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STUDY ON THE PROCESS OF OBTAINING PROTEIN MIXTURES WITH THE MAXIMUM POSSIBLE BIOLOGICAL VALUE

Pașan Diana*, Daniel Simeanu*

* "Ion Ionescu de la Brad" Iasi University of Life Sciences, 3 Mihail Sadoveanu Aleey, 700490, Iasi, Romania, e-mail: dsimeanu@uaiasi.ro, dianapasan@yahoo.com

Abstract

The nutritional assessment of foods presents different ways of approaching the subject. This paper has shown how protein mixtures with the highest possible biological value can be formulated using FAO / WHO / UNU recommendations for children, young people and adults as standard proteins. The mixtures were made from rice and peas using a graphical method. In the end, it was found that the requirements for essential amino acids were covered differently depending on the category of people. Thus, in the case of children it was not possible to ensure the necessary because the values of the chemical indices did not exceed the threshold of the minimum requirements with only one exception - Isoleucine was + 20%. This state of affairs could also be highlighted by calculating the EAA-index, VB and IN%, indicators that had values lower by 9.1-11.1% compared to the requirements. In the case of young people, the three indicators of protein quality indicated a slight satisfaction of the requirements, but the detailed analysis showed that three amino acids have values slightly below the minimum threshold (Lysine - 96.32, Methionine + Cystine - 97.95 and Threonine - 93 , 92). In the case of adults, it has been found that all the requirements for essential amino acids are covered to a very high level.

Key words: essential amino acids, protein mixture, biological value, chemical indices, nutritional index

INTRODUCTION

Proteins, carbohydrates and lipids are the group of macronutrients. Chemically, macronutrients include the groups of organic substances that the human body needs. Ingesting them provides the amino acids needed for growth and development, but also the energy that the body needs in carrying out physiological processes and physical activities (Georgescu A. et al., 2014).

Protein is the class of organic matter present in all living organisms, both animal and plant; they are made up of nitrogen-containing molecules called amino acids. Proteins are part of the structure of all cells in the body, maintaining their proper functioning, enter into the composition of enzymes and hormones, intervene in the body's defense process, but also in maintaining osmotic balance, and provide energy if necessary; therefore, proteins are indispensable components of life (Dinu V. et al., 2006).

Amino acids, the constituents of proteins, can be essential and non-essential, but also semi-essential according to the considerations of some researchers. Essential amino acids cannot be synthesized by the body from other amino acids, their source is exogenous, being represented by foods in daily rations (Simeanu D., 2015).

Depending on the source of the protein, animal or vegetable sources, the essential amino acids differ in terms of quantity, but also in terms of quality; In most cases, this can lead to a deficiency or excess of protein that can have serious repercussions on the body. In order to properly ensure the essential amino acids, it is important to know how to mix two or more foods that can complement each other's shortcomings reaching a maximum possible biological value. In most cases, the need to create a protein mixture is necessary when foods of plant origin are introduced occasionally, mainly or entirely in the daily rations (Dinu V. et al., 2006).

MATERIAL AND METHOD

One method by which the nutritional qualities of proteins derived from plant sources can be increased is by creating mixtures that have the role of compensating for limiting amino acids. The present research aims to combine two sources of plant origin, namely rice and peas, in order to complement each other's essential amino acid spectra, namely, finally the mixture obtained to provide a higher biological value compared to the foods that are at its base.

