CALCULATION OF OPTIMAL FORMULATION BASED ON BALANCED AMINO ACID COMPOSITION OF PASTE CANNED MEAT PRODUCTS

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Traditional foods balanced by nutritional quality are not common. It makes difficult their assimilation and leads to unbalance in nutrition. Besides, considerable changes in chemical composition of the primary raw material lead to changes of indices in chemical composition of the finished product and, as a result, to changes in its quality, nutritive and biological value.

That is why manufacture of combined meat products is a trend in development of technology of food production, what allows to operate the process of their production and consumption, stabilize quality at the preset level.

At present different protein additives distinguished by their functional properties, chemical composition and biological value are used or recommended for use in formulations of combined meat products.

More perspective means to increase efficiency of development of combined meat products are utilization of raw materials with certain characteristics and application of formulation optimization methods [1].

The objective of this study was to develop formulations of paste canned products with high protein balance by essential amino acids and low total value of ingredients.

To attain this purpose, the following task was set: based on the knowledge of chemical composition and cost characteristics of the available raw materials, formulated target function and restrictions for raw material use and requirements for chemical composition and quality of the final product, to calculate variants of optimal formulations of paste canned products and by the results of their comparison with traditional canned foods to choose the best ones according to the complex index.

When solving the formulated task, the following was carried out:

- choice of the target function, in the capacity of which the total cost of ingredients included into the formulation, specifically, $C=\Sigma^{k}_{j=1} C_j X_j \rightarrow$ min was used (here: C_j is the cost of mass unit of the j-th ingredient, roubles/kg; X_j is the amount of the j-th ingredient in the formulation);
- determination of the list of ingredients allowed for manufacture of pastes. During development of new paste kinds the following basic ingredients were chosen: beef liver, melted fat, pork skin, pork with mass share of fat tissue not over 30 or 60 %, wheat flour, as well as concentrates of animal proteins of various grades, added water, salt and spices;
- collection of actual data on the amount and characteristics of ingredients included into the formulation;
- choice of restrictions with regard to the influence of separate ingredients and their chemical composition on the product quality, as well as laid down requirements and actual data on similar products.

Minimum and maximum values by the content of moisture, fat, protein and essential amino acids (EAA) in the finished product were taken as preset parameters:

$$Ж^{min} \le \Sigma^{k}_{j=1} Ж_j X_j \le Ж^{max}; \quad Б^{min} \le \Sigma^{k}_{j=1} Б_j X_j \le Б^{max}; \quad Ак^{min} \le \Sigma^{k}_{j=1} Ак_j X_j \le Ак^{max},$$

where $Ж_j$, $Б_j$, $Ак_j$ is the content of moisture, fat, protein and the k-th EAA in the j-th ingredient of the formulation, unit shares;
min and max are indices at minimum and maximum values of elements of the finished product chemical composition.

Restriction for amino acid composition of ingredients mixture was evaluated with regard to FAO scale content and requirements to the protein content in the mixture and is determined by the equations:

$$Ак_{min} = Фк * Б_{min}/100; \quad Ак_{max} = Фк * Б_{max}/100,$$

where Фк is the content of the k-th EAA in standard protein, g/100 g of protein;

- evaluation of the obtained formulas analyzing therewith efficient protein value, energy value, dry substances cost (including fat and protein cost) in the finished product, as well as the value of protein balance coefficient (PBC), whose calculation procedure was taken from the work [2].

In the obtained formulation variants the protein content level was from 8.2 to 12.4 %, compared to GOST (12.0-14.9 %), fat content – from 22.8 to 25.1 % (GOST – from 25.3 to 32.8 %), moisture content – from 56.9 to 62.4 % (GOST – from 49.7 to 57.4 %).

Analysis of protein quality in the obtained formulations, determined by the share of total essential amino acids (Table 1), shows that quality of protein in formulations utilizing animal protein concentrations is higher, as compared to the traditional production, and averages 35.99 % against 21.05 % under GOST. Balance coefficient by EAA averaged 0.62 for all formulas, methionine being the limiting amino acid.

Formulations with animal protein concentrate on an average are cheaper by 706.9 roubles, compared to the GOST production, and they are also cheaper (by the cost of dry substances unit) by 7.2 roubles per 1 kg.

