MATHEMATICAL SIMULATION OF THE PHYSICOCHEMICAL AND AMINOACID COMPOSITION OF A DIETARY MEAT PRODUCT

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INTRODUCTION

Meat processors in our country and abroad show interest toward meat products with predetermined chemical compositions. Formulas for dietary meat products are of special importance because of the fact that the final product must possess specific chemical composition. Dietary food is supposed to contribute to the limitation or elimination of pathologies in some organs or systems manifested as different diseases. The easiest way to solve this problem is to use mathematical methods.

The most common mathematical method that has been applied up till now in meat technology is the statistic mathematical simulation involved in linear optimization. Recent attempts have been aimed at computer aided preparation of optimal formulas for sausages. Some authors (1) have experimented production of cooked sausages with predetermined chemical compositions. Their formulas have been computer-optimized following preliminary mathematical simulation of the chemical composition. As target function of these models has been chosen the product's price. The limiting conditions include the product's weight, chemical composition, quality, and price of the raw materials. Similar problems have been treated by other authors as well (3).

The method of linear programming (direct or by linearization) has found application in optimization of formulas aimed at improving the eating quality of the sausage (2). Mathematical methods have been used to determine the biological value of protein mixtures (4).

The aim of the present work was as follows: in view the requirements for dietary nutrition, to simulate and optimize the physicochemical and aminoacid composition of a high protein and low fat children's dietary meat product observing the organoleptic requirements and the specificity of the processing technology.

METHODS AND MATERIALS

We used the method of linear optimization to develop the mathematical models. The raw materials used were: non-fat veal, non-fat pork, semifat pork and yoghurt concentrate.

Initially, the physicochemical and aminoacid compositions of the raw materials were determined (Tables 1 and 2), and were later used to work out the mathematical models. In our case, it is only one for the product's aminoacid composition. To determine the limiting conditions for the model we took into consideration the following requirements: it had to approach FAO "ideal protein" (1973) (aminoacid composition) while the physicochemical requirements were concerted with specialists in dietary nutrition. Our children dietary sausage includes three types of limiting conditions:

1. Related to the admissible amount of aminoacids in the final product. These limitations are of type (1).

$$\frac{A}{B} \leqslant C_j \qquad (1)$$

where C_j is the aminoacid level in FAO "ideal protein" in g/100 g of protein, %.

$$A = \sum_{i=1}^{4} a_{ij} . b_i \quad \text{mg aminoacid}$$

for 100 g of product.
Here a_{ij} (i=1,...,4) and (j=1,...,8) is the aminoacid level in g/100 g of total protein; b_i (i=1,...,4) is total protein percentage in the respective ingredient;

$$B = \sum_{i=1}^{4} b_i \cdot x_i \quad \text{g total protein/100 g of product, where}$$

b_i-as indicated above, x_i-percentage of each ingredient (i=1,...,4).

2.The second type of limiting conditions refer to the percentage of each raw material in the final composition. They are of type (2).

$$x_i \leqslant d_i \qquad (2)$$

where d_i, (i=1,...,4), is the admissible percentage of the ingredients in the final mixture, the interval is in %.

3.The third type of limiting conditions are related to the fact that the sum total of the participating raw materials should be 100%.

$$\sum_{i=1}^{4} x_i = 100 \qquad i=1,...,4$$

As a target function we chose function type (4)

$$B = \sum_{i=1}^{4} b_i \cdot x_i = \max \qquad (4)$$

b_i, x_i - as given above.

RESULTS AND DISCUSSION

The model's optimal formula was solved by "modified simplex method for solving problems of linear optimization". The model solution first involved protein maximum content as a target function, and then the protein content was accepted as a limiting condition, while the target function was the minimum fat content (type 5 function).

$$M = \sum_{i=1}^{4} m_i x_i \qquad (5)$$

where m_i (i=1,...,4) is the fat content in the ingredients.

The model's solution gave the following sausage formula: nonfat veal (x_1) - 60%; semifat pork (x_2) - 5%; nonfat pork (x_3) - 30%; yoghurt concentrate (x_4) - 5%.
Based on the above formula, a technology has been developed for the production of a dietary cooked smoked sausage for children with cardiovascular diseases. The results from the chemical analyses are given in Tables 3 and 4. It is obvious from Table 3 that the final product is characterized by low fat and high protein contents and thus meets the preset requirements through the target functions for maximum protein and minimum fat content. As far as the aminoacid composition is concerned (Table 4), it has been established that the only limiting aminoacid was tryptophan with an aminoacid number 78. The essential aminoacid levels are very high as illustrated by the essential aminoacids : total content ratio - 44,95.

CONCLUSION

The results obtained give reason to assume that the simulated and optimized final product satisfies the preset requirements and limitations, and can be consumed as dietary food by children suffering from cardiovascular diseases.

Table 1 - Aminoacid composition of the ingredients

Aminoacid a_{ij} (g/100 g protein)	Ingredient			
	Veal (x1)	Semifat pork (x2)	Nonfat pork (x3)	Yoghurt conc. (x4)
Valine	a_{11}=4,65	a_{21}=5,77	a_{31}=5,25	a_{41}=5,76
Isoleucine	a_{12}=4,41	a_{22}=5,17	a_{32}=4,95	a_{42}=4,92
Leucine	a_{13}=7,46	a_{23}=8,66	a_{33}=8,49	a_{43}=9,38
Lysine	a_{14}=11,71	a_{24}=9,15	a_{34}=8,67	a_{44}=7,69
Methionine + Cystine	a_{15}=3,06	a_{25}=3,59	a_{35}=3,41	a_{45}=3,09
Threonine	a_{16}=4,24	a_{26}=4,38	a_{36}=4,22	a_{46}=3,98
Tryptophan	a_{17}=1,10	a_{27}=1,19	a_{37}=1,19	a_{47}=1,03
Tyrosine + Phenylalanine	a_{18}=7,27	a_{28}=8,56	a_{38}=8,32	a_{48}=9,42

Table 2 - Physicochemical composition of the ingredients

Factor	Ingredient (x_i)			
	Veal (x_1)	Semifat pork (x_2)	Nonfat pork (x_3)	Yoghurt conc. (x_4)
Water content, V_i, %	V_1=73,47	V_2=72,42	V_3=52,43	V_4=86,32
Protein content, b_i, %	b_1=21,6	b_2=19,01	b_3=13,45	b_4=12,00
Fat content, m_i, %	m_1=5,23	m_2=4,50	m_3=33,75	m_4=0,52

Table 3 - Physicochemical composition of the final product

Water content % of t.w.	Fat content % of t.w.	Fat content % of d.s.	Kjeldal protein cont. % of t.w.	Salt % of t.w.
75,1	6,8	27,3	19,75	1,3

Table 4 - Aminoacid composition of the final product

Aminoacid	g/100 g of product	g/100 g of protein	Chemical score %
Valine	0,96	5,30	106
Isoleucine	0,88	4,85	121
Leucine	1,52	8,43	120
Lysine	1,70	9,43	171
Methionine + cystine	0,64	3,53	101
Threonine	0,82	4,52	113
Tryptophan	0,14	0,78	78
Tyrosine + phenylalanine	1,47	8,15	136

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