Mem. Inst. Oswaldo Cruz, Rio de Janeiro, Vol. *87*, Suppl. IV, 297-301, 1992

NUTRITION AND ACUTE SCHISTOSOMIASIS

ERIDAN M. COUTINHO; HAROLDO S. FERREIRA; LUCILA P. C. G. DE FREITAS; MARLENE R. SILVA; CLAUDIA L. CAVALCANTI & MARIA DE JESUS A. SAMICO

Centro de Pesquisas Aggeu Magalhães - FIOCRUZ, Av. Moraes Rego, s/nº, 50670-420 Recife, PE, Brasil

In northeast Brazil, nutritional deficiency diseases and schistosomiasis mansoni overlap. An experimental model, which reproduces the marasmatic clinical form of protein-energy malnutrition, was developed in this laboratory to study these interactions. Albino Swiss mice were fed with a food association ingested usually by human populations in northeast Brazil. This diet (Regional Basic Diet – RBD) has negative effects on the growth, food intake and protein utilization in infected mice (acute phase of murine schistosomiasis). Nitrogen balance studies have also shown that infection with Schistosoma mansoni *has apparently no effect on protein intestinal absorption in well nourished mice. However, the lowest absorption ratios have been detected among RBD – fed infected animals, suggesting that superimposed schistosome infection aggravated the nutritional status of the undernourished host. The serum proteins electrophoretic pattern, as far as albumins are concerned, is quite similar for non-infected undernourished and infected well-fed animals. So, the significance of albumins as a biochemical indicator of the nutritional status of human populations residing in endemic foci of Manson's schistosomiasis, is discussable.*

Key words: nutritional status – schistosomiasis mansoni – proteins

Malnutrition areas and major schistosomiasis mansoni endemic foci overlap considerably in northeast Brazil (Coutinho, 1976). Multiple deficiencies, mainly of the calorie-protein type, have been detected in the population living in these areas (Coutinho et al., 1964; Batista Filho et al., 1971; Coutinho et al., 1972, Coutinho, 1980). Based on food habits of this population, a definition was possible for the Regional Basic Diet (RBD), a multideficient food blend with low protein content (Kidney beans – *Phaseolus vulgaris*, manioc flour – *Manihot esculenta*, salted and dried meat – "Charque" and sweet potatoes – *Iponaea batatas*) which reproduces dietary dificiencies prevalent in the region (Coutinho, 1976, 1980; Teodósio et al., 1986). To manioc flour and sweet potatoes have been ascribed the amino acid imbalance and further decrease in the protein content of the diet.

A type of malnutrition rather similar to the marasmatic form of calorie-protein malnutrition seen in humans, which is quite common in northeast Brazil, has been induced in weanling mice (Coutinho, 1976, 1980) and rats (Teodósio et al., 1986; Lago et al., 1988) fed RBD. In addition to growth disturbances (Coutinho, 1980; Lago et al., 1988) RBD intake results in a deficient glycemic regulation (Teodósio et al., 1986), a reduction in the sciatic nerve conduction velocity (Silva et al., 1987) and an impaired propagation of spreading depression in the cerebral cortex of Sprague – Dawley rats (Guedes et al., 1987).

This experimental model reproduces the relationship between undernourished host and parasite infection as it is found among Brazilian populations living in schistosomiasis endemic areas.

Effects of RBD on the protein nutritional status of the host – Protein nutritional status indicators were studied in weanling Swiss albino mice, of both sexes, divided into infected and non-infected subgroups.

The composition of RBD is shown in Table I. The two control diets (Tables II and III) contained casein at two levels: 7.82% (control I) and 22.60% (control II). The diets were given in pellet form. The control diets I and II were supplemented with mineral salts and vitamin mixture, according to Tagle & Donoso (1965).

Financial support provided by CNPq and FACEPE.

