Metabolic studies with a corn and soya mixture for infant feeding

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SUMMARY

Nitrogen balance was used to study, in normal and malnourished children, the nutritive value of a vegetable protein mixture. Basically the mixture contained corn and soybean flour. The results were compared with those obtained with children fed cow's milk.

It was found that, when the undernourished children received this mixture as the only source of food, absorption and retention of nitrogen were 70.1 and 21.3% respectively. These values were inferior to those obtained with children fed cow's milk.

In the group or normal children this vegetable mixture increased the absorption and retention of nitrogen when substituted for part of their basic diet. This absorption and retention showed to be equal and even greater than when cow's milk substituted part of the basic diet. This is a very important finding considering that this mixture is intended as a supplement to the regional diets of low nutritive value.

It is well known that protein malnutrition is one of the most common causes of infant mortality in the tropics and subtropics (1). Since production and consumption of animal proteins are relatively negligible in these areas, attempts are currently being made to develop vegetable protein mixtures from locally available sources to obtain infant food of good nutritive value.

In Brazil, where the problem of infant malnutrition is as

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Recibido: 7-11-1966

serious as in other developing countries, attemps of this nature are also being made. Thus, studies have been conducted by Nelson Chaves *et al.* (2), on the utilization of cashew nut and "macaçar" bean proteins for human consumption. In Ribeirâo Prêto, Dutra de Oliveira *et al.* have been concentrating their efforts on the development of supplementary proteins based on soya beans. Studies with soya milk produced in this country revealed that it's nutritive value is similar to that of cow's milk (3). Dutra de Oliveira *et al.* have also developed a mixture based on the soybean flour which proved to be an effective protein supplement to local infant feeding (4).

This paper describes the results of nitrogen balances on malnourished and normal children with another protein mixture where soya and corn are the principal components. This mixture was developed at the Institute of Nutrition of Central America and Panamá (INCAP) and their findings on animals and children are soon to be published (5). The replacement of part of a local diet with this protein mixture was the approach utilized in the study of this new infant food in normal children. The results obtained were compared with those found in a similar group of children fed cow's milk protein.

MATERIAL AND METHODS

Studies were carried out on a total of 13 children, in the 1 to 3 years age group. Eight were malnourished, according to our pre-estabished criteria (6). Five were considered clinically normal with their weights and heights corresponding to the standard Brazilian table developed by Ema de Azevedo (7).

Clinical data regarding these children is shown in Table I.

After admission to a metabolic ward, the malnourished children we divided at random into two groups —one to be fed cow's milk and the other the vegetable mixture under study. Both foods were given to the children in isocaloric and isoproteinic quantities.

The product under study includes 39.0% soya flour, 59.9% corn flour and 1.1% vitamin and mineral mixtures. Total protein content is 27%, as per INCAP's formula (5).

TABLE 1

CHILDREN'S CLINICAL DATA ON ADMISSION TO THE METABOLIC STUDIES

Child	Sex	Age (months)	Weight (kg.)	Height (cm.)	Remarks
M. F.	M	12	7.9	76.5	Malnourished
R. J.	F	26	9.9	82.0	Malnourished
R. F.	F	25	8.5	79.0	Malnourished
M. A.	M	14	5.2	66.0	Malnourished
S. D. S.	F	15	8.8	74.0	Malnourished
M. S. C.	F	15	6.1	68.0	Malnourished
N. M. F.	F	24	5.8	70.0	Malnourished
L. C. F.	M	12	8.4	73.0	Malnourished
M. R. R.	F	22	10.2	81.5	Normal
I. I. S.	F	34	12.8	87.5	Normal
M. A.	M	34	13.4	91.5	Normal
S. M. S.	F	29	13.3	86.5	Normal
W. C.	M	30	12.7	90.0	Normal

The soya flour utilized is a solvent extracted product manufactured in Southern Brazil (4).

During the first 24 hours after admission, all children received a hydrosaline solution. On the second day, the children were bottle fed cow's milk or the vegetable mixture in progressive quantities, up to a daily total of 1000 ml. This amount was reached after 3 to 4 days of treatment, providing a daily intake of approximately 630 calories and 15 grams of protein.

Two metabolic balances of 72 hours' duration were carried out on each malnourished child. These were started respectively on the 7th and 18th day of treatment. During the balance periods the children were placed in metabolic beds where feces and urine were collected separately. The beginning and the end of the feces collection were marked respectively by the appearance of carmine and carbon.

The nitrogen in the foods, feces and urine was determined by the Kjeldahl method.

