BIOLOGICAL VALUE STUDY FOR MILK-PLANT MINCED MASSES FROM BUTTERMILK CONCENTRATE

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Abstract: This article presents the feasibility of combining of animal and plant material in terms of population provision with biologically valuable food. It is established that the development of milk-plant minced mass technology from buttermilk concentrate is an important task that will expand the range of combined minced masses with high nutritional and biological value. The results of study of biological value of milk-plant minced mass from buttermilk concentrate are presented in the article. The indispensable amino acid score of prototypes was calculated and the digestion degree and relative biological value of the developed minced masses were defined. The study results show that the protein composition of developed minced mass does not include limiting amino acid, while the level of all essential amino acids exceeds the standards of FAO / WHO and the protein of developed minced masses is characterized by the high digestion degree, enabling their widespread use in the production of culinary products in restaurants.

Keywords: milk-plant mass, minced mass, buttermilk, concentrate, biologically value food.

Introduction

The population providing with the biologically valuable food is the first task, which solution may contribute to the expansion of food production resources through the creation of waste-free technologies for complex processing of raw materials. Thus, the use of biologically valuable recycled milk-protein and local plant materials require particular attention.

It is known that 60-65 % of the protein daily maintenance should be met by animal products due to the fact that they contain more essential amino acids and are better absorbed by the human body than plant proteins. Plant proteins are more common in nature and constitute 68.0-80.0 % of the total consumption of all proteins, but most of them are limited by the content of lysine, isoleucine, sulfur-containing amino acids (Lipatov et al, 2001). However, it should be noted that replacement of animal raw materials for plant raw materials helps to reduce the food caloric value, while enriching it with vitamins, most of which are powerful antioxidants, with dietary fibres, minerals, organic acids, which facilitate the absorption of calcium, phosphorus, ferrum, which maintain the acid-base balance, as well as with other essential nutrients, which presence is vital for the proper functioning of the human body in terms of the adequate nutrition theory. Also, it stands to mention the very important physiological phenomenon, first discovered by A. A. Pokrovskiy (Pokrovskiy et al, 1970) according to which with a combination of diverse origin proteins in food rations, their digestion almost always gets better.

Analysis of the literature demonstrates the rationality of the combination of animal and plant raw materials in terms of getting products with high nutritional and biological value (Lipatov et al, 2001). Thus, the scientific studies and technology development of milk-plant minced mass from milk-protein concentrate (MPC) of buttermilk is a current task, which solution shall extend the range of combined minced masses with high nutritional and biological value and provide the products with desired functional properties.

Given the information, contained in scientific and technical literature and based on data, obtained during the experiments the technology of milk-plant minced masses production with desired functionality was developed. The developed technology provides the use of MPC of buttermilk as a main component, as well as the vegetable puree of carrots, pumpkins and squash, egg, flour, sugar including in minced masses.

As milk-plant minced masses, obtained by the developed method, are non-traditional products targeted for further use in the production of culinary products, it was required to perform a study of their biological value. Therefore, the purpose of this scientific paper is to study the biological value of milk-plant minced masses from buttermilk concentrate.
Method

The score of essential amino acids was calculated and compared it with the standard of FAO / WHO to determine the biological value and presence of limiting amino acids in studied products.

Amino acid score of proteins in developed semi-product was calculated according to the following formula:

\[ AC = \frac{T}{B} \cdot 100, \]

where \( AC \) – amino acid score, %;
\( T \) – amino acid content (mg) in 1 g of protein;
\( B \) – content of the same amino acid (mg) in 1 g of ideal protein according to FAO/WHO.

The utility ratio of amino acid composition was determined by the following formula:

\[ U = \frac{C_{\text{min}} \sum_{j=1}^{k} A_{ej}}{\sum_{j=1}^{k} A_{j}} \]

where \( C_{\text{min}} \) - minimal score of essential amino acids of the evaluated protein compared with the physiological required rate (standard), ppm;
\( A_{ej} \) - mass fraction of j-essential amino acid in protein benchmark, g/100g of protein;
\( A_{j} \) - mass fraction of j-essential amino acid in the product, g/100g of protein.