TABLE I

Composition of the Regional Basic Diet (RBD)
g/100 g

Components	Amounts in g/100 g	Proteins	Carbo-hydrates	Fats	Minerals	Fibers
Kidney beans (Phaseolus vulgaris)	18.34	3.96	10.66	0.24	0.57	1.09
Manioc flour (Manihot esculenta)	64.81	0.82	48.59	0.12	0.43	5.64
Salted and dried meat (Charque)	3.74	2.74	0.43	0.21	0.06	–
Fat from salted and dried meat	0.35	–	–	0.35	–	–
Sweet potato (Iponaea batatas)	12.76	0.30	9.99	0.03	0.20	0.48
Total	100.00	7.82	69.67	0.95	1.26	7.21

NDpCal % = 5.97

TABLE II

Composition of the control diet I
g/100 g

Components	Amounts in g/100 g	Proteins	Carbo-hydrates	Fats	Minerals	Fibers
Casein	8.87	7.06	–	–	–	–
Soybean oil	8.00	–	–	8.00	–	–
Water-soluble vitamins	1.00	–	–	–	–	–
Fat-soluble vitamins	1.00	–	–	1.00	–	–
Salts mixture	2.50	–	–	–	2.50	–
Cellulose	3.50	–	–	–	–	3.50
Corn starch	75.13	7.76	74.37	–	–	–
Total	100.00	7.82	74.37	9.00	2.50	3.50

Supplemented with mineral salts and vitamin mixtures according to Tagle, M. A. & Donoso, G., 1965. *J. Nutrition, 87*: 173-178.

TABLE III

Composition of the control diet II
g/100 g

Components	Amounts in g/100 g	Proteins	Carbo-hydrates	Fats	Minerals	Fibers
Casein	27.80	22.09	–	–	–	–
Soybean oil	13.00	–	–	13.00	–	–
Water-soluble vitamins	1.00	–	–	–	–	–
Fat-soluble vitamins	1.00	–	–	1.00	–	–
Salts mixture	2.50	–	–	–	2.50	–
Cellulose	4.00	–	–	–	–	4.00
Corn starch	50.70	0.51	50.19	–	–	–
Total	100.00	22.60	50.19	14.00	2.50	4.00

Supplemented with mineral salts and vitamin mixtures according to Tagle, M. A. & Donoso, G., 1965. *J. Nutrition, 87*: 173-178.

Each mice was infected percutaneously with 40 cercariae of a *Schistosoma mansoni* strain isolated from São Lourenço da Mata (Pernambuco State, Brazil) maintained in *Biomphalaria glabrata* reared and infected in the laboratory.

The experiment lasted 63 days. The growth curve, food consumption, protein intake and weight gain were the parameters investigated.

For all the animals, the body weight was determined weekly and the food intake recorded daily. Subgroups of five mice per control diet were submitted to a pair-feeding trial. So, the daily food intake of control mice (diets II and III) was restricted to the *ad libitum* intake of RBD-fed animals.

The post-weanling rapid growth period of the mouse was observed during the first 28 days of the trial (Phase I). Henceforth, the *S. mansoni* oviposition and maturation of hepatic and intestinal lesions were investigated (Phase II).

RBD-fed mice showed a marked weight loss (Fig. 1), a lower food and protein intake (Fig. 2) and a slower body weight gain when compared to casein-fed animals (Fig. 3).

