

# SUPPLEMENTARY VALUE OF A PROTEIN FOOD BASED ON A BLEND OF SOYA, GROUNDNUT AND COCONUT FLOURS TO A TAPIOCA-RICE DIET

By P. K. TASKER, A. A. JOSEPH, H. N. ANANTHASWAMY, A. PAUL JAYARAJ, K. INDIRAMMA, M. NARAYANA RAO, M. SWAMINATHAN, A. SREENIVASAN AND V. SUBRAHMANYAN

(Central Food Technological Research Institute, Mysore)

The incidence of protein malnutrition among children is particularly high in countries where tapioca and other starchy tubers are consumed along with cereals<sup>1-6</sup>. The possibility of using protein-rich foods based on oilseed meals and legumes as supplements to the diets of children in the above regions has been investigated by several workers<sup>7-9</sup>.

In earlier publications from this laboratory<sup>10, 11</sup> the results of studies on the preparation and nutritive value of a protein food based on a 4:3:3 blend of full-fat soya flour, groundnut flour and coconut meal and adequately fortified with vitamins and minerals have been reported. The present investigation deals with the supplementary value of the protein food to a low protein diet based on tapioca and rice as compared with that of skim milk powder.

## Experimental

**Materials:** The protein food used in this investigation was the same as that described in an earlier paper<sup>10</sup>. An imported sample of skim milk powder of good quality was used. The chemical composition of the protein food and skim milk powder has already been reported<sup>10</sup>.

**Animal Experiments:** Groups of freshly weaned albino rats (Wistar strain) weighing about 40-45g. (10 in each group, equally divided according to sex and body weight and allotted according to a randomized block design ignoring litters) were fed *ad lib* on the different diets, the composition of which are shown in Table I. Sufficient quantities of the protein food and skim milk powder were incorporated by replacing an equal amount of tapioca flour in the control tapioca-rice diet so as to provide 10 per cent extra protein in the diet. The composition of the basal diet is given in Table I. The procedure adopted for the preparation of the diets and feed-

TABLE I. Percentage composition of experimental diets\*

	Diets		
	Rice-tapioca diet	Rice-tapioca diet + protein food	Rice-tapioca diet + skim milk powder
Rice flour	39.2	39.2	39.2
Tapioca flour	39.2	15.2	11.2
Protein food	...	24.0	...
Skim milk powder	...	...	28.0

\* All the diets contained the following other ingredients: redgram dhal (*Cajanus cajan*), 5.0; amaranth leaves (*Amaranthus gangeticus*), 2.1; brinjal (*Solanum melongena*), 8.2; skim milk powder, 0.9; common salt, 0.3 and groundnut oil, 5.0 per cent.

ing of the experimental animals was similar to that of Subrahmanyam *et al.*<sup>12</sup> Careful records of food intake were maintained for all the groups and the rats were weighed weekly.

After feeding for a period of 8 weeks, the haemoglobin and red blood cell counts were determined in blood drawn from the tail veins of the animals according to Joseph *et al.*<sup>13</sup>. The animals were anaesthetized with ethyl ether. Blood was drawn by heart puncture and the serum separated. The total serum protein content was determined according to King and Wootton<sup>14</sup>. The liver and carcass were analysed for moisture, protein and fat according to Joseph *et al.*<sup>13</sup>. A separate group of weanling rats in the same weight range was used to determine the initial body protein. From the data, the retention of protein in the different groups of rats over a period of 8 weeks was calculated.

**Histological examination of the liver:** The histological examination of the livers of female

TABLE II. Gain in body weight of rats on rice-tapioca diet supplemented with different protein-rich foods<sup>1</sup> (5 males and 5 females in each group: Duration of experiment: 8 weeks)

Supplement to diet <sup>2</sup>	Protein content of diet <sup>3</sup> %	Initial body weight (g)	Daily food intake <sup>3</sup> (g)	Mean weekly gain in weight (g)
None	5.4	44.3	7.8	5.5
Protein food	15.2	44.1	9.5	18.1
Skim milk powder	15.3	44.5	9.5	18.1

Critical difference at 5% level 1.89

„ 1% level 2.60

„ 0.1% level 3.59

<sup>1</sup> The different protein-rich foods supplied approximately 10% protein.

