J Food Sci Nutr Res 2020; 3 (3): 136-139 *DOI: 10.26502/jfsnr.2642-11000044*

Review Article

Historical Overview of the Evidence Used for Setting Protein Requirements for the Japanese Population

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Received: 15 May 2020; **Accepted:** 29 May 2020; **Published:** 06 July 2020

Citation: Tatsuya Koyama. Historical Overview of the Evidence Used for Setting Protein Requirements for the Japanese Population. Journal of Food Science and Nutrition Research 3 (2020): 136-139.

Abstract

The aim of this study was to describe the transition in the evidence of digestibility for setting the protein requirement in the Japanese population. Evidence cited by the Recommended Dietary Allowances for Japanese (RDAs-J) third, fourth, and sixth revisions and Dietary Reference Intakes in Japan (DRIs-J) 2005, 2010, 2015, and 2020 editions was searched and assessed. From the RDAs-J third revision to the fifth revision, the relative utilization of high-quality protein was used instead of digestibility to correct the results of nitrogen balance studies. From the RDAs-J sixth revision to the DRIs-J 2015 edition, digestibility of mixed proteins was used to correct the results of nitrogen balance studies. Digestibility was set to 90% by quoting experimental results that used a practical diet based on the National Nutrition Survey of 1975 and 1982. Although DRIs-J 2020 also uses digestibility to correct the results of nitrogen balance studies, it quotes only the results of experiments that used mixed proteins on the basis the results of the National Nutrition Survey in 1982 and set the digestibility at 90%. In conclusion, when setting protein requirements for the Japanese population, digestibility has remained the same (90%) since the RDAs-J, sixth revision, that was established in 1999.

Keywords: Protein requirement; Digestibility; Net protein utilization; Dietary reference intakes; Recommended dietary allowances

1. Introduction

Protein is an essential substance for life and a major constituent of cells [1]. Proteins have various forms and functions. Proteins are high molecular-weight compounds consisting of 20 amino acids. Usually,

proteins are ingested from various foods, and the types of proteins differ depending on the food. The amino acid composition and digestibility of proteins differ depending on the type of food, resting in a difference in protein quality. The protein requirement in Japan has been determined by nitrogen balance studies as the value required to maintain the nitrogen equilibrium with high-quality protein, based on the Recommended Dietary Allowances for the Japanese (RDAs-J), third revision. The values were revised to account for the relative utilization or digestibility of mixed proteins in habitual food intake [2-9]. Therefore, this study describes the transition in the evidence of digestibility for setting the protein requirement in the Japanese population.

2. Materials and Methods

Evidence cited by the RDAs-J third [2], fourth [3], fifth [4], and sixth [5] revisions and Dietary Reference Intakes in Japan (DRIs-J) 2005 [6], 2010 [7], 2015 [8], and 2020 [9] editions was searched.

3. Results

The RDAs-J, third revision, cited the study by Komatsu et al. who prepared a diet model on the basis of the results of the National Nutrition Survey in 1975 and measured net protein utilization at the maintenance energy level. As a result, the amount of ingested protein required for nitrogen equilibrium maintenance was estimated to be 115 ± 14 mg N/kg, and the biological value at this maintenance level was 43.6%. The digestibility was 90.6%, and the nitrogen protein utilization was 39.9% [2]. RDAs-J, third revision, cited the article by Komatsu et al. [10]. However, it uses the ratio of relative utilization to nutritional utilization of egg protein to correct the mixed proteins instead of digestibility of mixed proteins.

The RDAs-J, fourth revision, cited the study of Kishi et al., who prepared a diet model based on the results of the National Nutrition Survey of 1986 and measured the biological value of high-quality protein in adults at the maintenance energy level. The biological value of the ingested protein to the high-quality protein was 85.4%, and the digestive absorption rate was 98.0% [3]. However, the fourth revision did not specifically refer to this statement. In the fourth revision, the relative ratio of high-quality protein to biological value was used to correct the mixed proteins instead of digestibility of mixed proteins.

