Increasing amino-acid score of chopped semi-finished products

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Abstract. In today's world diseases of alimentary etiology are common. They occur when there is insufficient intake of important essential substances, that include amino acids. Lack of essential amino acids can lead to serious disruptions in vital functions of body. Therefore, development of food products, balanced in amino acid composition, is the most important technological task of food production. Semi-finished products are one of the food groups, that in great demand among the general population. Therefore, these foods are often enriched with disease-preventing nutrients. In addition, creation of products with specified properties allows to reduce cost price due to introducing cheap plant materials into the product. The article provides data on effect of milk thistle powder and flaxseed flour on amino acid composition of meat stuffed chopped semi-finished products. Calculation of parameters of amino acid score and amino acid index in the products is presented. The results of organoleptic evaluation of experimental samples are also presented. During the study, mass fractions of proteins, fats and carbohydrates were determined. Organoleptic evaluation was carried out and energy value of each sample was calculated. Based on obtained data, a comparison was made between control sample and experimental samples in all parameters. In addition, it was found that a test sample containing milk thistle powder is capable of increasing protein content, as well as increasing amino acid index and amino acid score of the product.

1. Introduction

Currently, no one doubts that amino acids are an important component of food. Since huge amount of chemicals are consist of them. They are essential for life on our planet. Humans need for certain amino acids, like any other organism, is very acute. In addition, body's needs can be fully provides only with certain ratios of essential amino acids. Lack of at least one essencial amino acid can lead to disruption of vital functions in long term. Therefore, development of food products with balanced amino acid composition is very important. Especially for those products that are popular. [1-4].

Consumption of semi-finished meat products has only been growing in recent years. This is due to fast pace of modern life, since semi-finished products can be quickly brought to culinary readiness. At the same time, most often consumers prefer to buy semi-finished products that have pleasant taste and are easy to prepare. Moreover, introduction additional vegetable ingredients into mass consumption products make it possible to give them specified properties [5-7].
Flaxseed flour and milk thistle powder were used as vegetable raw materials. Flaxseed flour is rich in proteins (36%) and lipids (42%). Milk thistle powder contains 32% fiber and 21% proteins, that able to retain water and absorb fat [8-10]. Flaxseed flour is rich in α-linolenic acid and lignans. In addition, flaxseed flour contains a lot of fiber – up to 27.3%, and contains omega-3 in amount of 23% [11-13].

Aim of the research is to study influence of flax flour and milk thistle powder to amino acid composition and organoleptic properties of the stuffed chopped semi-finished products.

2. Materials and methods

The amino acid composition of the products were determined by the method of measuring mass fraction of amino acids using system «Kapel» M 04-38-2009, and to determine protein content in samples of stuffed chopped semi-finished products, the method from GOST 25011-2017 was used, that is based on the Kjeldahl method.

Calculation of amino acids content $A_j$ in the stuffed chopped semi-finished product (formula 1):

$$A_j = \sum \left( \frac{m_i}{100} \cdot AK_j \right),$$

where $AK_j$ – content of j-th amino acid in i-th component, g;

$m_i$ – mass of the i-th component, g.

To calculate amino acid index (AI) (formula 2) and amino acid score (AC) (formula 4), it was necessary to know mass of amino acid (ak) in 100 g of protein (formula 3).

$$AH = \frac{\sum HAK}{\sum 4ZAK + \sum 3AK},$$

where $\sum HAK$ – amount of essential amino acids, g / 100 g;

$\sum 4ZAK + \sum 3AK$ – sum of partially nonessential and nonessential amino acids, g / 100 g.

$$ak = \frac{AK}{B} \cdot 100,$$

where $AK$ – weight of amino acid in 100 g of raw material, g;

$B$ - amount of protein in 100 g of raw material, g.

$$AC = \frac{ak}{M} \cdot 100 \%,$$

where $M$ – content of the same amino acid in g per 100 g of standard protein according to FAO / WHO scale.