All malnourished infants were kept in the ward for a pe-

TABLE 2

RANDOM SEQUENCE OF DIETS FED TO NORMAL CHILDREN

Children	PERIODS		
	1st	2nd	3rd
M. R. R.	B. D.	B. D. + C. M.	B. D. + C. M.
I. S. S.	B. D.	B. D. + C. M.	B. D. + V. M.
M. A.	B. D. + C. M.	B. D. + V. M.	B. D.
S. M. S.	B. D. + C. M.	B. D. + V. M.	B. D.
W. C.	B. D. + V. M.	B. D.	B. D. + C. M.

B. D.=Basic diet; C. M.=Cow's milk; V. M.=Vegetable mixture.

riod of 25 days and during this time received a commercial pediatric vitamin solution as well as penicilin and sulfaguanidine during the first ten days.

Studies were carried out on a group of five children, considered as normal, belonging to the same age group as the malnourished ones. Food given to them was according to the sequence shown on Table II. During this study, all the children had to pass through three different stages of feeding. At one, they received only the basic foods, at others, half of the basic diet protein was substituted by cow's milk or by the vegetable mixture under study. Cane sugar and/or corn starch were added to keep the diet isocaloric.

The quantity of proteins and calories given to the children was calculated to be constant, both during the period of basic diet as well as when part of it was substituted by cow's milk or the vegetable mixture under study. The basic diet included food usually eaten by the children of the region, which furnished a total of 26 grams of protein and 1100 calories daily (Table III). These foods were offered in the form of porridge; first cooked and then homogenized in a blender.

After five days on the same diet, the normal child was submitted to the 72 hour balance period and then the food

TABLE 3
DIET FED TO NORMAL CHILDREN

FOOD	Basic Diet g.	Basic Diet plus Vegetable Mixture g.	Basic Diet plus Cow's Milk g.
Rice	200	100	100
Beans	56	28	28
Potatoes	45	45	45
Tomatoes	28	28	28
Oil	15	15	15
Vegetable Mixture	—	53	—
Cow's Milk (skimmed)	—	—	44
Corn Starch	—	—	40
Sugar (Cane)	—	64	37

was changed. The time spent by a normal child at the hospital was approximately 30 days during which period each was submitted to three balances of 72 hours each. Techniques and methods utilized in this group were similar to those used with the malnourished children.

RESULTS

Tolerance and acceptance of the vegetable mixture were good. No refusals or gastrointestinal disturbances were observed which could have been attributed to the vegetable mixture.

Results of nitrogen balances showing individual values in each 3-day period appear in Tables IV and V.

Average nitrogen absorption and retention in malnourished children fed cow's milk were 79.7% and 34.2% respectively. In the group which received the vegetable mixture under study, these values were 70.1% and 21.3% respectively. In normal infants the average nitrogen absorption and retention with the basic diet were 56.4% and 13.9%. During the substitution of part of basic diet by cow's milk, average nitrogen

TABLE 4

NITROGEN BALANCES ON MALNOURISHED CHILDREN FED COW'S MILK OR THE VEGETABLE MIXTURE

COW'S MILK				VEGETABLE MIXTURE			
Name	Nitrogen Intake g/day	Absorpt. %	Retent. %	Name	Nitrogen Intake g/day	Absorpt. %	Retent. %
M. F.	2.4	82.7	44.4	S. D. S.	2.5	56.5	9.6
M. F.	2.7	84.8	43.6	S. D. S.	2.1	57.8	16.4
R. F.	2.6	76.9	35.4	M. S. C.	1.8	71.4	17.3
R. F.	2.8	77.3	20.0	M. S. C.	2.5	73.9	24.4
R. J.	2.4	81.6	45.3	N. M. F.	2.6	78.7	27.4
R. J.	2.4	82.2	29.0	N. M. F.	2.2	76.4	20.4
M. A.	2.5	80.5	28.1	L. C. F.	2.3	73.0	27.7
M. A.	2.4	71.4	27.6	L. C. F.	2.4	73.3	27.9

TABLE 5

NITROGEN BALANCES ON NORMAL CHILDREN

Name	BASIC DIET			BASIC DIET Plus VEGETABLE MIXTURE			BASIC DIET Plus COW'S MILK		
	Nitrog. Intake g/day	Absorp. %	Retent. %	Nitrog. Intake g/day	Absorp. %	Retent. %	Nitrog. Intake g/day	Absorp. %	Retent. %
M. R. R.	3.3	62.9	22.9	4.1	68.9	26.9	4.3	73.5	31.4
I. I. S.	4.2	58.5	17.6	4.5	63.4	19.6	4.4	70.6	17.6
M. A.	4.5	48.4	6.7	4.6	69.7	33.4	4.5	70.3	8.7
S. M. S.	3.8	54.5	11.2	4.7	67.7	24.1	4.8	64.3	23.8
W. C.	4.5	57.6	11.3	4.4	77.1	23.3	4.6	76.9	16.8

absorption and retention were 71.1% and 19.7%. When substituting part of basic diet by the vegetable mixture under study, average nitrogen absorption and retention were 69.4% and 25.5% respectively.