In the RDAs-J, fifth revision, mixed-protein diets were based on the results of the National Nutrition Survey of 1975. The digestibility was 90.6%, and the relative utilization of egg protein was 80%. In addition, an experiment was conducted with a diet model based on the results of the National Nutrition Survey in 1986. The digestive absorption rate was 95.4%, and the relative utilization efficiency of egg protein was 89.5%. Kaneko et al. examined the mixed proteins in female students' diets in light of the results of the National Nutrition Survey of 1982. The digestibility was estimated to be 92.2%, and nitrogen protein utilization was 48% [4]. The fifth revision did not specifically refer to the research based on the results of the National Nutrition Survey in 1975 and 1986, but it cited the study by Kaneko et al. [11].

The RDAs-J, sixth revision, cited the study by Higaki et al., who used mixed proteins and measured the digestibility. They estimated the digestibility to be 95%, and the relative utilization of high-quality protein was 89.5%. Kaneko et al. also measured the digestibility of mixed proteins in women and estimated it to be 92.2%. Accordingly, this revision adopted a digestibility value of 90% for mixed proteins [5]. The sixth revision cited the articles by Higaki et al. [12] and Kaneko et al. [11]. In the study by Higaki et al., the amount of mixed proteins was based on the results of the National

Nutrition Survey of 1975. The DRIs-J 2005 and 2010 editions reported that the average digestibility of habitually ingested mixed proteins was 92.2% in a study involving 12 females and was 95.4% in a study involving six males. Accordingly, the digestibility of mixed protein in daily foods was set at 90% [6, 7]. The DRIs-J 2005 and 2010 cited the articles by Kaneko et al. [11] and Higaki et al. [12].

The DRIs-J 2015 edition reported a study that measured the digestive efficiency of everyday mixed proteins in women (12 individuals) and reported an average efficiency of 92.2%. In addition, the result for men (6 individuals) was 95.4%. The digestive efficiency of everyday mixed proteins was therefore set at 90% [8]. The DRIs-J 2015 edition cited the articles by Kaneko et al. [12] and Higaki [10]. However, the article by Kaneko et al. (1985) dealt with the utilization of egg protein instead of mixed proteins [13]. Therefore, the article by Kaneko et al. [11] seems to be the correct reference. The DRIs-J cited a study that measured the digestibility of habitually ingested mixed proteins in 12 women (92.2%). Accordingly, the digestibility of the mixed proteins was set at 90% [9]. The DRIs-J 2020 edition also cited the article by Kaneko et al. [13], instead of the one by Kaneko [11].

4. Discussion

Many kinds of proteins are ingested as food, and their quality and digestibility differ, which can be calculated by applying the digestibility of various food proteins to protein intake. However, this value is only a weighted average of the digestibility of individual food proteins, and there is no evidence to show that the calculated digestibility matches the digestibility of ingested meals [5]. Therefore, it is necessary to measure the digestibility of habitually ingested proteins in the daily diet. The RDAs-J, fifth revision, cited the study by Kaneko et al. They estimated the digestibility of egg protein to be 96% and net protein utilization to be 47%. On the basis of the net egg protein utilization values, the relative nutritional utilization of mixed proteins was almost 100% [4]. However, the RDAs-J, fifth revision, set the relative utilization of habitually ingested mixed proteins at 85%, which is similar to that in the fourth revision. The net egg protein utilization rate was cited from the article by Kaneko et al. [13].

Japanese dietary protein sources have not changed significantly [14]. In addition, dietary protein sources did not differ significantly depending on the age group; however, the protein intake from fish and that from meat has been found to increase and decrease, respectively, with increasing age [14]. The basis of digestibility for determining the protein requirement for Japanese has not been revised since the RDAs-J, sixth revision, established in 1999 [5-9]. According to the references cited from the RDA-J, third revision, to DRIs-J 2020 edition, the digestibility of the current habitually ingested mixed proteins in the Japanese population did not change to a large extent.

This study focused on the transition of digestibility to determine the protein requirement for Japanese. In the meta-analyses of the results of the nitrogen balance tests to estimate protein requirements, protein requirements are determined by sex, temperature, climate in the area where participants live, physical activity, and the source of protein intake [15, 16]. The meta-analyses also showed variations in protein requirements due to factors such as energy intake [15, 16]. Further research should consider quantitatively evaluating variations in protein requirements.

Conflict of Interest

The authors declare that there is no conflict of interests.

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