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Nutritional Evaluation Laboratory

By

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The Nutritional Evaluation Laboratory (NEL) was established in 1979-1980 as a unit of the Food and Nutrition Research Institute (FNRI) and undertook nitrogen and energy utilization studies in Filipino preschool children on rice based weaning foods. Chemical aspects of the study were undertaken by the Cereal Chemistry department of the International Rice Research Institute.

a) Degree of milling and protein and energy availability from rice grain

Brown rice has more protein, vitamins, minerals, and lipids, and its protein has higher lysine content than the protein of milled rice (Santiago et al 1983). Hence, brown rice had been advocated to be more nutritious than milled rice. However, when diets of brown, undermilled, and milled IR32 rice were fed to preschool children at two N intake levels (200 and 250 mg N/kg body wt) at the NEL, no differences in protein absorption and retention were observed (Table 1). The rice-casein experimental diets (2/3 of N from rice and 1/3 from casein) though, showed poorer protein absorption than the control casein or milk diets. Energy and fat absorption values were higher for the milled-rice diets than for the brown-rice diets.

Earlier biological tests with growing rats at the National Institute of Animal Science (NIAS), Copenhagen, also indicated that protein of the bran and polish of IR32 have slightly poorer digestibility but better biological value than protein of brown and milled rices (Eggum et al 1982). The poorer digestibility of bran and polish explains the inferiority of brown rice to milled rice in both protein and energy digestibilities in rats.

b) Nutritional evaluation of rice-based weaning foods

The NEL is primarily concerned with the nutritional evaluation of rice-based weaning foods developed in the Southeast Asian region.

In children, an extrusion-cooked blend of 60% rice flour, 35% full fat ASEAN soy flour, and 5% nonfat dry milk (ENERGRO), develop at the FNRI showed nitrogen absorption and retention values similar to those of the control milk diets. In rats, protein efficiency ratio (PER), true digestibility (TD), biological value (BV) and net protein utilization (NPU) were comparable to those of casein. Coco-cereal, another FNRI product, is a drum-dried precooked preparation from rice flour, coconut-skimmed milk, insoluble protein solids, nonfat dry skimmed milk, and coconut oil. In children, it was comparable

in BV and NPU to the control casein diet, although its digestibility was lower (Santiago et al 1983).

c) Protein requirements of children and adults consuming local diets

The facilities of the NEL were also used in the United Nations World Hunger Programme studies on the protein requirements of young children and adults consuming local diets.

The protein requirements of male 18 to 30-month-old Filipino toddlers consuming rice-fish and rice-mungbean diets were evaluated using the multilevel N-balance assay (Intengan et al 1983). Two thirds of the N in the diet came mainly from rice and one third from fish or mungbean. The higher mean protein requirement of the toddlers given rice-mungbean diets, compared with that of the toddlers given the rice-fish diet (Table 2), may be attributed to the poorer digestibility of mungbean, especially of the undehulled beans probably because of the phenolics present in the seedcoat. High protein rice (IR58, 12% protein) had better protein quality than rice-whole mungbean diet, but rice-milk diet had the best quality (Table 2).

Because children at higher N intake levels using rice-mungbean diets lost weight without any drop in N retention, samples of whole, toasted and winnowed, soaked and mechanically dehulled mungbean were evaluated for energy and protein digestibilities in rats. Results at the NIAS, Copenhagen, indicate that dehulled mungbean had the highest digestible energy and N in rats probably because mechanical dehulling drastically reduced total free sugars, phenolics, and neutral detergent fiber content (Eggum et al 1984) (Table 3). Mechanical dehulling of beans presoaked for 2 hours leached out and reduced the level of galactose containing nonreducing sugars, which are believed to cause flatus. Toasting of mungbeans partly decomposed proteins, slightly lowering lysine content, thereby decreasing N utilization of the toasted beans.

An attempt was made to determine the protein quality of high-protein rice (IR9752-71-3-2) relative to milk (reference protein) using the conventional and the short-term multilevel N balance assays on three to four children. With Relative Protein Value (regression coefficient of N retention on intake) and Relative N Requirement (N intake when Y = 0) as indices of protein quality, the values obtained were 73.2% and 78.8%, respectively. Raw high-protein rice fed to rats had an NPU of 68.3%.

