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Determination of the biological value of minced semi-finished products with a complex food additive by the enzymatic method

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Abstract. Providing the population with protein products of animal origin is becoming an increasingly difficult task at present. Therefore, the development of new meat products using animal protein is quite relevant. One of the criteria for determining the biological value of a product is the degree of its digestibility. The method is to determine the kinetics of acid and alkaline hydrolysis of protein components in minced semi-finished products in the “in vitro” system. For the study, minced semi-finished products (cutlets) were used: a control sample (the main raw material is beef cutlet meat and fat pork) and three prototypes with partial replacement of beef cutlet meat with a complex food additive based on animal and vegetable raw materials – 0.5%, 0.75%, and 1.0%, respectively. The hydration of the supplement is 1:15. The food supplement contains in its composition, g/100g: sodium alginate – 60, whey protein – 16, soy fibre – 24. Determination of the biological value of a protein by the enzymatic method is a fairly objective way to determine the ability of a protein to be broken down by proteolytic enzymes in the gastrointestinal tract. A device for protein hydrolysis was used by the enzymatic method to determine the biological value of minced semi-finished products. The essence of the method is six-hour hydrolysis by enzymes of the finished product. The first stage is fermentation with pepsin (3 hours), and the second stage is fermentation with trypsin (3 hours) with an hourly selection of hydrolysis products to determine the degree of digestibility at a certain stage of the study. It is proved that the addition of a food mixture to the recipe of minced semi-finished products is advisable since it allows providing them with better digestibility indicators. Therewith, the digestibility of the prototypes was slightly higher

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than the control one. The digestibility index for the control was 69%, and for the experimental subjects – 68-74%. The expediency of using a complex food additive based on animal and vegetable raw materials for the production of minced meat semi-finished products with the share of replacement of the main raw materials from 8% to 16% with an increase in quality indicators was experimentally established, namely, the digestibility of minced semi-finished products has been confirmed by the “*in vitro*” system, pepsin-trypsin

Keywords: minced meat cutlets, food mixture, pepsin-trypsin proteinase system, digestion

Relevance

Today in Ukraine and the world there is an increased demand for the consumption of fast-food products (frozen and chilled minced meat semi-finished products). The increase in their popularity is due to the long shelf life of products for consumption and their fast cooking time. The production of quick-frozen products is one of the most promising areas for the development of industrial processing of meat raw materials. Recently, animal proteins have become increasingly popular in the production of the above-mentioned products. Therefore, the development of new food products using animal protein, namely whey protein, is quite relevant.

Analysis of recent studies and papers

The analysis of recent studies indicates a steady interest of specialists in expanding and improving the range of minced meat semi-finished products by introducing various additives into their composition. One of the most effective ways to compensate for alimentary insufficiency in nutrition is the regular inclusion of functional food additives of various preventive purposes in the diet. A special feature of functional food additives obtained based on balanced compositions is their multicomponent and the realisation of the functional properties of raw food ingredients that can create structural systems.

There are many food additives and mixtures on the modern market, and each of them is limited in its component composition, so a new complex food additive was created based on animal and vegetable raw materials, which provides high functional and technological indicators of minced meat semi-finished products.

The food supplement is a mixture of the following components: as a biologically active component, it contains sodium alginate – 60%, as dietary fibre – soy fibre – 24%, and as a protein – whey protein – 16%. Each component of the mixture has its own functionality.

There is a group of polysaccharides, different from starch that is not digested by digestive enzymes. In a physiological sense, they are combined into a group of dietary fibres. Dietary fibre is a diverse composition and structure of polymers of natural origin. They are widely distributed in plant products: cereals, vegetables, and legumes.

Fibre (cellulose) is the most common high-molecular non-starchy polysaccharide. It is the main component and supporting material of plant cell walls. Fibre does not dissolve in water and under normal conditions does not undergo hydrolysis by acids. For the production of meat products, natural dietary fibres were developed, which are fibre, the raw material of which is soy.

The use of sodium alginate is based on the ability to form gels, that is, to work as a thickener, gelling agent and emulsifier. Sodium alginate is able to stabilise the structural and mechanical properties of the product. The widespread use of alginates is associated with such properties as increased viscosity, the ability to swell and gel, stabilisation of aqueous, and water-fat solutions.

