention on the different diets were as follows: Basal diet I (B_1), 345.9 mg and 49.1 mg; Experimental diet (E_1)—465.2 mg and 210.7 mg; Basal diet II (B_2) 345.7 and 46.2 mg and Experimental diet II (E_2) 815.7 mg and 231.7mg respectively.

Discussion

The results obtained in the present study have shown that supplementation of a poor rice diet with 100 g of wild green leafy vegetables providing about 480 mg of Ca brought about a highly significant increase in the retention of Ca in the diet. It is of interest to note that calcium from green leafy vegetables was utilised as well as milk calcium by the subjects. It may be concluded from the results that the increased consumption of wild green leafy vegetables will help effectively in making up the calcium deficiency in poor Indian rice diet, without increasing the cost.

Summary

1) The effect of supplementing a poor Indian rice diet with 100 g of wild green leafy vegetables (providing about 480mg calcium) or with 35g skim milk powder (providing about 480 mg calcium) on the metabolism of nitrogen, calcium and phosphorus in 6 adolescent girls aged 19-21 years was studied

2) The intake and retention of nitrogen on the different diets were as follows: Basal rice diet (period I), 10.43g and 2.0g: Experimental diet containing green leafy vegetables (Period II), 10.98g and 2.29g; Basal rice diet (Period III), 10.42g and 1.70g and Experimental diet containing skim milk powder (Period IV), 12.03g and 3.06 g respectively.

3) The intake and retention of calcium on the different diets were as follows: Basal diet (Period I) 217. 8 mg and 2.6mg; Experimental diet containing green leafy vegetables (Period II), 702.9 mg and 307.0mg; Basal diet (period III), 217.6mg and 7.2mg and Experimental diet containing skim milk powder (Period IV) 704.6 mg and 396.1 mg respectively.

4. The intake and retention of phosphorus on the different diets were as follows; Basal diet (Period I), 345.9 mg and 49.1 mg; Experimental diet containing green leafy vegetables (Period II), 465.0mg

and 210.7 mg; Basal diet (Period III), 345.7 mg and 46.2 mg and Experimental diet containing skim milk powder (Period IV), 815.7 mg and 231.7 mg. respectlvely.

REFERENCES

1. Patwardhan, V. N. (1962), *Nutrition in India*, published by Indian J.Med. Sciences,Bombay.
2. Aykroyd, W. R. and Krishnan, B. G. (1937) *Indian J. Med. Res.*, **25**, 367.
3. Devadas, R. P., Devadoss, M. V. K. and Rowlands, R. (1964). *J. Nutr. Diet.* **1**, 34.
4. Aykroyd W. R., Gopalan, C., and Balasubramanian S. C. (1963). *The nutritive value of Indian Foods and planning of satisfactory diets.* Special Report Series 42. Indian Council of Medical Research, New Delhi.
5. Murthy, H. B. N., Swaminathan, M., and Subramanyan, V. (1954) *Brit. J. Nutr.* **8**. 11.
6. McCrudden, F. H. (1911–12) *J. Biol. Chem.*, **10**, 187.
7. Fiske, C. H. and Subbarow, Y. (1925) *J. Biol. Chem*, **66**, 375.