<sup>2</sup> Replaced on equal weight of tapioca in rice-tapioca diet.

<sup>3</sup> Expressed on moisture free basis.

rats was carried out according to Venkat Rao *et al*<sup>15</sup>. In addition frozen sections were taken from each specimen and stained with Sudan IV in propylene glycol to study the distribution of fat.

### Results and Discussion

**Growth rate and composition of blood:** Table II gives the average weekly gain in body weight of rats over a period of 8 weeks on the tapioca-rice diet and the same supplemented with the protein food and skim milk powder. Incorporation of the different foods in the tapioca-rice diet resulted in a highly significant ( $P < 0.001$ ) increase in the growth rate of rats. There was no significant difference in the growth rate of rats receiving supplements of protein food or skim milk powder. The results show that both the protein food and skim milk powder, when providing 10 per cent extra protein are equally effective in supplementing tapioca-rice diet. The serum proteins, haemoglobin and red blood cell counts of rats (Table III) receiving the supplements of protein food and skim milk powder were significantly higher than those of the control tapioca-rice diet.

**Composition of liver and carcass:** Table IV shows that supplementation of tapioca-rice diet

TABLE III. Composition of blood of rats on a rice-tapioca diet supplemented with different protein-rich foods

Supplement to diet <sup>1</sup>	Haemoglobin <sup>2</sup> (%)	Red blood cell count <sup>2</sup> (10 <sup>6</sup> /cu.mm)	Total serum protein <sup>3</sup> (%)
None	13.85	6.00	5.14
Protein food	15.18	6.44	5.78
Skim milk powder	15.00	6.87	6.10

Critical

difference

at 5% level 1.07 0.49 0.46

„ 1% level 1.48 0.67 0.67

„ 0.1% level 2.03 0.93 1.01

<sup>1</sup> Replaced an equal weight of tapioca in rice-tapioca diet.

<sup>2</sup> Average of 5 males and 5 females per group.

<sup>3</sup> Average of 5 males per group.

with the protein foods caused a significant increase in liver protein and decrease in liver lipids. There were no significant differences in the mean moisture, nitrogen and fat contents of the livers or carcass of rats receiving the protein food or skim milk powder. The protein content of the carcass of rats fed on the control, tapioca-rice diet, however, was significantly ( $P < 0.001$ ) less and the moisture content higher ( $P < 0.001$ ) than those of rats receiving the protein supplements.

**Histological structure of liver:** The livers of rats receiving the tapioca-rice diet showed a moderate degree of cytoplasmic vacuolation and parenchymal damage of the protein deficiency type and mild degree of periportal fatty infiltration. There was no necrosis of the liver cells. The livers of rats receiving the supplements of protein food or skim milk powder were quite normal indicating thereby that addition of 10 per cent extra protein was quite effective in correcting the protein deficiency in tapioca-rice diet.

**Intake and retention of protein:** The data on the intake and retention of protein by the rats fed on the different diets is given in Table V. No significant differences were observed in the amount of protein retained per 100 g. increase

TABLE IV. *Composition of liver and carcass of rats on a rice-tapioca diet supplemented with protein-rich foods*

Supplement to diet <sup>1</sup>	Fresh weight of liver <sup>2</sup> (g)	Composition of liver <sup>2</sup>			Body weight <sup>2</sup> (g)	Composition of carcass <sup>2</sup>		
		Moisture %	Fat %	Protein %		Moisture %	Fat %	Protein %
None	4.1	68.7	4.3	15.1	83.4	62.2	16.8	17.8
Protein food	7.3	68.5	3.6	18.2	225.6	59.2	18.2	18.6
Skim milk powder	7.4	67.7	3.5	18.4	224.5	58.9	18.2	18.7
Standard error of the mean with degrees of freedom		±0.99 (8 d.f.)	±0.11 (8 d.f.)	±0.15 (8 d.f.)		±0.23 (8 d.f.)	±0.19 (8 d.f.)	±0.20 (8 d.f.)
Critical difference at 5% level		3.21	0.37	0.48		0.74	0.61	0.64
„ 1% level		4.66	0.54	0.69		1.07	0.87	0.93
„ 0.1% level		7.01	0.81	1.04		1.61	1.34	1.40