Determination of mass fraction of fat was carried out by extracting fat with ethyl ether, followed by evaporation of the solvent and weighing. Mass fraction of carbohydrates and energy value were determined by calculation method based on obtained and reference data [14]. To conduct the research in laboratory of the Department of Food Production Technology of the Volgograd State Technical University, control and experimental samples of stuffed chopped minced semi-finished products were produced. The mince of each of them consisted of beef, wheat flour, egg melange, table salt and ground black pepper. The filling were a mixture of sauteed eggplant, parsley and garlic, seasoned with the same spices as minced meat. The difference between the experimental and the control samples were addition (0.5 g per 100 g of product) to the minced meat flax flour or milk thistle powder instead of raw meat.

3. Results and discussion

In the study, an organoleptic evaluation of the produced samples was carried out. The results are presented on the profillogram (figure 1). It was determined that the experimental samples have a subtle
specific taste, that is associated with introduction of vegetable ingredients into minced meat - flax flour or milk thistle powder. Moreover, for the experimental sample with milk thistle powder, a slight deterioration in consistency was observed. And with insufficient mixing or an increase in its content, a plaque sensation may occur in oral cavity.

Figure 1. Profilogram of sensory evaluation of samples.

The results of analysis of amino acid composition of the control and experimental samples with information about content of each amino acid by groups are presented in table 1. From the presented data it can be seen that addition of milk thistle powder and flaxseed flour in most cases increases amount of essential amino acids. However, for the experimental sample with addition of milk thistle powder, threonine content dropped slightly.

Table 1. Amino acid composition, mg / 100 g.

| Index                | Control sample | Experimental sample (flaxseed flour) | Experimental sample (milk thistle powder) |
|----------------------|----------------|-------------------------------------|------------------------------------------|
|                      | Content of essential amino acids, mg |                                      |                                          |
| Valine               | 665            | 669                                 | 735                                      |
| Leucine and Isoleucine| 1760           | 1834                                | 2022                                     |
| Lysine               | 1143           | 1184                                | 1305                                     |
| Methionine           | 297            | 319                                 | 360                                      |
| Threonine            | 504            | 537                                 | 473                                      |
| Tryptophan           | 284            | 287                                 | 584                                      |
| Phenylalanine        | 581            | 584                                 | 655                                      |
| Total:               | 5234           | 5414                                | 5951                                     |
| Content of partially-essential amino acids, mg |                                      |                                          |
| Arginine             | 867            | 835                                 | 922                                      |
| Histidine            | 406            | 407                                 | 484                                      |
| Total:               | 1273           | 1242                                | 1406                                     |
| Content of nonessential amino acids, mg |                                      |                                          |
| Alanin               | 1150           | 957                                 | 1041                                     |
| Glycine              | 1368           | 790                                 | 881                                      |
| Proline              | 1026           | 711                                 | 790                                      |
| Serine               | 555            | 503                                 | 572                                      |
| Tyrosine             | 464            | 468                                 | 530                                      |
| Total:               | 4563           | 3429                                | 3814                                     |

Addition of flaxseed flour slightly reduced partially non-essential amino acids content. It was noticed that in the experimental samples content of nonessential amino acids is lower in comparison with the control sample. However, tyrosine content in the experimental samples was slightly higher.
When comparing the experimental samples with each other, it can be seen that addition of milk thistle powder is an effective way to increase amino acid content. Moreover, that sample contains significantly higher partially nonessential amino acids than the control sample.

Thus, introduction of the powder allows to increase the amount of essential and partially replaceable amino acids in the product, that leads to an increase in biological value of the product. However content of nonessential amino acids reduces.