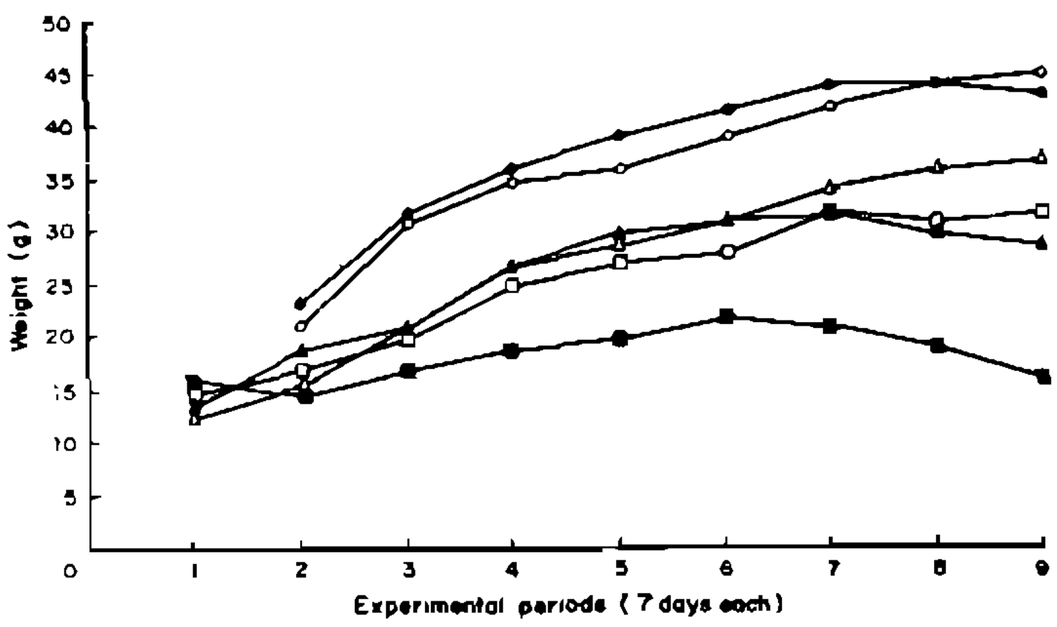

Fig. 1: weight curves of infected and non-infected mice fed RBD and Casein diets.

Biological utilization of the Regional Basic Diet – The biological utilization of RBD was investigated by means of the following biological assays:

a) Food efficiency ratio: $\frac{\text{Weight gain (g)}}{\text{Food intake (g)}}$

