

The metabolism of nitrogen, calcium and phosphorus in undernourished children

7.* The effect of partial or complete replacement of rice in poor vegetarian diets by pearl millet (*Pennisetum typhoideum*)

BY P. P. KURIEN, M. SWAMINATHAN AND V. SUBRAHMANYAN

Central Food Technological Research Institute, Mysore, India

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Pearl millet is an important food grain consumed widely as a staple food by poor people in different parts of India (Patwardhan, 1952), but no metabolic studies have so far been reported with diets containing it. Further, in view of the acute shortage of rice in the country, the use of pearl millet as a partial substitute needs to be studied. This paper describes the results of investigations on the effect on the metabolism of nitrogen, calcium and phosphorus of replacing rice in a poor vegetarian diet partially or completely by pearl millet (*Pennisetum typhoideum*).

EXPERIMENTAL

The plan of the experiment and the analytical methods used were similar to those described by Kurien, Narayanarao, Swaminathan & Subrahmanyam (1960) in their studies with kaffir-corn diets. The ages, heights and weights of the eight boys studied

Table 1. *Ages, heights and weights of the boys at the beginning of the experiment*

Child no.	Age (years)	Height (cm)	Weight (kg)
1	12	142	31.4
2	12	138	30.5
3	12	137	29.6
4	11	137	28.2
5	11	137	27.8
6	12	132	26.9
7	11	135	25.5
8	11	132	23.7

are given in Table 1. They were poor-class children living in a boarding home in Mysore City. The composition of the rice and pearl millet used is given in Table 2.

The mean daily intake (g) of the cereals by the children was:

Cereal	Rice diet	25 % pearl-millet diet	50 % pearl-millet diet	Pearl-millet diet
Rice	360	270	180	—
Pearl millet	—	90	180	360

* Paper no. 6: *Brit. J. Nutr.* (1960), 14, 339.

The rest of their diet was the same as in the previous test (Kurien *et al.* 1960); the feeding procedure and collection of excreta were similar. Total N, Ca and P in food, urine and faeces were determined by the methods of Murthy, Swaminathan & Subrahmanyam (1954).

RESULTS AND DISCUSSION

Pearl millet, like kaffir corn, contains fairly large amounts (9.0%) of roughage, i.e. cellulose and hemicelluloses. The mean daily faecal bulk increased with the amount of pearl millet in the diet. Similar observations have been reported earlier with diets based on ragi (Joseph, Kurien, Swaminathan & Subrahmanyam, 1959) and kaffir corn (Kurien *et al.* 1960).

Table 2. *Percentage composition of the raw milled rice and pearl millet (Pennisetum typhoideum) used*

	Raw milled rice	Pearl millet
Moisture	10.1	12.2
Protein (N × 6.25)	7.9	11.3
Fat (ether extractives)	0.5	3.8
Ash	0.5	1.8
Starch	80.1	60.7
Total sugars	0.3	1.2
Crude fibre	0.2	3.2
Pentosans and other hemicelluloses (by difference)	0.4	5.8
Calcium	0.012	0.046
Phosphorus	0.142	0.314
Phytate phosphorus	0.089	0.224
Calories (kcal/100 g)	358	327

Table 3. *Mean daily intake, excretion and balance of nitrogen of the boys on the different diets*

Diet Description	Calorie value (kcal/day)	Intake (g)	Excretion (g)			Apparent digesti- bility coeffi- cient (%)	Balance (g)
			Faecal	Urinary	Total		
Rice	1861	6.92	1.71	3.19	4.90	75.3	+2.02
25 % pearl millet	1829	7.26	1.95	3.44	5.39	73.1	+1.87
50 % pearl millet	1802	7.83	2.79	3.55	6.34	64.4	+1.49
Pearl millet	1741	8.67	4.08	3.48	7.56	52.9	+1.11
Standard error of the mean (21 D.F.) ± 1.40							± 0.09

Nitrogen (Table 3). The mean daily protein (N × 6.25) intake on the different diets ranged from 43 to 54 g. All the children were in positive N balance. The mean apparent digestibility of the proteins in the diet and the mean retention of N progressively decreased as the amount of pearl millet in the diet was increased.

Calcium (Table 4). The mean daily intake on the different diets ranged from 0.35 to 0.48 g. All the children were in positive balance. The mean daily retention decreased as the amount of pearl millet in the diet was increased; this effect may have been due to the increased amount of phytate P in the diet.

Phosphorus (Table 4). The mean intake on the different diets ranged from 0.73 to 1.35 g. A large part (48–60%) of the P in the diet was in the form of phytate P. The mean daily retention of P ranged from 0.16 to 0.36 g. Both intake and retention increased as the amount of pearl millet in the diet increased.

Table 4. Mean daily intake, excretion and balance of calcium and phosphorus of boys on the different diets

Diet		Intake (mg)	Excretion (mg)			Balance (mg)
Description	Calorie value (kcal/day)		Faecal	Urinary	Total	
Calcium						
Rice	1861	352	178	55	233	+119
25 % pearl millet	1829	378	212	49	261	+117
50 % pearl millet	1802	418	250	55	305	+113
Pearl millet	1741	479	333	54	387	+92
Standard error of the mean (21 D.F.)						± 6.8
Phosphorus						
Rice	1861	726	274	290	564	+162
25 % pearl millet	1829	867	359	284	643	+224
50 % pearl millet	1802	1029	468	264	732	+297
Pearl millet	1741	1346	704	286	990	+356
Standard error of the mean (21 D.F.)						± 12.9

SUMMARY

1. The effect on nitrogen, calcium and phosphorus metabolism of replacing 25%, 50% or all of the rice in a poor vegetarian diet by pearl millet (*Pennisetum typhoideum*) was studied in eight boys aged 11–12 years.

2. The daily intake of N was nearly the same on the different diets. All the subjects were in positive balance. The apparent digestibility of the proteins and the mean daily retention of N decreased as the proportion of pearl millet in the diet increased.

3. Although the addition of pearl millet led to a higher Ca intake, the amount of Ca retained decreased as the proportion of pearl millet in the diet increased. All the subjects were in positive balance.

4. Both the intake and retention of P increased as the proportion of pearl millet in the diet increased.

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REFERENCES

- Joseph, K., Kurien, P. P., Swaminathan, M. & Subrahmanyam, V. (1959). *Brit. J. Nutr.* **13**, 213.
 Kurien, P. P., Narayanarao, M., Swaminathan, M. & Subrahmanyam, V. (1960). *Brit. J. Nutr.* **14**, 339.
 Murthy, H. B. N., Swaminathan, M. & Subrahmanyam, V. (1954). *Brit. J. Nutr.* **8**, 11.
 Patwardhan, V. N. (1952). *Nutrition in India*. Bombay: Indian Journal of Medical Sciences.