Taking into consideration that the obtained formulations by mass share of protein in the finished product of the formulation with animal protein concentrates yield GOST, but their cost and energy value are less, as compared to the GOST production, for choosing the best formula variant the complex index was calculated as the sum of relative values of efficient protein content (total protein - unbalanced EAA part), cost and energy value of the product being developed, specifically:

$$П = Бв/Б_{max} + Э_{min}/Эв + С_{min}/Св,$$

where Бв, $Б_{max}$ is efficient protein content in the в-th formulation and its maximum value;

$C_в$, C_{min} is the cost of the в-th formulation and its minimum value;
$Э_в$, $Э_{min}$ is energy value of the в-th formulation and its minimum value.

By the value of complex index П paste formulations being analyzed may be distributed in the following diminishing sequence: formula 3 (2.582), meat paste (2.567), formula 5 (2.559), formula 1 (2.546), formula 2 (2.53), liver paste (2.437).

Use of formulation optimization methods allows to get formulations of paste canned products well balanced by essential amino acids (PBC = 0.62), as well as to expand the assortment of paste canned products, not yielding to traditional products by quality indices.

References

1. Lisitsyn A.B., Lubchenko V.I., Goroshko G.P. Methods of mathematical modeling when grounding formulations of multi-component meat products// M.: Collection of scientific papers of VNIIMP. 1996.
2. Ivashov V.I., Goroshko G.P., Salavatulina R.M., Lebedeva L.I. Procedure for calculation of optimal formulation based on the balanced amino acid composition// M.: Collection of scientific papers of VNIIMP. 1989.

Table 1. Quality indices of obtained formulations for paste canned products

Indices	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	"Meat paste"	"Liver paste"
1	2	3	4	5	6	7	8
Content in the final product (calculation), %:							
moisture	56.94	59.2	62.43	61.4	60.65	57.39	49.68
fat	24.49	24.8	22.85	25.1	24.2	25.34	32.88
protein	12.39	10.0	9.49	8.17	9.6	14.93	12.01
dry substances	43.0	40.8	37.57	38.6	39.35	42.61	50.32
essential amino acids:							
valine	0.760	0.526	0.515	0.457	0.525	0.466	0.363
isoleucine	0.580	0.400	0.393	0.364	0.405	0.399	0.312
leucine	0.983	0.707	0.671	0.625	0.684	0.660	0.516
lysine	0.983	0.661	0.674	0.579	0.698	0.645	0.506
methionine	0.293	0.206	0.204	0.176	0.209	0.193	0.151
threonine	0.531	0.373	0.360	0.343	0.371	0.376	0.295
tryptophan	0.148	0.095	0.096	0.090	0.099	0.105	0.082
phenylalanine	0.581	0.419	0.409	0.341	0.415	0.344	0.268
EAA sum	4.859	3.387	3.322	2.975	3.406	3.188	2.493
% to total protein	39.2	33.87	35.00	36.41	35.47	21.35	20.75
PBC to FAO/WHO	0.602	0.626	0.632	0.608	0.631	0.623	0.620
$Б_{эф}$ ($Б_в$)	10.55	8.732	8.276	7.005	8.341	13.805	11.054
$СК_{min}$ (methionine)	0.675	0.589	0.614	0.615	0.622	0.366	0.357
Energy value of 100 g of product ($Э_в$), kcal	257.66	250.28	235.42	239.66	246.59	288.39	339.48
Cost of 100 kg, roubles	2939.16	2535.33	2276.3	2650.5	2342.46	3355.09	3156.24
Cost per unit, roubles/kg:							
fat	78.8	72.07	70.14	78.52	69.13	83.3	69.96
protein	80.26	73.00	68.98	80.41	67.77	83.05	70.84
dry substances	68.02	61.7	60.08	68.08	59.05	78.65	62.62
Relative values of unit criteria:							
efficient protein ($Б_в$)	0.764	0.632	0.599	0.507	0.604	1.0	0.801
energy value ($Э_в$)	0.914	0.941	1.0	0.982	0.955	0.816	0.693
cost of unit of dry substances ($С_в$)	0.868	0.957	0.983	0,867	1.0	0.751	0.943