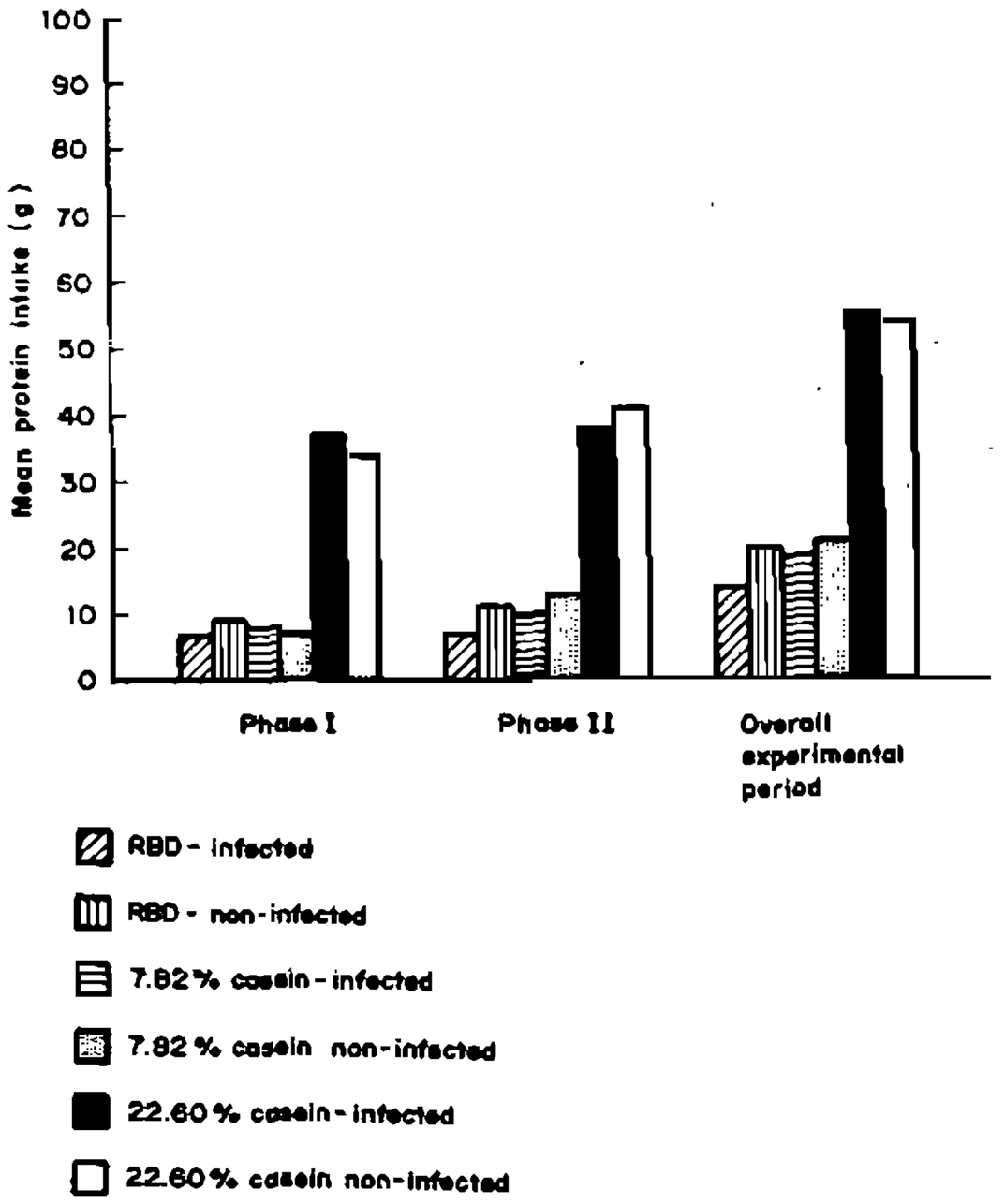

Fig. 2: mean protein intake of infected and non-infected mice fed RBD and Casein diets.

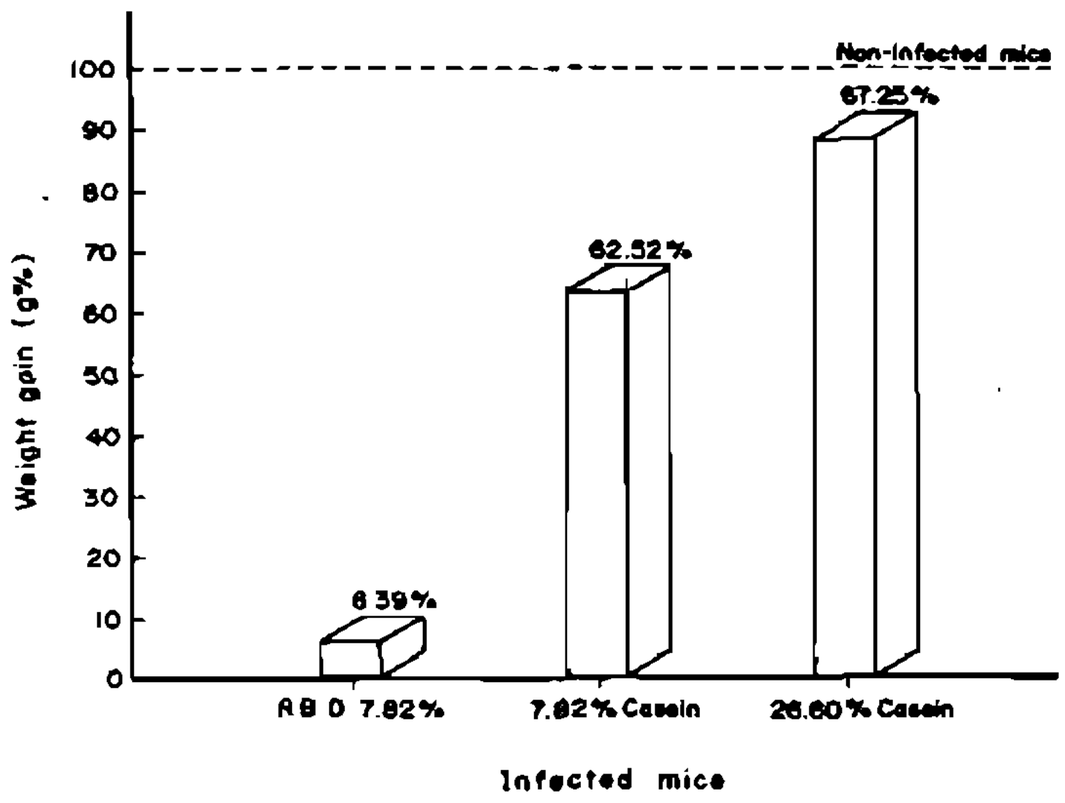

Fig. 3: weight gain of infected and non-infected mice fed RBD and Casein diets.