To determine the optimal amount of vegetable protein components, rice and peas, a graphical method using chemical indices of essential amino acids (CI) was applied, reporting the amino acid content of the studied proteins to the standard protein.

$$CI = \frac{\text{content in amino acid A of studied protein}}{\text{content in amino acid A of etalon protein}} \times 100$$

As standard protein usually is utilized protein from egg or etalon protein FAO/WHO/UNU. In the current paper nutritional value of proteins was calculated function of standard demands for amino acids for children (Tryptophan – 1.7, Threonine – 4.3, Isoleucine – 4.6, Leucine – 9.3, Lysine – 6.6, Methionine + Cysteine – 4.2, Phenylalanine + Tyrosine – 7.2, Valine – 5.5; EAA = 37.9 g/16 g N) (Kasiss et al., 2010), young people (Tryptophan – 1, Threonine – 4, Isoleucine – 4, Leucine – 7, Lysine – 5.5, Methionine + Cysteine – 3.5, Phenylalanine + Tyrosine – 6, Valine – 5; EAA = 36 g/16 g N) (Mierliță et al., 2018, Simeanu D. et al., 2017) and for adult persons (Tryptophan – 0.6, Threonine – 2.6, Isoleucine – 3, Leucine –

4.4, Lysine – 3.1, Methionine + Cysteine – 2.7, Phenylalanine + Tyrosine – 3.3, Valine – 2.3; EAA = 22 g/16 g N) (FAO, 1991, 1998, Kotlarz et al., 2011).

At the same time, formulas from chemical methods for assessing the biological value of proteins based on the content of essential amino acids (Oser index - EAA, for example) were used, as well as other relationships that provide the role of providing information on the mixture. protein formed.

The Oser index or EAA - index was calculated according to the formula:

$EAAI=\sqrt[n]{CI1 \times CI2 \times CI3 \times \ldots \times CIn}$ (Stoica I. et al., 2001).

The biological value of the mixture was calculated according to the method described by Oser, using the following formula:

BV = 1.09 (EAAI) – 11.7 (Mieliță D., 2019).

The nutritional index of the rice and pea mixture was calculated using the formula described by Crisan and Sands, 1978:

$$NI\ (\%) = \frac{EAAI \times \%\ protein}{100}.$$

The steps required to determine the optimal ratio between the two sources of vegetable origin, peas and rice, which allow to obtain a protein mixture with the maximum possible biological value were the following:

- using the bibliographic data on the content of essential amino acids of plant sources (rice and peas) chemical indices were calculated for standard proteins;
- the chemical indices thus obtained were tabulated and represented graphically: the percentages of rice protein (A) and peas (B) were passed on the abscissa axis, respectively the percentages of rice protein were distributed in the upper part and the percentages of pea protein were lowered in descending order. At the same time, to the right of the graph were the chemical indices of the essential amino acids in rice, and to the left were the chemical indices of the essential amino acids in peas. The points that represented the chemical indices for the same amino acid were joined. At the same time, the lines of the first limiting amino acids intersected at a point (O) that corresponded to the abscissa, at a certain percentage of the two plant sources;

- knowing the percentage protein content of rice and pea sources, the proportion of them was determined which led to the obtaining of a protein mixture with maximum possible biological value, respectively of a mixture with high biological value;
- the chemical index of the mixture (rice and peas) was established and compared with the initial chemical index of plant sources;
- the Oser index (EAA) was calculated, the biological value and the nutritional index for the proteins in rice, peas and mixture.

RESULTS AND DISCUSSION

In order to make the protein mixture from the two sources of protein of vegetable origin, rice and peas, computational relationships were used to analyze the effectiveness of the mixture in relation to the requirements of the human body from a nutritional point of view. To provide suggestive information, the steps in making the protein blend were performed considering the standard requirements for essential amino acids of children, young people and adults.

Considering the profile of the two sources of vegetable origin, rice and peas, obtaining a protein mixture is the way in which the two proteins can compensate each other limiting essential amino acids, more precisely they can provide a higher biological value.

Using data on the protein content of the two sources studied and the amino acid content (g/100 g protein), the amount of essential amino acids expressed in g/100 g protein (equivalent to g/16 g N) was calculated (Table 1).

