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PROTEIN SUPPLEMENTATION

Relationships Between Milled Rice and Milled Flour And Between Milled Rice and Milled White Corn Meal

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Because the proteins in milled rice were found to be much superior to the proteins in milled wheat and corn, the possible supplementary relationships among these proteins were investigated. When one half of the proteins in milled wheat was replaced by an equivalent amount of proteins in milled rice, there were 114% increase in growth and 86% increase in protein efficiency; when one third of the proteins in wheat was replaced by proteins in milled rice, there was 55% increased growth and 55% increase in protein efficiency. When one half of the proteins in milled corn meal was replaced by proteins in milled rice, there were 236% increase in body weight and 165% increase in protein efficiency; when one third of the proteins in corn meal was replaced by proteins in milled rice, there were 190% increase in growth and 148% increase in protein efficiency. It would seem most desirable for people of low income level, now using corn for their basic cereal food, to consume a greater proportion of rice to balance the deficient proteins in corn.

Of all the proteins ingested, only those of animal origin are considered to be of superior biological value, but it takes approximately 2 acres of land to graze a cow, if soil and moisture conditions are favorable. The conversion of vegetable calories into animal calories has long been known to be inefficient. Only 15% of vegetable calories is recovered in producing milk, 7% in eggs, and 4% in beef (*2*). It is consequently impossible to raise sufficient cattle for human consumption in overpopulated and underdeveloped countries; plant proteins of inferior biological value must necessarily provide sustenance for the greater portion of the world, and these are supplied chiefly by cereal grains. It has been suggested that a high incidence of infectious diseases is related to low intake of high quality protein foods (*1, 3, 4*). The world's food supply is dominated by cereals. Cereal grains are the most economical sources not only of proteins but also of fuel requirements of the human race. About 80% of the earth's population belong either to the rice- or wheat-eating worlds. Rice has always been the food of the yellow and brown races, while for several centuries wheat, through preference, has been the universal grain of the white race.

Experimental Procedure and Results

The author has demonstrated the low biological value of the proteins in milled wheat flour and milled white corn meal and the supplementary values of dried food yeasts, soybean flour, peanut meal, dried nonfat milk solids, and dried buttermilk (*10–12*).

As the proteins in milled rice were found to be much superior biologically to the proteins in milled wheat (*13*) and milled corn (*8*), it was of interest to investigate the possible supplementary value of the proteins in milled or polished rice to the proteins of milled patent-enriched wheat flour and to milled white corn meal, the latter being used extensively in the South in quick breads—i.e., corn muffins and corn bread. A summary of the results of this study is presented in Table I.

This investigation was carried out on Wistar strain albino rats, 30 days old; each weighed 50 to 55 grams when started on experiments. They were housed in metal cages on false screen bottoms and, therefore, had no access to fecal excretions. There were 12 males and 12 females in each group.

Table I. Supplementary Relationship Between Proteins in Milled Rice, Milled Wheat Flour, and Milled White Corn Meal

(24 animals in each group. Average results per animal for an 8-week period)

Type of Ration	% in Ration	Protein in Ration	Gains in Body Weight G.	Gains in Body Weight %	Total Food Intake, G.	Protein Intake, G.	PER[a]	Increase, %
Milled wheat flour	71.4	7.0	22.2	...	441.1	30.9	0.70 ± 0.05[b]	...
Milled wheat flour Milled rice	35.7 54.7	3.5 3.5	47.3	114.1	521.1	36.5	1.30 ± 0.04	85.7
Milled wheat flour Milled rice	47.7 35.6	4.67 2.33	34.3	54.5	451.4	31.6	1.09 ± 0.06	55.7
Milled white corn meal	77.9	6.0	10.1	...	352.1	21.1	0.48 ± 0.08	...
Milled white corn meal Milled rice	39.0 49.5	3.0 3.0	34.0	236.2	441.6	26.5	1.27 ± 0.06	164.6
Milled white corn meal Milled rice	51.9 33.0	4.0 2.0	29.3	190.1	411.4	24.7	1.19 ± 0.08	148.0

[a] Protein efficiency ratio, expressed as gains in body weight per gram of protein intake.
[b] Standard deviation of means.

Each animal was weighed once weekly and accurate records were kept of food consumption. From the gains in body weight per gram of protein intake, the protein efficiency ratios were calculated. The results in Table I are expressed as average growth per animal during an 8-week experimental period.

The milled rice, milled wheat flour, and corn meal furnished the only sources of proteins in the rations and were fed to incorporate the necessary protein levels. The composition of the rest of the rations was: 2% cellu flour for roughage; 4% of Sure's salt mixture No. 1 (*9*); 2% vegetable shortening; 2% cod liver oil and 1% wheat germ oil as sources of vitamins A, D, and E; and the rest cerelose (glucose). The following crystalline components of the vitamin B complex were administered daily to each animal separately from the rations six times a week, with a double dose on Saturdays: 25γ each of thiamine, riboflavin, pyridoxine, and niacin, 150γ of calcium pantothenate, 3 mg. of *p*-aminobenzoic acid, 6 mg. of choline chloride, and 1 mg. of inositol. These vitamins were given in Petri dishes in a dilute solution of glucose. Folic acid and vitamin B_{12} were not added to the rations, because under the dietary regime followed these vitamins are synthesized in the intestinal tract of the rat.

The milled enriched wheat flour (Gold Medal) and the white corn meal were purchased in local grocery stores. The milled rice was the Arkansas Zenith variety supplied by the Arkansas Rice Growers Cooperative Association. The total protein contents of the wheat, corn meal, and rice were 9.8, 7.7, and 6.1%, respectively. The wheat and corn meal rations were planned to allow a maximum of protein, after the essential ingredients had been incorporated, to furnish roughage, minerals, fat, and fat-soluble vitamins. It was possible to study the proteins in milled wheat at a 7% protein level and the proteins in milled white corn meal at a 6% protein level.

Table I indicates that when one half of the proteins in milled wheat were replaced by an equivalent amount of proteins in milled rice, there were 114.1% increase in growth and 85.7% increase in protein efficiency ratio and when one third of the proteins in the wheat were replaced by an equivalent amount of the proteins in rice, there still were 54.5% increased growth and 55.7% increase in protein efficiency ratio.

The proteins in milled rice showed much greater supplementary value to the proteins in milled corn meal than to the proteins in milled wheat. When one half of the proteins in the milled corn meal was replaced by an equivalent amount of proteins in milled rice, there were 236.2% increase in body weight and 164.6% increase in protein efficiency ratio and even when only one third of the proteins in the corn meal were replaced by the same amount of proteins in the milled rice, there still were 190.1% increased growth and 148.0% increase in protein efficiency ratio. These effects are interpreted as being due to the proteins and amino acids in milled rice and not to other components of this product.

The surprising revelation from this study is that rice, which is the basic food of the yellow and brown races of the world—95% is produced in the Far East and only 1% in the United States (*5*)—contributed biologically such valuable proteins as a supplement to wheat, the white man's proverbial "staff of life," and supplied even a greater protein supplementary value to the proteins in corn meal, which is the basic breadstuff in the South of this country. For people of low income levels who use largely corn for their basic cereal foods—those residing in the southern part of the United States, Guatemala in Central America (*6*), South Africa, Yugoslavia, and Mexico (*14*)—it would seem most desirable to grow more rice under favorable soil and climatic conditions, and consume a greater proportion of rice to balance the proteins in corn, which are deficient in a number of amino acids but particularly in lysine, tryptophan, threonine, and methionine (7).

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