Table 2 shows intermediate results of calculating AC. The calculation of AI, ak and AC was carried out according to formulas 1-4. An example of calculating for valin in the control sample is shown in equations 5.

\[
AI = \frac{5234}{1273 + 4563} = 0.897 \quad ak = \frac{0.665}{15.16} \quad 100 = 4.386 \quad AC = \frac{4.386}{5} \cdot 100 \% = 87.73 \%
\] (5)

| Amino acid | In FAO / WHO reference protein, mg / 100 g | Control experimental sample (flaxseed flour), mg / 100 g | experimental sample (milk thistle powder), mg / 100 g |
|------------|------------------------------------------|------------------------------------------------------|---------------------------------------------------|
| Valine     | 5000                                     | 4.39                                                 | 4.07                                              | 4.68                                              |
| Isoleucine and leucine | 11000                                  | 11.61                                                | 11.16                                             | 12.86                                              |
| Lysine     | 5500                                     | 7.54                                                 | 7.21                                              | 8.3                                               |
| Methionine | 3500                                     | 1.96                                                 | 1.94                                              | 2.29                                               |
| Threonine  | 4000                                     | 3.32                                                 | 3.27                                              | 3.01                                               |
| Tryptophan | 1000                                     | 1.87                                                 | 1.75                                              | 3.72                                               |
| Phenylalanine | 6000                                   | 3.83                                                 | 3.55                                              | 4.17                                               |
| Tyrosine   | 6000                                     | 3.06                                                 | 2.85                                              | 3.37                                               |

The results of calculating AC are shown in table 3. The values of AI are presented in table 4.

The calculation shows that control and experimental samples have many limiting amino acids. However, the experimental sample with flaxseed flour has lowest value of AC for each essential amino acid, slightly behind the control sample. Introduction of milk thistle powder increases AC and makes the product more balanced. However, tryptophan, at the same time, exceeds physiological requirements by almost 4 times.

| Amino acid          | Amino-acid score, % | experimental sample (flaxseed flour) | experimental sample (milk thistle powder) |
|---------------------|---------------------|--------------------------------------|------------------------------------------|
| Valine              | 87.73               | 81.44                                | 93.51                                    |
| Isoleucine and leucine | 105.54              | 101.48                                | 116.93                                   |
| Lysine              | 137.08              | 131.02                                | 150.94                                   |
| Methionine          | 55.97               | 55.47                                 | 65.43                                    |
| Threonine           | 83.11               | 81.71                                 | 75.22                                    |
| Tryptophan          | 187.34              | 174.68                                | 371.5                                    |
| Phenylalanine       | 63.87               | 59.24                                 | 69.44                                    |
| Tyrosine            | 51.01               | 47.47                                 | 56.19                                    |

Thus, the experimental sample containing milk thistle powder has the best amino acid score compared to other samples. Due to this, the product has a higher biological value.
Table 4. Chemical composition and amino acid index.

| Sample                          | Content, %  | fat       | carbohydrate | energy value, kcal | AI |
|---------------------------------|-------------|-----------|--------------|--------------------|----|
| Control                         | 15.16±1.12  | 7.58±0.23 | 5.44±0.02    | 150.62±3.45        | 0.9|
| Experimental (flaxseed flour)    | 16.43±1.02  | 8.05±0.12 | 5.51±0.02    | 164.77±2.86        | 1.16|
| Experimental (milk thistle powder) | 15.72±1.11  | 7.53±0.31 | 5.32±0.02    | 149.85±3.49        | 1.18|

Table 4 shows the results of determining proteins, fats and carbohydrates, and also displays energy value and amino acid index of each of the samples of stuffed chopped semi-finished products. The experimental samples contain more protein, that is due to its high content of milk thistle powder (21%) and flax flour (36%), which is also rich in lipids (42%). That explains their increase in the test sample with flax flour. At the same time, carbohydrate content in all samples is approximately at the same level, and energy value of the test sample with milk thistle powder was the same as in the control one. Due to increased content of proteins and fats, experimental sample with flaxseed flour has a slightly increased energy value. Introduction of additional vegetable ingredients to the stuffed chopped meat products also increased amino acid index, that increased an average of 27%.

4. Conclusion
Thus, addition of milk thistle powder to composition of the stuffed chopped semi-finished products allows not only to slightly increase protein content in the product, but also to increase amino acid rate of most essential amino acids. With exception of threonine, content of which drops slightly compared to control sample. In addition, it was noted that the use of flaxseed flour as a vegetable supplement slightly impaired amino acid score of the product.

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