<sup>1</sup> Replaced an equal weight of tapioca in rice-tapioca diet.<sup>2</sup> Average of 5 males per group.TABLE V. *Intake and retention of protein by the different groups of rats<sup>1</sup> on a rice-tapioca diet supplemented with protein food or skim milk powder*

Supplement to diet <sup>2</sup>	Total protein intake (g)	Total increase in body weight (g)	Body protein		Protein retained	
			Initial <sup>3</sup> (g)	Final (g)	g	g/100 g. increase in body weight
None	24.8	39.6	7.66	14.85	7.19	18.16
Protein food	85.9	182.2	7.60	41.96	34.36	18.86
Skim milk powder	86.5	182.3	7.38	41.98	34.60	18.98

<sup>1</sup> Average of 5 males per group.<sup>2</sup> Replaced an equal amount of tapioca in rice-tapioca diet.<sup>3</sup> Calculated at 17.5% of the initial weight.

Critical difference at 5% level 0.18

„ 1% level 0.26

„ 0.1% level 0.39

in weight of rats, receiving the different protein supplements showing thereby that the increase in body weight of rats was accompanied by a corresponding increase in tissue protein also.

A poor diet based on equal amounts of rice and tapioca flour is deficient in protein, and several other dietary essentials such as calcium, vitamin A and riboflavin. Such a diet promotes very little growth in rats. Supplementation of the diet with 10 per cent extra protein from a protein food based on a 4:3:3 blend of full-fat soya flour, groundnut flour and coconut meal or skim milk powder made up the deficiencies in the diet and promoted good growth of rats, there being no significant difference in the growth

response obtained with the different protein foods. The livers of rats fed on the tapioca-rice diet showed moderate degree of cytoplasmic vacuolation and mild periportal fatty infiltration. The protein food, when incorporated in the tapioca-rice diet was equally effective as skim milk powder in preventing the liver damage in rats.

The results obtained in the present investigation are of considerable importance to several countries producing soyabean, coconut and groundnut in large quantities. Since milk and other animal foods are in short supply in several developing countries, production and consumption of processed protein foods based on soya bean, coconut and groundnut and fortified with

vitamins and minerals will help to make up the deficiencies in the diets consumed by the low income groups of the population.

### Summary

1. Supplementation of a poor tapioca-rice diet with a protein food based on a 4:3:3 blend of full-fat soya flour, groundnut flour and coconut meal and adequately fortified with vitamins and minerals or skim milk powder so as to provide 10 per cent extra protein to the diet resulted in a highly significant ( $P < 0.001$ ) increase in the growth rate of rats.

2. The serum proteins, haemoglobin and red blood cell count of rats receiving the supplements of protein food or skim milk powder was significantly higher ( $P < 0.001$ ) than those of rats receiving the control tapioca-rice diet.

3. The mean protein content of livers of rats fed on the tapioca-rice diet was significantly lower than that of the livers of rats receiving the protein supplements. The protein food and skim milk powder were equally effective in maintaining the liver protein content at normal level.

4. No significant differences were observed in the mean protein retained per 100 g. increase in body weight of rats receiving the protein food or skim milk powder showing thereby that the increase in body weight of rats was accompanied by a corresponding increase in the tissue protein content also.

5. A moderate degree of cytoplasmic vacuolation and parenchymal damage of the protein deficiency type and a mild degree of periportal fatty infiltration were observed in the livers of rats fed on the rice-tapioca diet. On the other hand, the livers of rats receiving the protein supplements were quite normal indicating that

when providing 10 per cent extra protein, the protein food based on a 4:3:3 blend of soya flour, groundnut flour and coconut meal was as effective as skim milk powder in correcting the protein deficiency in the diet and in preventing liver damage.

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