One of the promising raw materials for research in this area, which contains a complex of biologically active substances and is rational in terms of economic indicators, is whey, based on which whey protein is produced.

The biological value of whey is determined by the content of protein nitrogenous compounds (primarily essential amino acids), carbohydrates, lipids, mineral salts, vitamins, organic acids, enzymes, immune bodies, and trace elements. Milk protein is considered one of the main components of meat products, which, however, is responsible for the taste, and the nutritional value of the finished product or semi-finished product.

The higher the biological value of food, the more it meets the physiological needs of the body. The rate at which hydrolysis of food proteins occurs is one of the indicators of their biological value (BV) since it allows for predicting the degree of protein utilisation by the tissues of living organisms. The BV of a food product can be determined by several methods: chemical, biological, and enzymatic. A fairly effective method of enzymatic hydrolysis, according to which the rate of protein digestion in the gastrointestinal tract is determined to examine this indicator, a proteinase system containing pepsin and trypsin consistently acts on dietary protein. Therewith, hydrolysis products are constantly removed from the reactive medium by dialysis. This method mimics the conditions under which food proteins are hydrolysed in the body.

The purpose of the study – analysis and determination by the enzymatic method of the biological value (degree of digestibility) of minced semi-finished products with a complex food additive based on animal and vegetable raw materials with its use in experimental samples, respectively, 0.5%, 0.75%, and 1.0%.

Materials and Methods

The objects of study are control and experimental samples of minced semi-finished products. The study was conducted in the laboratory of the Department of Technology of Meat and Meat Products of NUFT. The method of enzyme hydrolysis (pepsin-trypsin system) for determining the biological value of minced meat semi-finished *invitro* products was used as a basis. A device was used to conduct the study that has external and internal vessels separated by a semipermeable membrane (Fig. 1).



Figure 1. Hydrolysis device

Minced semi-finished products (cutlets) were used for research. Four samples were formed from them. The control sample (C) contained only the main raw materials – beef cutlet meat and fat pork. In three experimental samples, the main raw materials were partially replaced with a complex food additive based on animal and vegetable raw materials. The

food supplement contains: sodium alginate – 60 g/100g, whey protein – 16 g/100g and soy fibre – 24 g/100g. Dietary supplement administration was 0.5% (S1), 0.75% (S2), and 1.0% (S3). The hydration of the supplement is 1:15.

The research technique was as follows: firstly, frozen semi-finished products were subjected to heat treatment (frying) and then cooled. A sample containing approximately 150 mg of protein was selected from the finished product. Placed in the internal container of the device, 15 ml of 0.02 n hydrochloric acid solution with a pH of 1.7 was added. 60 ml of hydrochloric acid of the same concentration was added to the outer container. The inner container was immersed in the outer one until the liquid level in them was equal to adhere to the isotony. The samples were incubated in a water bath at a temperature of 37°C for 15 minutes with constant stirring. 15 mg of crystalline pepsin was then added to the internal container. Fermentation was conducted for 3 hours with constant stirring. During each hour, the hydrolysate was collected for further studies to determine the degree of digestibility. After fermentation, the mixture from the inner container was neutralised with a solution of sodium hydroxide, and then 10 ml of bicarbonate buffer was added. The mixture from the outer container was replaced completely with bicarbonate buffer. The liquid in both containers is at the same level. After temperature control for 15 minutes, 15 mg of crystalline trypsin was added to the internal vessel and further fermentation was performed for 3 hours. The hydrolysate was also collected each hour. The degree of digestion of product proteins is assessed by the difference between the amount of protein taken for the study and the protein that remained after sequential treatment of the product with pepsin and trypsin. The amount of accumulated

hydrolysis products in the dialysate was determined by the Lowry method (the method is based on the staining of products during the interaction of Folin's reagent with an alkaline solution of proteins). According to it, the tyrosine content was identified in the samples of minced semi-finished products formed as a result of enzymatic hydrolysis using the enzymes pepsin and trypsin. The amount of protein in the solutions was determined according to the calibration graph. It was made using a standard tyrosine solution.

