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Amino acid content in rice and lentil meal for vegan and pescatarian diet

I. Lignicka*, A. Graci (Balgalve) and A.M. Zīdere - Laizāne

Felici LLC, Rigas gatve 8, LV-2164 Adazi, Adazu novads, Latvia
*Correspondence: ilva.lignicka@musli.lv

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Abstract. Combining different raw materials, it is possible to increase plant-based protein functionality. Traditionally lentils are combined with rice. As rice complements lentils in sulphur-containing amino acids this plant-based combination provides a complete profile of essential amino acids. The aim of this study was to compare amino acid content and scoring pattern in vegan and pescatarian quick preparation meals and analyse developed meal suitability for a vegan diet containing all needed amino acids. Results show that vegan and pescatarian quick preparation meals contain all essential amino acids at adequate amounts according to FAO`s recommendation, results showed no significant difference between samples ($p > 0.05$). These results show that combining rice and lentils it is possible to develop a meal suitable for a vegan diet that contains all needed amino acids.

Key words: essential amino acids, lentils, pescatarian, rice, vegan.

INTRODUCTION

Proteins play important role in human nutrition. Proteins are built from amino acids joined together by peptide bonds between the carboxyl and the amino group of the next amino acid. These polypeptide chains are folded into a three-dimensional structure to form protein. Dietary proteins are sources of nitrogen and essential amino acids for the body (EFSA, 2012). Proteins are made from 20 amino acids. Nine of them, histidine, threonine, valine, methionine, isoleucine, leucine, phenylalanine, lysine, and tryptophan are classified as essential for humans as they cannot be synthesized in the human body from naturally occurring precursors at a rate to meet the metabolic requirements. The remaining 11 amino acids can be made by the body from essential amino acids or glucose (EFSA, 2012; Yu & Fukagava, 2020). After food consumption, its proteins are hydrolyzed, following enzymatic digestion small peptides and amino acids are released and absorbed into the body. Amino acids have an important role in nutrition and whole-body homeostasis as they participate in many biochemical pathways for the growth, maintenance, and metabolic activity of cells and organs (Wu, 2010; Aristoy & Toldra, 2016; Yu & Fukagava, 2020). A high-quality protein provides an adequate quantity of essential amino acids that can be easily digested and utilized for protein synthesis. The amino acid profile is considered the most important among quality parameters (Kumar et al., 2021).

Low protein content and lack of essential amino acids limit plant-based protein functionality (Kumar et al., 2021). Combining different raw materials, it is possible to increase plant-based protein functionality. Traditionally lentils are combined with rice. As rice complements lentils in sulphur-containing amino acids this plant-based combination provides a complete profile of essential amino acids (Juliano, 2016). Amino acid content in rice and lentil are listed in Table 1. Since methionine can be converted to cysteine (Brosnan & Brosnan, 2006) and tyrosine can be formed by the hydroxylation of phenylalanine (Litwack, 2018), specific requirement for total methionine and cysteine and total phenylalanine and tyrosine content are also mentioned. It shows that lentils have lower methionine and cysteine (sulphur-containing amino acids) content and rice has lower lysine content than written in FAO (2013) recommendation. Data about amino acid content in lentils and rice support previously mentioned combining. Rice complements the lower amount of sulphur-containing amino acids in lentils. Lentils complement the lower lysine content in rice.

Table 1. Amino acid content in lentils and rice

Amino acid	Lentils, mg 100 g^{-1} protein[1]	Rice, mg g^{-1} protein[2]	Recommendation, mg g^{-1} protein (FAO, 2013)
Histidine	28	23	15
Isoleucine	43	42	30
Leucine	71	80	59
Lysine	69	*35*	45
Methionine + cysteine	21	43	22
Phenylalanine + tyrosine	75	85	38
Threonine	35	35	23
Tryptophan	9	11	6
Valine	49	59	39

[1] (NutrientOptimiser database, n.d.a); [2] (NutrientOptimiser database, n.d.b).

Vegans exclude many proteins rich foods and studies show that protein intake in vegan groups is lowest. Bakaloudi et al. (2021) in her study informed that total protein intake in vegan groups was the lowest compared to other diets. Tyrosine and other essential amino acids showed the lowest plasma concentrations in vegan diets compared to other diet types. It is necessary to meet daily amino acid requirements. There are not many studies on amino acid content in vegan and pescatarian meals. The aim of this study was to compare amino acid content and scoring pattern in vegan and pescatarian quick preparation meals and analyse developed meal suitability for a vegan diet containing all needed amino acids.

MATERIALS AND METHODS

For amino acid content analysis previously prepared pescatarian and vegan quick preparation meal samples were used. Two base ingredients were used - dried lentils (*Lens culinaris* L.) and rice (*Oryza sativa* L.). For vegan meal 64% of rice and 26% of green lentils were used. For pescatarian meal 69% of rice, 20% of red lentils and 2.5% freeze-dried salmon (*Salmo Salar* and *Oncorhynchus* spp) powder were used. The remaining quantity is additional ingredients such as dried vegetables and spices used to enrich the meal taste.