b) Operacional protein efficiency ratio:

$$\frac{\text{Weight gain (g)}}{\text{Protein intake (g)}}$$

c) Net protein ratio:

$$\frac{\text{Weight gain (g) + loss of weight (g) of a free-protein fed group}}{\text{Protein intake (g)}}$$

Undernourished mice when infected with 80 cercariae of *S. mansoni* showed, after 63

days of infection, lower values regarding protein utilization when compared to well-fed infected animals (Coutinho et al., unpublished data). However, in lighter infections (40 cercariae per mouse), non-significant results between infected and non-infected RBD-fed mice could be detected (Ferreira, 1991). It is possible that marked metabolic derangements require a longer time to become apparent and so could not be detected in the acute phase of schistosomiasis in this experimental host.

Protein intestinal absorption – The nitrogen-balance technique, known as Coefficient of Apparent Absorption

$$\frac{\text{Nitrogen absorption}}{\text{Nitrogen intake}} \times 100$$

was used to study the protein intestinal absorption in mice.

To obtain the Coefficient of True Absorption, a correction of the value for the fecal metabolic nitrogen (FMN) was made as follows:

$$\frac{\text{Nitrogen intake} - (\text{Fecal nitrogen} - \text{Fecal metabolic nitrogen})}{\text{Nitrogen intake}} \times 100$$

The FMN was determined in a non-protein group and by extrapolation through linear regression. According to these assays, protein intestinal absorption was lower for RBD – fed mice and was not affected in well – nourished, infected animals (Table IV).

Electrophoretic pattern of serum proteins in undernourished mice – Undernourished mice had lower values for serum total proteins concentration as compared to the controls. Infection with *S. mansoni* (acute phase) had apparently no influence on the levels of total proteins, although in infected mice a slight non-significant rise became apparent. Control casein-fed groups had higher albumins levels than infected well-fed mice.

A similar behaviour was not seen in RBD-fed animals. These had a low total protein and albumins levels. Alpha-1 globulins were low in RBD-fed mice, again no difference being detected between infected and non-infected animals.

High levels of gamma-globulins were detected in infected undernourished RBD-fed mice, this fact probably reflecting a policlonal activation due to immunoregulatory disturbances occurring in undernutrition. Infection was responsible for the high levels of gammaglobulins detected in infected casein fed mice.

The serum protein electrophoretic pattern, as far as albumins are concerned, was quite similar for non-infected undernourished and infected well-fed animals. So, the significance

TABLE IV

Coefficients of apparent and true absorption (biological assay and linear regression methods), in undernourished RBD-fed and well fed control mice, infected or not with *Schistosoma mansoni*

Group	No. mice	Coefficient of absorption		
		Apparent ($\bar{X} \pm Sd$)	True (a) ($\bar{X} \pm Sd$)	True (b) ($\bar{X} \pm Sd$)
Casein non-infected	10	87.7 ± 3.2	92.4 ± 3.6	89.4 ± 2.8
Casein infected	10	85.6 ± 6.1	91.0 ± 5.3	86.6 ± 5.9
RBD non-infected	10	46.8 ± 12.8	54.9 ± 11.4	76.9 ± 9.9
RBD infected	10	25.8 ± 20.9	47.0 ± 14.3	58.8 ± 13.5
Total	40			

RBD = Regional Basic Diet; $\bar{X}$ = arithmetic mean; Sd = standard deviation.
True (a) = Values obtained for the coefficient of true absorption when the fecal metabolic nitrogen was determined by using a non-protein fed group of mice (biological assay).
True (b) = Values obtained for the coefficient of true absorption when the correction for the fecal metabolic nitrogen was made after calculation of linear regression among the different levels of protein intake and the excretion of fecal nitrogen detected for each animal in each group of mice, with extrapolation to the point of protein intake = zero.

of such a protein fraction as a biochemical indicator of the nutritional status of human populations residing in endemic foci of Manson's schistosomiasis, is discussable.

