DIFFERENCES BETWEEN DIGESTIBILITIES OF PROTEIN AND FIRST LIMITING AMINO ACID IN SOME PLANT PRODUCTS

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ABSTRACT

Values /percent/ for true digestibility /TD/ of protein and essential amino acids /EAA/ in some cereals, legumes and oilseeds and their mixtures have been determined by the rat or pig fecal /balance/ method. In milling and utility wheats, the TD /bioavailability/ values of lysine /80-85/ were up to 12 percent lower than those of protein /92-95/ and other EAA /90-96/. As in wheat, lysine /the first limiting amino acid in cereals/ had the lowest bioavailability in barley /72/, oat /73/, rye /72/ and sorghum /71/. The TD values of protein and bioavailability of other EAA in barley, oat, rye and sorghum were, 82, 79-89; 79, 77-87; 81, 74-89 and 85, 83-87, respectively. The bioavailability values of methionine /the first limiting amino acid in legumes/ in field pea /75/, fababean /70/, lentil /60/ and navy bean /61/ were markedly lower than the TD values of protein /80-85/ and bioavailability of other EAA /80-96 in field pea, 78-90 in fababean, 67-90 in lentil/. Limiting amino acids were also less digestible than protein in soybean, rapeseed, sunflower and groundnut and blends of wheat with legumes and oilseeds. These data suggest that protein digestibility may not be a good predictor of bioavailability of the first limiting amino acid. Therefore, the rapid in vitro methods based on the amount of first limiting amino acid /amino acid score/ plus enzymatic digestibility may not accurately predict protein quality of foods. A preferable approach would be to obtain information on bioavailability of individual amino acids and then correct amino acid score for bioavailability of individual amino acids. Amino acid score corrected for true digestibility /bioavailability/ of individual amino acids has been termed as "available amino acid score". The positive correlation /r = 0.92/ between available amino acid score and relative net protein ratio /RNPR, the most suitable rat growth method for evaluating protein quality/ was highly significant. Protein digestibility and amino acid bioavailability has been a problem in preventing widespread acceptance of amino acid score. Available amino acid score provides a solution to this problem.

INTRODUCTION

Theoretically, the most logical method of estimating protein quality is by consideration of essential amino acid content of a food with human amino acid requirements /Harper, 1979; Pellett, 1978/. In this approach, the level of each dietary essential amino acid is expressed as a % of the amount of that specific amino acid in the reference protein such as human milk, egg or calculated reference mixture of essential amino acids based on human requirements. That amino acid

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which gives the lowest percentage value is the most limiting amino acid and would presumably determine the nutritive value. The term "amino acid score" was used in the FAO/WHO/1973 report which suggested a new scoring pattern based on the more recent assessment of human amino acid requirements. The procedure of scoring proteins from amino acid composition is simple and provides information about the supplementary or complementary value of proteins. Nevertheless, a serious weakness of the scoring procedure is that unlike bioassay methods amino acid scores do not take into account digestibility of protein and bioavailability of amino acids.

In diets based on a sole source of protein, first limiting amino acid can usually be easily predicted from amino acid compositions. However, in the case of protein mixtures in which the protein sources may differ in digestibility and availability of amino acids, it is often difficult to predict the true first limiting amino acid. Similarly, the amino acid score technique does not accurately predict the protein nutritional value of foods where processing has affected protein digestibility and amino acid bioavailability. Rapid in vitro tests for estimating protein digestibility have been developed. Digestibility of protein is a useful parameter for protein nutrition but it may not provide an appropriate correction factor for amino acid score. There is evidence that digestibility of individual amino acids may differ considerably from digestibility of total nitrogen in a protein source. Digestibility of protein and amino acids in some cereals, legumes, oilseeds and their blends; similarly, the amino acid score technique does not accurately predict the protein nutritional value of foods where processing has affected protein digestibility and amino acids in some plant products obtained in the Health Protection Branch laboratories, Ottawa, Canada.

METHODS FOR DETERMINING BIOAVAILABILITY OF AMINO ACIDS

The fecal method as proposed by Kuiken and Lyman is the most widely used animal assay for the estimation of bioavailability of individual amino acids. In this method, true digestibility of amino acid is calculated using the following equation:

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\text{True digestibility} \times 100 = \frac{\text{AAI} - (\text{FAA} - \text{MFAA})}{\text{AAI}}
\]

Where, AAI = total intake of amino acid, FAA = fecal excretion of amino acid, MFAA = metabolic fecal amino acid determined by analyzing the feces of animal fed nitrogen-free diet.

The determination of bioavailability of amino acid by balance trials is criticized on the grounds that the intestinal microflora may modify dietary amino acids especially the non-essential amino acids. This modification may overestimate bioavailability of amino acids, particularly in foods damaged by processing. Measurement of the disappearance of amino acids from the small intestine has been proposed as an accurate measure of their bioavailability. Cho and Bayley compared the amino acid profiles of ileal and rectal digests of pigs fed soybean or rapeseed meal diets and found no significant difference in the proportions of most amino acids. The ileal recovery method neglects the absorption in the large intestine. Therefore, this method may underestimate bioavailability of amino acids because 30-40% of the amino acids present in rat's ileum were reported to be absorbed in the large intestine.