Table 1

Essential amino acids/100 g protein (rice and peas)

Components	Protein and AA/100 g		AA/100 g protein	
	Rice	Pea	Rice	Pea
Protein	7.3	23	-	-
Valine	0.40	1.10	5.47	4.78
Isoleucine	0.39	1.33	5.34	5.78
Leucine	0.73	1.65	10	7.17
Lysine	0.29	1.66	3.97	7.21
Methionine + Cystine	0.29	0.61	3.97	2.65
Threonine	0.26	0.93	3.56	4.04
Tryptophan	0.09	0.26	1.23	1.13
Phenylalanine + Tyrosine	0.41	1.80	5.61	7.82

The highlighted values of the two protein sources, respectively of the essential amino acids, supported the need to form the protein mixture for growth, development or maintenance, considering the different requirements of the three categories of people.

Analyzing the essential amino acids that correspond to the two protein sources of plant origin, two categories were detected, namely a category with high values and a category with low amounts.

In the case of rice protein, the high value essential amino acid was leucine (0.73 g) and the reduced constituents were tryptophan (0.09 g) and lysine (0.29 g).

As for the pea protein, the highest amount of essential amino acid was phenylalanine + tyrosine (1.80 g) and the constituents found in the lowest amount were tryptophan (0.26 g) and methionine + cysteine (0.61 g).

The values highlighted for the two protein sources supported the need to form the protein mixture with the maximum possible biological value for the maintenance, growth and development of the three categories of people studied.

With the help of essential amino acids, expressed in g/100 g protein (rice and peas), the chemical indices corresponding to the two sources of vegetable origin, rice and peas, were calculated, taking into account the three standard proteins corresponding to children, young people and adults (Table 2).

Table 2

Chemical indices calculated for the three mixtures

Essential amino acids	Children	Young	Adult
Valine	94.17	103.73	234.06
Isoleucine	120.09	138	179.83
Leucine	94.73	126.27	219.82
Lysine	80.76	96.32	141.12
Methionine + Cystine	81.31	97.95	140.91
Threonine	87.46	**93.92**	**139.22**
Tryptophan	**69.87**	118.9	202.91
Phenylalanine + Tyrosine	90.79	108.3	177.62

By calculating the chemical indices, it was highlighted that in the case of children the limiting amino acids were lysine (60.15), an amino acid that corresponded to rice protein, and methionine + cystine (63.09) constituent of pea protein. Based on the graphical representation of the chemical indices, it was possible to identify the optimal point for the bet of the two proteins for children (Fig. 1). Thus, the intersection of the rights of limiting amino acids for children showed that out of 100 g of mixed protein, rice covers 58 g of protein, and peas 42 g.

In the case of young people, the limiting amino acids were lysine (72.10-rice) and methionine + cystine (75.71-peas) (Fig. 2). This time, the intersection of the two lines of the limiting amino acids pointed out that 100 g of mixed protein contains 59 g of rice protein and 41 g of pea protein.

In the case of the adult category, the first limiting amino acids were also lysine (128.06-rice) and methionine + cystine (98.14-peas) (Fig. 3). For adults, the optimal point, given by the intersection of the straight lines of essential amino acids, highlighted the fact that out of 100 g of mixed protein, rice covers 87.5 g of protein, and peas 12.5 g of peas.