On the other hand, further researches are recommended to estimate the extent to which improvement of the nutritional status of the host may contribute for decreasing the effects of schistosomiasis in mice and possibly in human beings residing in endemic areas of Manson's schistosomiasis.

REFERENCES

BATISTA FILHO, M.; CHAVES, N.; VARELA, R. M.; MARTINS, M. H. S.; SALZANO, A. C.; BAZANTE, M. O.; TEIXEIRA, S. M. G.; LIMA, E. J. C.; REIS, F. M.; MARTINS, G. C. & LINHARES, E. R., 1971. Inquérito nutricional em área urbana da Zona da Mata do Nordeste brasileiro (Água Preta, Pernambuco). *O Hospital, 79:* 707-723.

COUTINHO-ABATH, E.; ESPIRITO SANTO, M.; BARBOSA, J. M. & MELLO, S. A., 1964. Padrão alimentar em áreas endêmicas de Esquistossomose mansônica, no Nordeste do Brasil. *Rev. Bras. Malariol D. Trop., 16:* 553-589.

COUTINHO, E. M., 1976. *Relações hospedeiro-parasito na esquistossomose mansônica, em função da Dieta Básica Regional (Estudo epidemiológico e anátomo-patológico).* PhD Thesis. Centro de Ciências da Saúde da Universidade Federal de Pernambuco, Brazil.

COUTINHO, E. M., 1979-1980. Estado nutricional e esquistossomose. *Rev. Soc. Bras. Med. Trop., 13:* 91-96.

COUTINHO, E. M.; BARBOSA, F. S.; BARBOSA, J. M.; PESSOA, D.; PINTO, R. F.; OLIVEIRA, P. A. & RODRIGUES, B. A., 1972. Inquérito clinico-nutricional e antropométrico preliminar, em áreas endêmicas de esquistossomose mansônica, no Nordeste do Brasil. *Rev. Soc. Bras. Med. Trop., 6:* 211-236.

FERREIRA, H. S., 1991. *Utilização de proteinas na desnutrição induzida pela Dieta Básica Regional, associada à esquistossomose mansônica, em camundongos.* Ms. Thesis, Univ. Federal de Pernambuco.

GUEDES, R. C. A.; ANDRADE, A. F. D. & CABRAL FILHO, J. E., 1987. Propagation of cortical spreading depression in malnourished rats: facilitatory effect of dietary protein deficiency. *Braz. J. Med. Biol. Res., 20:* 639-642.

LAGO, E. S.; PESSOA, D. C. N. P.; TEODÓSIO, N. R. & CABRAL FILHO, J. E., 1988. Longevity and growth curve of chronically malnourished rats fed the Regional Basic Diet (RBD), p. 40-41 In Proceedings of the 2nd. International Symposium of Nutrition, Recife, Brazil.

SILVA, A. T.; COSTA, F. B. R.; COSTA, J. A.; TEODÓSIO, N. R.; CABRAL FILHO, J. E. & GUEDES, R. C. A., 1987. Sciatic nerve conduction velocity of malnourished rats fed the human "Basic Regional Diet" of the northeast of Brazil. *Braz. J. Med. Biol. Res., 20:* 383-392.

TAGLE, M. A. & DONOSO, G., 1965. Net protein utilization determined in short and long-term experiments with rats. *J. Nutr., 87:* 173-178.

TEODÓSIO, N. R.; LAGO, E. S.; MEDEIROS, M. C.; FERREIRA, L. M. P. & SANTOS, E. T. V., 1986. Carbohydrate metabolism in malnutrition induced by the Regional Basic Diet – 1. Fasting glycemia and liver glycogen in rats with RBD-induced malnutrition, p. 40-41. In Proceedings of the Ist International Symposium of Nutrition, Recife, Brazil.

TEODÓSIO, N. R.; ROMANI, S. A. M. & LAGO, E. S., 1986. Dietary deficiencies and malnutrition. 1 – An experimental dietetic model, p. 38-39 In Proceedings of the Ist International Symposium of Nutrition, Recife, Brazil.