Results and Discussion

The biological value (BV) of proteins characterises their quality, ability to provide plastic processes and synthesis of metabolically active substances, and is explained by the presence of essential amino acids in them, their ratio with substitutes and digestibility in the gastrointestinal tract.

It is known that animal proteins of different origins are digested differently. The speed of digestion is affected by a number of factors: the type of raw material, the degree of grinding, and heat treatment.

Figure 2 shows that minced semi-finished products at the initial stage are characterised by high rates of digestion under the action of pepsin. Digestion over the course of three hours occurred gradually without drastic changes. The best indicator of digestibility was prototype No. 3. It contains the largest amount of a food supplement based on whey protein. The control sample had the lowest digestibility index. This is due to the fact that the composition includes beef meat and pork fat, these types of meat raw materials have a relatively low rate of protein digestion compared to experimental samples that contain pure whey protein that is fully digested during the first three hours – pepsin.

Figure 3 shows the results obtained from further study with trypsin. In the 4th hour of the study, trypsin was added to pepsin hydrolysate.

Subsequent studies were determined by relatively small indicators of digestion. Prototypes 2 and 3 had the best performance.

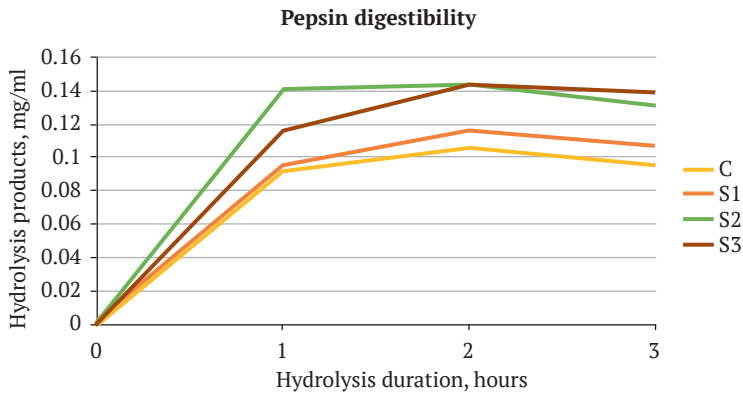


Figure 2. Pepsin protein digestibility (*in vitro*)

Figure 4 shows that the digestibility of all prototypes has a certain pattern. This is due to the gradual and partial replacement of the main raw materials of minced meat semi-finished products with a complex food additive. In the composition of the finished minced semi-finished product, the content of the food mixture (hydrated 1:15) is from 8 to

16%. The best digestibility index was demonstrated by prototypes No. 2 and No. 3, which were 72.0% and 74.0%, respectively, and the control sample – 69.0%. This is due to the fact that whey proteins are rapidly and almost completely digested by pepsin and trypsin, while raw meat is slower and not fully digested by trypsin.

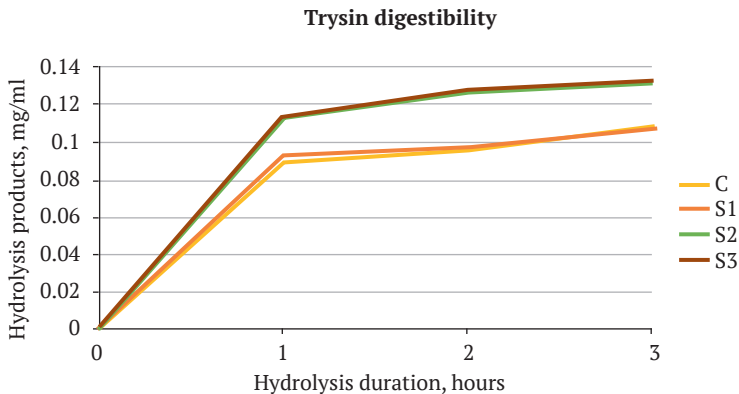


Figure 3. Trypsin protein digestibility (*in vitro*)