Amino acid content

To check amino acid content in prepared samples, one pescatarian and one vegan meal were tested. Amino acid content was determined at food quality testing laboratory. PB-136/HPLC ed. I of 06.02.2012. method for tryptophan and PB-53/HPLC ed. II of 30.12.2008. method for other proteinogenic amino acid analyses were used. Analyses were performed in triplicate.

Statistical analysis

Statistical analyses were performed with RStudio (RStudio PBA, USA). Results were evaluated using Wilcoxon signed-rank test for paired comparisons ($p = 0.05$) to determine the difference between amino acid content in vegan and pescatarian meal. Factors were defined as significant if p-value was below 0.05.

RESULTS AND DISCUSSION

Foods that are obtained from plants are usually low in one or more essential amino acids, so when consumed individually, they are considered incomplete proteins (Yu & Fukagava, 2020). The term complete protein refers to foods that contain all essential amino acids in the correct proportion to build protein in the body (Nehete et al., 2013). Lentil protein is a good source of essential amino acids leucine, lysine, threonine, and phenylalanine, but has lower content of sulphur-containing essential amino acids methionine and cysteine (Samaranayaka, 2017). Table 1 shows that rice has lower lysine content. Due to this reason during quick preparation meal development rice and lentils were used. Table 1 shows that, comparing to lentils, rice has two times higher sulphur-containing amino acid content and lentils have two times higher lysine content, showing that they are suitable for combination. Amino acid content in vegan and pescatarian quick preparation meals are listed in Table 2.

Table 2. Amino acid content in vegan and pescatarian quick preparation meals

Amino acid	Vegan meal, mg $100g^{-1}$	Pescatarian meal, mg $100g^{-1}$
Aspartic acid	1,140 ± 60	1,120 ± 60
Glutamic acid	2,120 ± 113	2,120 ± 113
Serine	580 ± 30	560 ± 30
Glycine	530 ± 26	520 ± 26
Histidine	280 ± 13	270 ± 13
Arginine	940 ± 50	900 ± 46
Threonine	430 ± 23	440 ± 23
Alanine	600 ± 33	600 ± 33
Proline	530 ± 26	510 ± 26
Tryosine	370 ± 20	360 ± 20
Valine	640 ± 33	620 ± 33
Methionine	210 ± 10	240 ± 13
Cysteine	71 ± 3	84 ± 4
Isoleucine	480 ± 26	470 ± 23
Leucine	930 ± 50	920 ± 50
Phenylalanine	610 ± 33	580 ± 30
Lysine	580 ± 30	590 ± 30
Tryptophan	100 ± 4	124 ± 5

Results show that vegan and pescatarian meals have similar amino acid content. As for essential amino acids, vegan quick preparation meal has higher histidine, valine, isoleucine, leucine, phenylalanine content, pescatarian quick preparation meal has higher methionine, lysine, and tryptophan content, however, results show no significant difference ($p > 0.05$). It could be affected by rice and lentil content, lentil type, and different additional ingredients used for taste enrichment. Freeze-dried salmon affect pescatarian quick preparation meal amino acid content. However, it has lesser importance for amino acid composition as its proteins are complete. Table 3 illustrates

essential amino acid scoring pattern. Results were compared with FAO (2013) recommended amino acid scoring pattern for adults (> 18 years).

Table 3. Amino acid scoring pattern in vegan and pescatarian quick preparation meals

Amino acid	Vegan meal, mg g^{-1} protein	Pescatarian meal, mg g^{-1} protein	Recommendation, mg g^{-1} protein (FAO, 2013)
Histidine	22	21	15
Isoleucine	37	36	30
Leucine	72	71	59
Lysine	45	45	45
Methionine + cysteine	22	25	22
Phenylalanine + tyrosine	75	72	38
Threonine	33	34	23
Tryptophan	8	10	6
Valine	49	48	39

The data shows that all vegan and pescatarian quick preparation meal amino acid scoring patterns are equal or higher than recommended values. As FAO (2013) described, there may be specific cases in which it is desirable to increase the intake of specific amino acids. Supplementation of leucine, isoleucine, histidine, or threonine has been considered a good strategy to promote weight loss (Xiao & Guo, 2021). Gwin et al. (2020) data demonstrate that high compared to standard-essential amino acids ingestion enhances whole-body protein status during underfeeding, still, the effects of consuming high and standard essential amino acids on mixed muscle protein synthesis are the same during energy deficit.

CONCLUSIONS

Vegan and pescatarian quick preparation meals contain all essential amino acids at adequate amounts according to FAO`s recommendation. Results showed no significant difference between samples ($p > 0.05$). This shows that combining rice and lentils it is possible to develop a meal suitable for a vegan diet that contains all needed amino acids. It is possible to substitute lentils with other legumes such as peas and faba beans. These legumes in different varieties have similar amino acid content as lentils (Sterna et al., 2020). To consume all needed nutrients, vegans should follow protein intake and combine different raw materials to consume all essential amino acids in one meal. Protein quality is determined by comparing the relative composition of essential amino acids and their bioavailability (Siahbalaei et al., 2021). For further analysis vegan and pescatarian quick preparation meal protein and amino acid bioavailability tests should be performed. Even though the HPLC method does not consider bioavailability it can give a good indication of essential amino acid composition of a meal.

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