Nutritional Availability of Rice Protein

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The Japanese consumed about 280 g of polished rice per head per day in 1967 and rice is our principal calorie food. The compositions of polished rice are starch (73%), protein (6-7%), fat (less than 1%), etc. Rice is called, then, starchy food. Next, rice may be considered from the standpoint of protein source. Protein consumption per head per day was 74.7 g in Japan in 1967, of which about a quarter (17.5 g) is from rice protein. And among protein-supplying foods rice ranks the first, and fish is the second. Therefore rice is very important not only as calorie food but also as protein-supplying food in Japan.

In recent years consumption of protein from dairy products has been increasing little by little in Japan, but importance of rice as protein food appears to last further. In the countries of Southeast Asia whose people live on rice, the circumstances may be considered to be similar to in Japan.

Problems in nutritional value of rice protein

Nutritional value of rice protein is better among vegetable proteins, and its amino acid composition is well known, too.[1] The first limiting amino acid of rice protein is lysine, with its protein score 78.

It has been considered for a long time that if rice is supplemented with lysine its nutritional value will increase, whereas it has been made cleared that effect of lysine supplementation on nutritional value of rice is little and that addition of lysine plus threonine improve it remarkably.[2] Then this problem has become an important subject of study in Japan also.

We also considered these findings to be important and first of all carried out some experiments. Growth of rats fed on polished rice diet for 30 days was average 55 g; on 0.3 per cent lysine supplemented diet, 69 g; and on 0.3 per cent lysine plus 0.2 per cent threonine supplemented diet, 90 g. From the results it is known that threonine is very effective for rat growth, but an effect from the addition of threonine alone is not obtained. According to the findings up to this time, threonine is not one of the amino acids deficient in rice. Thus the above phenomenon is unable to be explained from the viewpoint of limiting amino acid.

The considerable factors are as follows. (1) Since protein content of rice is low, this phenomenon may be a kind of amino acid imbalance brought about by excess or deficiency of a very small amount of amino acid under a condition of low protein. (2) Biological availability of threonine in rice protein may be questioned. (3) Effects of other coexisting components which may have complex relations with protein nutrition may be questioned. (4) Metabolic specifications of individual amino acids, lysine, threonine, etc., may be related with the phenomenon. It is unable to solve all the problems at the same time, and we decided to begin with the second problem on biological availability of threonine.

Availability of threonine in rice protein

The reason for considering the availability of threonine may be questioned from the results of the following two experiments.

1) Polished rice diet, milk casein diet and

protein-free diet were fed to rats, and the excreted amino acids in the feces were determined. The results of experiments indicated good digestibility of lysine on both polished rice diet and milk casein diet, with the apparent digestibility 98 per cent and 99 per cent, respectively, while digestibility of threonine was seen to be less in the polished rice diet than in the milk casein diet and the apparent digestibility was 77 per cent and 95 per cent, respectively. This shows that availability of threonine in rice protein is low.

2) Using rats fed on amino acid mixture, which was same to amino acid composition to rice protein, experiments on lysine and threonine supplementation were carried out. In this case the addition of lysine alone improved nutritional value but the addition of lysine plus threonine was ineffective. Amino acid mixture diet does not need to be digested but is absorbed directly, and effect of lysine as limiting amino acid is only demonstrated. The results showed that threonine was not deficient in rice protein from the viewpoint of amino acid composition.

From the above results we thought that something disturbed availability of threonine in the process where rice protein was digested.

Peptide produced by digestive enzyme treatment of rice protein

From the above findings it was assumed that rice protein consisted of digestible and indigestible parts in vivo and that threonine might be contained in the latter part. Glutelin separated from polished rice exerted successively the action of protein-digestive enzymes, pepsin, pancratin, trypsin, erepsin, etc. And from the digested fluid indigestible peptide fraction was separated under the gel filtration method and then the amino acid composition was analysed.

In the peptide fractions of relatively large molecular weight threonine and lysine were seen to be included.[3] In further study, now under way, purification of peptide in question and determination of its amino acid sequence will be carried out. When the study is concluded, the structure of indigestible peptide will be clarified and the beneficient information on nutritional value of vegetable protein may be obtained.

The above is the development of our investigations but the details are not yet printed formally. Soon after the completion of investigations they are to be published.

In Japan much work has been done on the problem of rice protein nutrition. The investigations are as follows:

Yoshida, A.[4] found that the absorption rate of threonine in polished rice protein was slower than that of lysine from animal experiments. Tamura, E.[5] reported from rat growth tests that availability of threonine in polished rice was lower than threonine in milk casein. Nonaka, Y.[6] recorded an augmentation in the excretion of peptide, which contained threonine, in the urine from rats that ingested polished rice. And Tamura, E.[5] found a remarkable reducion of threonine content in blood plasma of rats fed on lysine-supplemented polished rice. By the synthesis of the results of these investigations this subject will be considerably clarified and is very interesting in its relation with protein nutrition essentially, too.

The problem of nutritional value of rice is very important for the people of rice-consuming countries. The improvement of nutritional value of rice protein is able to be achieved by the fortification with amino acids as the problem of vitamins deficient in rice has been resolved by the development of vitamin enriched rice. The expensiveness of amino acids brought about delay in the development of amino acid fortified rice.

However it may be a matter of time because the prices of essential amino acids, lysine, threonine, methionine, etc., have gone down recently in Japan with the remarkable growth of the amino acid manufacturing industry. Samples of amino acid enriched rice have been already produced by the manufactories in Japan.

References

1) Japan, Science and Technology Agency: The

Amino Acid Composition of Foods in Japan, 1966.
2) Pecora, L.J., Hundley, J.M.: Nutritional Improvement of White Polished Rice by the Addition of Lysine and Threonine. J. Nutrition, 44, 101, 1951.
3) Miyazaki, M.: The Peptide Produced From Enzyme-Treated Rice Protein. Report of Essential Amino Acid Study. 37, 3, 1968.
4) Yoshida, A.: Absorption of Amino Acid in Rice Protein by the Intact Rat. J. Japanese Society of Food and Nutrition. 20, 504, 1968.
5) Tamura, E.: Unpublished
6) Nonaka, Y., Ariyama, H.: On the Amino Acid Sequence of Urinary Peptides of Rats Fed on a Polished Rice Diet. Agricultural and Biological Chemistry. 26, 850, 1962.