Studies of protein requirements of adults indicate that the current recommended allowance for protein (1.12 g/kg body weight per day) is adequate for Filipino adults provided calories are adequate (Intengan et al 1982, Santiago et al 1984). Long-term studies (84 days) in which protein intake was maintained at adequate levels but in which calorie intake was reduced by 15% resulted in weight loss and negative N-balance for some time. However, the subjects were able to adapt and have positive N balance inspite of weight loss.

d) Protein-energy interrelationship studies

Only the first phase of the study, which aims to determine the effect of varying energy intake on protein utilization of rice-fish diet was accomplished in 1982-1983. Nitrogen and energy absorption values were similar at all energy intake levels. Percentage of N retention, however, was lower at the 90 kcal/kg per day energy intake level. The rate of weight gain was slower (in 3 out of the 6 children who participated in the study) after 2 weeks at 100 kcal/kg per day. At 90 kcal/kg per day, four out of five children progressively lost weight during the study. The results of the study indicate that the optimum daily energy intake for a rice-fish diet providing 1.6 g protein/kg may even be higher than the current recommendation of 100 kcal/kg. This energy intake level is adequate for 9-day balance periods with 1.56 g milk or casein protein/kg per day, but has not been tried for longer periods. Further investigation with a larger number of subjects is needed before any conclusion can be reached.

e) Other studies

Rice gruel, as a weaning food, aside from having inadequate protein, has a low energy density. Studies of the effect of starch properties on energy density of gruels indicate that the addition of oil may improve energy density of rice gruel by 14-22% and that parboiling of rice may improve it by 20-50%. Corn oil may be added at 6-10% by weight of the rice without appreciably changing the energy density.

Because red rices are important in some countries such as Sri Lanka and among African Oryza glaberrima varieties, the effect of their red and purple pigments on growing rats was studied at NIAS (Eggum et al 1982). The protein of two pigmented and two nonpigmented brown rices had similar lysine contents. The protein of the pigmented brown rice, was however, less digestible in rats (78% vs 97%). Milled pigmented and

nonpigmented rices have similar protein digestibility and NPU because of removal of pigments and phenolics.

"Yellow rice" results from stack-burning caused by the Philippine practice of heaping unthreshed rice plants. Microbial metabolism causes heat to build up to temperatures higher than 60°C. Yellow rice has lower lysine content than untreated white milled rice. Stack burning does not affect energy digestibility but decreases true nitrogen digestibility and NPU in growing rats (Eggum et al 1984).

Publications acknowledging AID grant

Resurreccion, A. P., and B. O. Juliano. 1981. Properties of poorly digestible fraction of protein bodies of cooked milled rice. Qual. Plant. Plant Foods Hum. Nutr. 31:119-128.

Eggum, B. O., E. P. Alabata, and B. O. Juliano. 1981. Protein utilization of pigmented and nonpigmented brown and milled rices by rats. Qual. Plant. Plant Foods Hum. Nutr. 31:175-179.

Eggum, B. O., B. O. Juliano, and C. C. Maningat. 1982. Protein and energy utilization of rice milling fractions by rats. Qual. Plant. Plant Foods Hum. Nutr. 32:371-376.

Intengan, C. Ll., B. V. Roxas, M. I. C. Santiago, and B. O. Juliano. 1982. Protein requirements of adult Filipinos consuming local diets. Philippine J. Nutr. 35:112-119.

Santiago, M. I. C., B. V. Roxas, C. Ll. Intengan, and B. O. Juliano. 1983. Protein and energy utilization of brown, undermilled and milled rices by preschool children. Qual. Plant. Plant Foods Hum. Nutr. 33 (4) (in press).

Santiago, M. I. C., B. V. Roxas, A. S. Loyola, and E. R. Alejandro. 1983. Protein quality of coco-cereal, a protein rich weaning food. Philippine J. Nutr. (in press).

Eggum, B. O., B. O. Juliano, C. M. Perez, and C. P. Villareal. 1984. Effect of processing on protein and energy utilization of rice and mungbean. Qual. Plant. Plant Foods Hum. Nutr. (manuscript).