COMMENTS

The primary conclusion of these experiments is that the mixture under study was well accepted by malnourished children when it was offered as their only food as well as by the normal ones when it was ingested along with a diet of the common foods of the region.

Results of the nitrogen balances obtained with malnourished infants showed that absorption and retention of nitrogen, as percentage of intake, was smaller in the group fed with the vegetable mixture under study than in the group fed cow's milk. Retention of nitrogen reached by us with this mixture is similar to that reported by Scrimshaw *et al.* (8) with a vegetable mixture based on corn flour and cottonseed flour. The results found in the experiments made with normal children fed a basic diet which was replaced in part by the vegetable mixture under study, or by cow's milk, seem to us more vital than those obtained with the malnourished children. The general aim of a supplementary food is to use it in addition to local staple foods; we cannot expect that a supplementary food would be accepted as a sole food. It was verified in these normal children that absorption and retention of nitrogen as a percentage of intake is comparatively lowest when these infants are being fed only a basic diet, including foods normally eaten by them. When part of this basic diet is substituted by cow's milk or by the vegetable mixture under study, there is a substantial increase in the nitrogen absorption as well as in the nitrogen retention, independent of the order in which these supplementary foods are introduced in the study. It is also to be noted that the nitrogen retention in these cases was higher with the use of the vegetable mixture than with the use of cow's milk.

When the vegetable mixture or cow's milk were fed in substitution of part of the normal diet (but maintaining the same total nitrogen intake level as with the normal diet alone) there was improvement in nitrogen absorption and especially

in nitrogen retention, compared to that obtained with the normal diet. This improvement was probably due to the fact that substitution of part of the diet with cow's milk or with the vegetable mixture provided better amino acid balance of the body's nitrogen metabolism than was provided by the normal diet.

These results are quite important to us. They show that foods commonly eaten by low socio-economic groups in our country, which is mostly of vegetable origin, could be improved in their nutritive protein values via the introduction of well-balanced vegetable mixtures.

Finally we would like to call attention to the following points:

1. A basic infant diet may show great variation from one region of a country to another.
2. A particular infant food may be a good source of protein when fed alone to normal or malnourished children.
3. The use of a tested infant food as a supplement to a rice-based infant diet of a country may not show the same results with a corn —or a bean— infant-based diet of different regions or countries.
4. We would like to suggest that new infant foods always be tested in combination with local "daily-use" foods.

SUMÁRIO

Estudos metabolicos com uma mistura de milho e soja para alimentação infantil

Os autores estudaram através de balanços nitrogenados em crianças normais e desnutridas, o valor nutritivo de uma mistura de proteínas vegetais. Esta mistura consistia bàsicamente de milho e soja. Os resultados obtidos foram comparados com aquêles de crianças alimentadas com leite de vaca.

Foi encontrado que quando as crianças desnutridas recebiam esta mistura vegetal como sua única fonte de alimento, a absorção e retenção nitrogenada foi 70,1% e 21,3% respectivamente. Êstes resultados foram inferiores aquêles obtidos com crianças alimentadas com leite de vaca.

No grupo de crianças normais esta mistura vegetal aumentou a absorção e retenção nitrogenada, quando era oferecida em substituição à parte de sua dieta básica. Esta absorção e retenção mostrou ser igual ou mesmo superior aquêla obtida quando a substituição foi feita com leite

de vaca. Êste último resultado foi de grande importância em se considerando que a mistura em estudo tem por finalidades a suplementação das dietas regionais de baixo valor nutritivo.

ACKNOWLEDGEMENTS

The authors wish to thank Produtos Alimenticios Quaker S. A., for their interest and support in the carrying out of this work. The present vegetable mixture is being manufactured in Brazil by the above mentioned firm, and will be marketed under the name of INCAPARINA by permission of the Institute of Nutrition of Central America and Panama (INCAP).

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