The biological value of the developed MPMMs was determined by their digesting “in vitro” by method of O. A. Pokrovskiy and I. D. Ertanov adapted by P. G. Starozhuk.

The relative biological value (RBV) was determined by testing with ciliate Tetrahymena periformis strain H-14. The method is based on determining the intensity of ciliates reproduction in the environment with studied product for a certain period of time.

Results

The amino-acid score calculation of essential amino acids of the studied products and its comparison with the standard of FAO / WHO are shown in Table 1.

<table>
<thead>
<tr>
<th>Name amino acids</th>
<th>Content of protein, recommended by FAO/WHO, mg/g</th>
<th>minced masses of carrot</th>
<th>minced masses of pumpkin</th>
<th>minced masses of squash</th>
<th>control</th>
</tr>
</thead>
<tbody>
<tr>
<td>isoleucine</td>
<td>40</td>
<td>105</td>
<td>107</td>
<td>119</td>
<td>122</td>
</tr>
<tr>
<td>leucine</td>
<td>70</td>
<td>107</td>
<td>109</td>
<td>120</td>
<td>129</td>
</tr>
<tr>
<td>methionine + cystine</td>
<td>35</td>
<td>106</td>
<td>106</td>
<td>117</td>
<td>93</td>
</tr>
<tr>
<td>lysine</td>
<td>55</td>
<td>105</td>
<td>107</td>
<td>120</td>
<td>128</td>
</tr>
<tr>
<td>phenylalanine + tyrosine</td>
<td>60</td>
<td>109</td>
<td>113</td>
<td>122</td>
<td>188</td>
</tr>
<tr>
<td>threonine</td>
<td>40</td>
<td>100</td>
<td>101</td>
<td>106</td>
<td>115</td>
</tr>
<tr>
<td>tryptophan</td>
<td>10</td>
<td>100</td>
<td>100</td>
<td>109</td>
<td>150</td>
</tr>
<tr>
<td>valine</td>
<td>50</td>
<td>112</td>
<td>114</td>
<td>129</td>
<td>119</td>
</tr>
<tr>
<td>U</td>
<td>-</td>
<td>0,91</td>
<td>0,91</td>
<td>0,90</td>
<td>0,69</td>
</tr>
<tr>
<td>BV, %</td>
<td>-</td>
<td>94,50</td>
<td>92,88</td>
<td>88,63</td>
<td>62,5</td>
</tr>
</tbody>
</table>

Analysis of the data in Table 1 shows that the limiting amino acids are absent in protein composition of developed MPMMs, while level of all essential amino acids exceeds the standard of FAO / WHO that
indicates the high biological value of products. Proteins of control sample have the methionine + cystine compound as a limiting amino acid. The increased level of sulfur-containing amino acids (methionine + cystine) in MPMMs is a consequence of presence of MPC of buttermilk in their structure, which containing serum proteins.

The biological value of the reference protein is 100%. According to Table 4.6, the biological value of developed minced masses is the following: for milk-carrot minced mass - 94.50%, milk-pumpkin minced mass - 92.88%, milk-squash minced mass - 88.63%. The lowest BV is for milk-squash minced mass, which can be explained by the low content extensin in squash, compared with carrot and pumpkin.

According to the modern concepts of amino acid balance (Harper, 1984) the protein, which provides human needs in essential amino acids in the amount and at the ratio corresponding to the minimum value requirements, has the optimal characteristics. Therefore, determining of the biological value involves the assessment of the correspondence of essential amino acid scale to dietary protein scale for most effective utilization of these amino acids for protein synthesis.

Professor M.M. Lipatov (1990) during several years developed the principles and formal methods of biological value assessment for food products. The author formulated the basic criterion for assessing the amino acid protein composition of food products. This criterion provides that the product can be considered as the best one when under conditions of equal adequate supply of the human body by anabolic material the portion of essential amino acid content in its proteins, which are assimilated, can to be used for anabolic purposes without degradation to the needs of essential amino acid biosynthesis and, especially, not participating in biological oxidation for body energy demands compensation.

