Studies on Adaptation to Protein Deficiency

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Papua New Guinea (PNG) highlanders, who live mainly on sweet potato, have been of great interest to many nutritionists. It is known that these people have fairly good muscular physique and rarely show symptoms of malnutrition even though their intake of protein and energy are very low. Our survey program in PNG was held in 1978, 1980 and 1982 to determine whether adaptation to low protein diet has occurred and, if so, to elucidate the mechanisms involved. The nutritional studies were held in the village of Kalugaluvi near Lufa in the Eastern Highland province of PNG. We carried out the anthropometric measurements and dietary surveys and collected 24-hr urine samples, 2-3 day feces samples for the examination of nitrogen balance and early morning blood samples for hematological studies. We also examined the urinary endogenous nitrogen excretion and the utilization of urea-N by these highlanders. The average consumption of potatoes was 1-1.5Kg/day, and 90% of them were eating sweet potatoes as the staple food. The mean daily energy intake was about 2800 Kcal in 1980 and 1982 which was about as much as daily energy expenditure. The daily intake of protein was 35-55g and sweet potatoes and other tubers accounted for 47.6% of the total protein consumed. It is noteworthy that the growth rate of children and the adults' physique were almost similar to those of Japanese, except that they were short in stature, despite the poor quantity and quality of protein in their food. Their nitrogen balance was slightly negative, but not as negative as that reported by Oomen. The urinary endogenous nitrogen excretion of eight male highlanders was lower than any reported for

male Caucasians or Asians indicating possible adaptation of the highlanders to low protein diet. Ability to utilize urea nitrogen for body protein synthesis was examined with PNG highlanders and Japanese by using ^{15}N -labeled urea. We elucidated that when PNG highlanders take more protein than usual in their diet, they effectively incorporate ingested protein into their body protein and urea nitrogen is utilized for synthesis of body protein.

On the other hand, we have been studying the adaptation to protein deficiency on rats to clarify the process of adaptation. We have reared protein deficient rats on 7% casein diet in successive generations, and various physiological and nutritional parameters were measured. It was found that the growth rate decreased at early stage of generations, but it recovered after the 3rd generation (LP3) gradually and successively and attained at a constant growth rate. Urea recycling was investigated by oral administration of ^{15}N urea on those protein deficient male rats. The retention of ^{15}N increased in protein deficient rats and the increase amounted to twice as much in carcass of LP8 as compared with LP1. On the immunological studies, the skin reactivity diminished as generation proceeded.

These results show that the effective incorporation of ingested protein into body protein and utilization of urea-N for the synthesis of body protein should be a possible mechanism of adaptation to protein deficiency of PNG highlanders and the rats were fed low protein diet in successive generations.

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