Intengan, C. Ll., B. V. Roxas, M. I. C. Santiago, A. S. Loyola, E. R. Alejandro, J. N. Abadilla, and G. F. B. Yu. 1984. Protein requirements of Filipino children 18-30 months old consuming local diets. I. Rice-fish and rice-mungbean diets. Philippine J. Nutr. (manuscript).

Santiago, M. I. C., C. Ll. Intengan, B. V. Roxas, and B. O. Juliano. 1984. Protein requirements of adult Filipinos consuming local diets. II. Effect of calorie restriction on nitrogen retention. Philippine J. Nutr. (manuscript).

Table 1. Protein, energy, and fat utilization in preschool children fed brown, undermilled, and milled rice diets with casein or milk (2:1 N ratio). Nutritional Evaluation Laboratory, Food and Nutrition Research Institute, Manila, and IRRI, 1980-1982.

Parameter	Apparent value[1/] (% of intake)			
	Brown rice diet	Undermilled-rice diet	Milled-rice diet	Control diet
	250 mg N/kg daily rice-casein in six children			
N absorbed	67.4 b	70.0 b	70.4 b	80.4 a
N retained	36.1 a	37.3 a	36.9 a	33.8 a
Energy absorbed	89.6 b	92.3 a	92.8 a	92.0 a
	200 mg N/kg daily rice-casein in five children[2/]			
N absorbed	63.0 b	62.6 b	61.9 b	77.3 a
N retained	28.2 a	25.7 a	27.3 a	35.7 a
Energy absorbed	89.5 b	90.5 b	92.6 a	91.2 b
Fat absorbed	93.4 b	95.5 ab	97.6 a	95.2 ab
	200 mg N/kg daily rice-milk in six children			
N absorbed	59.7 b	-	63.3 b	74.0 a
N retained	27.3 a	-	28.9 a	36.0 a
Energy absorbed	90.1 b	-	92.0 a	90.8 ab
Fat absorbed	94.3 b	-	97.1 a	94.9 b

[1/]Separation of means in a line by Duncan's multiple range test at the 5% level. [2/]Four children only for control diets. One child less (3 to 4 children) for fat absorption data.

Table 2. Mean protein requirement and safe levels of N intake by male Filipino toddlers (18-30 months old) consuming local diets[2/]. FNRI 1979-1983.

Property	Rice-fish	Rice whole mungbean	Rice toasted mungbean	High-protein rice	Rice-milk
Lysine content (g/16 g N)	6.2	5.3	5.2	3.6	5.4
Mean protein requirement[1/] (g/kg body weight/day)	0.69	1.00	0.85	0.87	0.64
Safe-level of intake (g/kg body weight/day)	1.0	1.48	1.19	1.33	0.93
Children (no.)	7	6	8	3	8

[1/]One third of total N from fish, mungbean or milk.

[2/]Allowing 10 mg N/kg/day for miscellaneous integumental losses.

Table 3. Effect of processing (dehulling) and cooking of green mungbean on energy and nitrogen utilization in growing rats (Eggum et al 1984).

Property*/	Whole mungbean	Toasted winnowed	Mechanically dehulled
Crude protein (% N x 6.25)	22.3	25.6	22.6
Lysine (g/16 g N)	6.9	6.0	7.0
Cystine + methionine (g/16 g N)	2.1	2.2	2.0
Phenolics (% as catechin)	0.98	0.31	0.13
Neutral detergent fiber (%)	7.5	6.1	2.0
Trypsin inhibitor activity (% inhibition /mg sample)	38.5a	7.8c	21.8b
Nonreducing sugars (% as glucose)	5.0	5.0	0.80
Energy content (Joules/g, dry basis)	18.8	18.8	19.0
Balance data in rats (raw beans)			
Digestible energy (% of intake)	82.4c	85.5b	93.0a
True digestibility (% of N intake)	85.2b	85.3b	95.2a
Biological value (% of absorbed N)	62.2a	52.1b	53.1b
Net protein utilization (% of N intake)	53.0a	44.4c	50.5b
Balance data in rats (cooked beans)			
Digestible energy (% of intake)	79.4b	79.6b	93.6a
True digestibility (% of N intake)	83.7b	81.6b	97.1a
Biological value (% of absorbed N)	60.0a	49.3b	60.1a
Net protein utilization (% of N intake)	50.2b	40.2c	58.3a

*/Separation of means in a row by Duncan's multiple range test at the 5% level.