The essence of the protein qualitative assessment using the formal quantitative indicators is that the higher the utility coefficient of amino acid composition (U), which defines the essential amino acid balance in relation to physiologically required norm (standard), corresponds to the better-balanced essential amino acids and higher efficiency of their utilization by the human body (ideally U = 1).

The executed calculations showed that the utility ratio of amino acid composition of developed minced masses of carrot, pumpkin and squash is 0.91, 0.91 and 0.90, respectively, compared with 0.69 for minced masses of low-fat sour curd, which is selected as a reference sample.

It should be noted that the biological value of product is defined on one side by the compliance of calculated essential amino acid score to the standard of FAO / WHO and on the other hand by the degree of proteins hydrolyzability by digestive track enzymes.

Under the influence of tough technological conditions of heat treatment the food proteins denature, resulting in a reduced ability of protein to be digested by the human body. Thus, there is a significant difference between the protein quantity and quality, determined by chemical methods, and quantity of proteins digested (utilized) by the human body, determined by biological “in vivo” or biochemical “in vitro” methods. The last figure is a comprehensive feature for maximum speed and depth of the studied protein hydrolysis, compared to the reference protein (caseine).

Information about the extent of digestibility and relative biological value (RBV) of milk-plant minced masses is presented in Table 2.

### Table 2

<table>
<thead>
<tr>
<th>Name of products</th>
<th>The extent of digestibility, g / eq %</th>
<th>RBV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pepsin</td>
<td>trypsin</td>
</tr>
<tr>
<td>kazeïn control</td>
<td>5,05±0,14</td>
<td>25,38±0,79</td>
</tr>
<tr>
<td>buttermilk concentrate</td>
<td>5,09±0,15</td>
<td>22,38±0,69</td>
</tr>
<tr>
<td>minced masses of carrot</td>
<td>6,00±0,19</td>
<td>23,2±0,63</td>
</tr>
<tr>
<td>minced masses of pumpkin</td>
<td>5,93±0,17</td>
<td>22,7±0,73</td>
</tr>
<tr>
<td>minced masses of squash</td>
<td>5,89±0,21</td>
<td>22,4±0,60</td>
</tr>
</tbody>
</table>

According to the data in table 2, the proteins of developed milk-plant minced masses have a high degree of digestion. The digestion degree of minced masses obtained by combining of milk (buttermilk MBC) and plant raw materials (vegetable puree) is higher than the digestion degree of buttermilk MBC. Analysis of the obtained data confirms the important physiological phenomenon, first discovered by A. A. Pokrovskiy,
according to which with a combination of diverse origin proteins in food rations, their digestion almost always gets better.

Analysis of RBV studies of the developed products (Table 2), performed with ciliate Tetrahymena periformis, shows that specimens are superior to the reference sample (caseine) for this indicator by 1.41-1.43 times. Herewith, the ciliates that were grown on the studied product extracts were larger and more mobile than those grown on caseine.

Discussion

This article presents the study of the biological value of milk-plant minced masses from buttermilk concentrate. The score of essential amino acids was calculated, as well as the digestion degree and relative biological value of developed minced masses was defined. The calculation of amino acid score for milk-plant minced masses shows that the limiting amino acids are absent in protein composition, while the level of all essential amino acids exceeds the standard of FAO / WHO that indicates the high biological value of products.

It was established that the utility rate of amino acid composition of developed minced masses exceeds the reference level by 1.3- 1.32 times. In terms of RBV and degree of digestion by gastrointestinal proteinases MPMMs from buttermilk concentrate also exceed the reference level. Analysis of the obtained data confirms the important physiological phenomenon, first discovered by A.A. Pokrovskiy, according to which with a combination of diverse origin proteins in food rations, their digestion almost always gets better.

Prospects for further studies in this direction provide the definition of rational parameters for the storage of developed milk-plant minced masses from buttermilk concentrate.

References