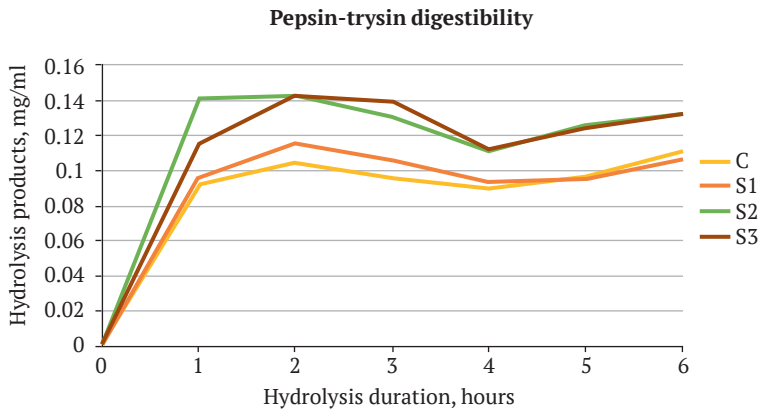


Figure 4. Rate of protein digestion by the pepsin-trypsin system

According to the obtained data, in accordance with the value of the concentration of accumulation of hydrolysis products of proteins of minced semi-finished products percentage to tyrosine, the value of digestion of proteins of semi-finished products changed.

Conclusions and Prospects

The biological value (digestibility under conditions of *in vitro*) of minced meat semi-finished products by the enzymatic method of protein

hydrolysis. It was found that minced semi-finished products with the addition of 0.75% and 1.0% additives had better digestion indicators relative to the control by 3% and 5%, respectively. This indicates an improved biological value of the product in general. Therefore, the replacement of raw meat with a food additive, which after hydration is from 12% to 16% of the total weight, is advisable and can be used for the production of minced semi-finished products.

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Визначення біологічної цінності січених напівфабрикатів з комплексною харчовою добавкою ферментативним методом

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Анотація. Забезпечення населення білковими продуктами тваринного походження стає все більш складним завданням нашого часу. Тому розробка нових м'ясних продуктів з застосуванням білка тваринного походження є досить актуальним. Одним із критеріїв визначення біологічної цінності продукту є ступінь його перетравності. Методикою є визначення кінетики кислотного та лужного гідролізу білкових складових речовин у січених напівфабрикатах у системі «*in vitro*». Для досліджень використовували січені напівфабрикати (котлети): контрольний зразок (основна сировина – м'ясо котлетне яловиче та свинина жилована жирна) та три дослідних зразки з частковою заміною м'яса яловичого котлетного на комплексну харчову добавку на основі тваринної та рослинної сировини – 0,5 %, 0,75 % та 1,0 % відповідно. Гідратація добавки становить 1:15. Харчова добавка містить у своєму складі г/100г: альгінат натрію – 60, білок молочної сироватки – 16, соєву клітковину – 24. Визначення біологічної цінності білка ферментативним методом є досить об'єктивним способом визначення здатності білка до розщеплення протеолітичними ферментами у шлунково-кишковому тракті. Для визначення біологічної цінності січених напівфабрикатів ферментативним методом використовували прилад для гідролізу білків. Суть методу полягає у шестигодинному гідролізі ферментами наважки готового продукту. Перший етап – ферментація пепсином (3 години), другий етап – трипсином (3 години). З погодинним відбором продуктів гідролізу для визначення ступеня перетравності на певному етапі дослідження. Доведено, що додавання до рецептури січених напівфабрикатів харчової суміші являється доцільним, оскільки дозволяє отримати січений напівфабрикат з кращими показниками перетравлюваності. При цьому перетравлюваність дослідних зразків була дещо вищою за контрольний. Показник перетравлюваності для контролю становив 69 %, а для дослідних – 68-74 %. Експериментально встановлено доцільність використання комплексної харчової добавки на основі тваринної та рослинної сировини для виробництва м'ясних січених напівфабрикатів з часткою заміни основної сировини від 8 % до 16 % з підвищенням показників якості, а саме підтверджено перетравність посічених напівфабрикатів системою «*in vitro*», пепсин-трипсин

Ключові слова: котлети м'ясні січені, харчова суміш, система протеїназ пепсин-трипсин, перетравлення