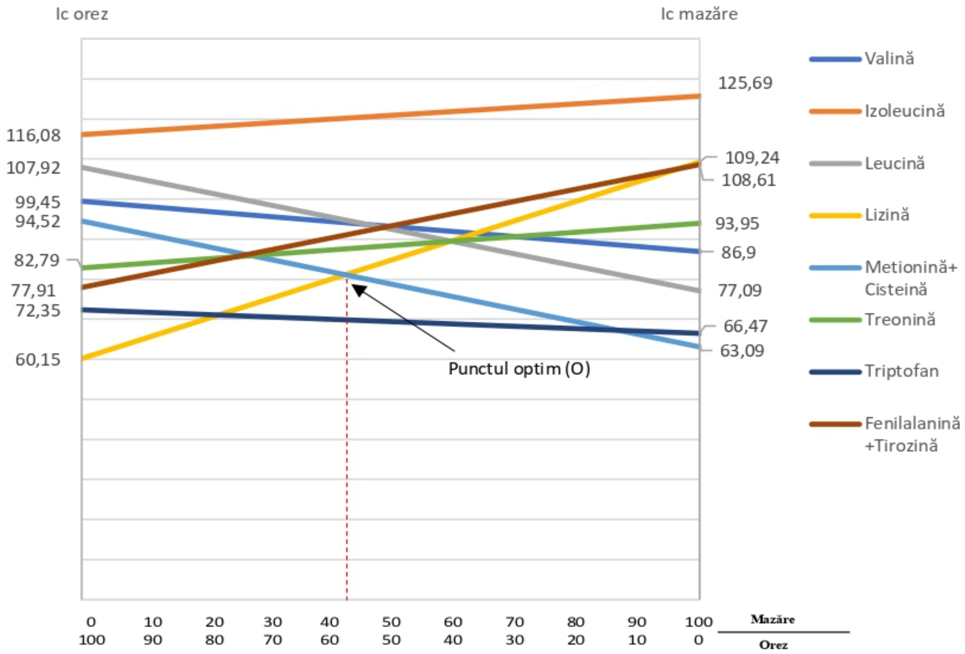

Fig. 1. Representation of the optimal point for children

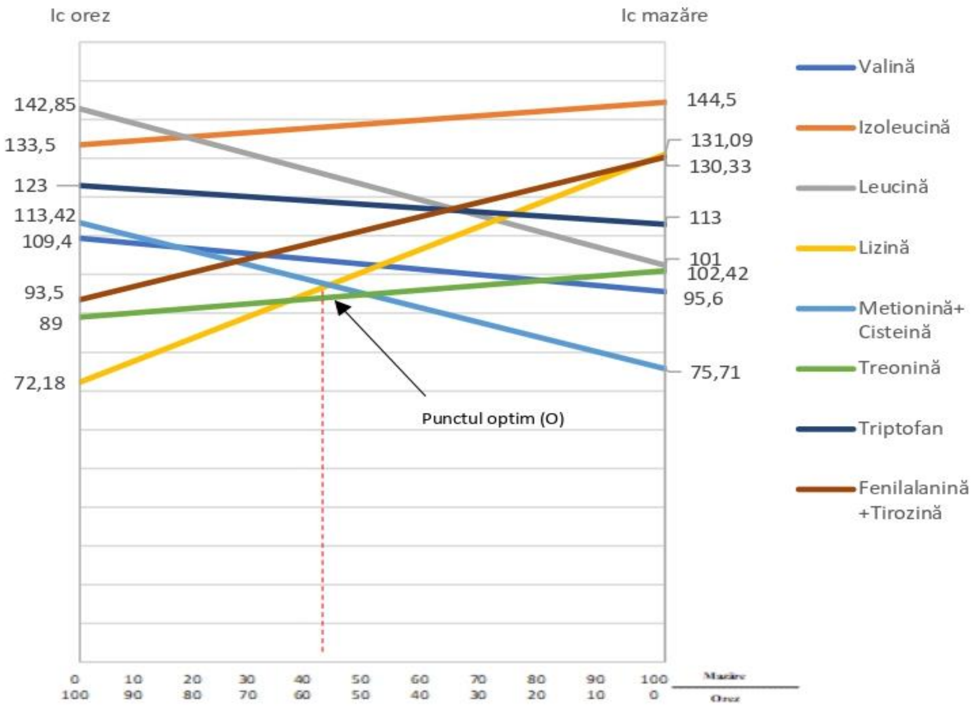

Fig. 2. Representing the optimal point for young people

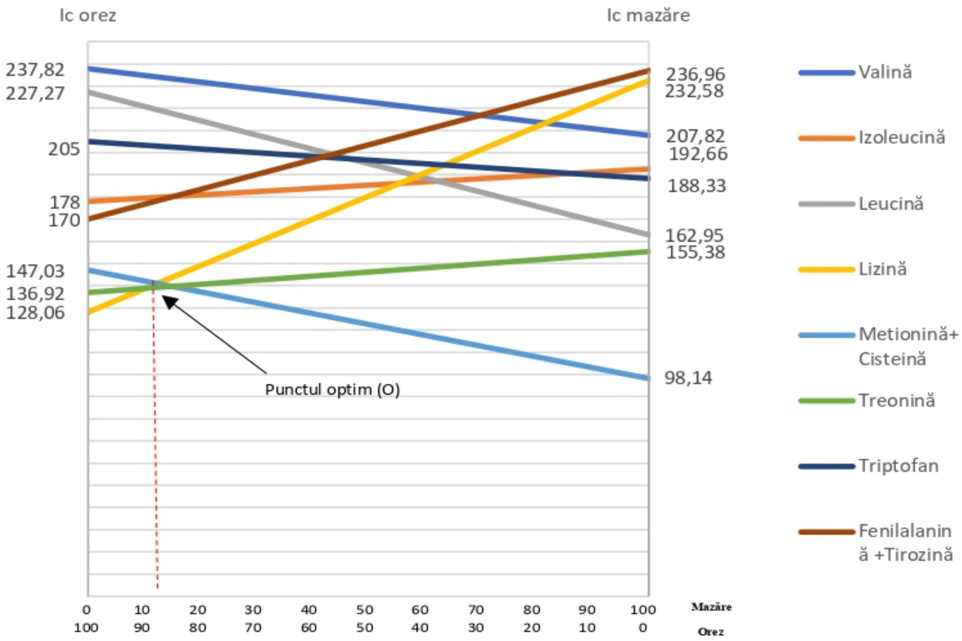

Fig. 3. Representation of the optimum point for adults

The three optimal points determined variable weights of the two foods in the mixtures recommended for the categories of persons studied (Table 3).

Table 3

The intake of the two foods in the mixture

Children		Young		Adult	
Rice	Pea	Rice	Pea	Rice	Pea
81.31%	18.68%	81.92%	18.07%	95.66%	4.33%

It is found that with age the share of food with more protein (peas) is decreasing. The nutritional evaluation of the mixtures obtained highlights the fact that, in the case of children, the mixture evaluated globally does not cover the requirements in essential amino acids. All three indicators analyzed had values lower by 9.1 - 11.1% compared to the minimum requirements for this age category (Table 4).

Table 4

Nutritional evaluation of the three mixtures obtained

Essential amino acids	Children	Young	Adult
EAA – index	88.90	109.47	176.05
Biological value	90.25	108.3	183.35
Nutrition index (%)	9.09	11.11	14

The mixture obtained for young people globally covered the requirements in essential amino acids slightly exceeding the minimum requirements for this category of people. In contrast, the adult mix has far exceeded the requirements for this category of people to almost double.

CONCLUSIONS

Mixtures of rice and peas for the three categories of people (children, young people and adults) cover different requirements in essential amino acids. Thus, the mixture made for children cannot provide the necessary essential amino acids because the calculated chemical indices did not exceed the threshold of the minimum requirements with only one exception - Isoleucine was 20% above the minimum threshold. This fact could be highlighted by the global evaluation of the mixed protein - the values of EAA-index, VB and IN% were 9.1-11.1% lower than the requirements. In the case of young people, the values of the three protein quality indicators indicated a slight satisfaction of the requirements, but the detailed analysis of their coverage in each amino acid showed that three amino acids have values slightly below the minimum threshold (Lysine - 96.32 , Methionine + Cystine - 97.95 and Threonine - 93.92). In the case of adults, it has been found that all essential amino acid requirements are covered at a very high level.

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