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THE AMINO ACID COMPOSITION OF MEAT PRODUCTS TREATED WITH PREPARATIONS OF MICROBIAL ORIGIN

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Abstract. Fermentation in the technology of dry-cured meat products helps to create products with high sensory characteristics and an extended shelf life. The purpose of this work was to study how bacterial and enzyme preparations affected the accumulation of free amino acids in dry-cured meat products. The work considers how the preparation *Iprovit-Lakmik* based on the cultures *L. plantarum*, *L. rhamnosus*, *L. casei*, and *Micrococcus varians* acts on the accumulation of free amino acids during the ripening of dry-cured sausages, and how the bacterial preparation *Iprovit-MKS* based on the cultures *Lactobaplantarum*, *L. rhamnosus*, and *Staphylococcus simulans* and the enzyme preparation *Protolad* acts on proteolysis during the ripening of dry-cured whole-muscle products from pork and beef. Fermentation was carried out in a climatic chamber at a temperature required by the technological process of accelerated ripening of fermented sausages, using bacterial and enzyme preparations. The starter culture *Iprovit-Lakmik*was added in the amount 0.05% to the volume of the sausage mince prepared in accordance with the formulation of the dry-cured sausage *Zhytomyrska*. The preparations *Protolad* and *Iprovit-MKS* were added at the stage of injecting the balyk (cured fillet) *Darnitsky*. Samples with no preparations added were the controls. The amino acid composition of proteins was determined by ion-exchange chromatography on an automatic amino acid analyser Biotronik LC2000. The total content of free cyclic amino acids was determined by the Hull method, and that of acyclic amino acids by the Gomez method, using colourimetry. It has been found that after fermentation, each product had its own characteristics of the qualitative and quantitative accumulation of free amino acids. Adding the preparation *Iprovit-Lakmik* to raw meat allowed directed biochemical transformations with the formation of a significant amount of free amino acids, which exceeded the control by 115.86 mg/100 g of dry matter. The enzyme preparation *Protolad* has a positive effect on the chemical and physicochemical characteristics of salted products from pork and beef. It has been proved that its use activates the breakdown of muscle tissue proteins and increases the pool of free amino acids. In the test samples from pork and beef, the content of free amino acids increased, respectively, by 1.7 times and 3.4 times, and that of non-essential amino acids by 1.4 times and 1.3 times respectively, compared with the control. In the samples with the bacterial preparation *Iprovit-MKS*, the total amount of amino acids increased significantly: by 32% for beef balyk and by 20% for pork balyk.

Keywords: fermentation, beef, pork, meat products, dry-cured sausages, enzyme preparations, bacterial preparations, proteolysis, amino acid composition.

Introduction. Formulation of the problem

An important indicator of the degree of ripening of fermented products is the content of free amino acids, which influence the formation of the desired specific taste of finished sausages. Besides, an increase in the pool of free amino acids increases the biological value of these products. The use of enzyme preparations with proteolytic action and of bacterial culturesaccelerates a number of biochemical reactions and thus makes it possible to increase the biological value and the functional and technological properties of raw meat. This opens up new opportunities for improving and intensifying the course of processing, since it allows effective maceration of meat tissues. The information found in the literature on using bacterial cultures and enzyme preparations to biomodify the properties of meat raw materials when manufacturing fermented products is not sufficiently complete and systematised. One of the most promising ways to improve the consistency of fermented meat and meat products is the treatment of raw materials with enzyme and bacterial preparations. Of particular importance is the study of how these preparations affect proteolytic processes of the vital activity of microorganisms, since these processes play a significant role in the formation of the flavour bouquet of fermented products.

Analysis of recent research and publications

A meat product is considered fermented if beneficial microorganisms play a key role in its ripening. The spontaneous microbiota of raw or salted meat is concentrated on the surface of the product, but when it is cut or ground, natural and specially inoculated microorganisms act throughout its volume. A specific feature of the fermentation of meat products is that, unlike milk and wort, meat is not heat-treated. Meat is low in fermentable carbohydrates and has a high buffering capacity due to proteins, phosphate-containing compounds, etc. Muscle cells contain membrane structures (sarcoplasmic reticulum) with polyunsaturated fatty acids and with transition metals (iron, copper). Thus, grinding or heat treatment of meat in the presence of oxygen causes oxidative changes [1,2]. Fermentation is also a traditional method to preserve foodstuffs (for example, fermented sausages), where some groups of microorganisms prevent the growth of others due to their interspecific competition or the formation of compounds in the course of their metabolism (such as lactic acid or certain bacteriocins) [3,4]. Enzyme systems of meat are complex microbial ecosystems where bacteria, yeasts, and moulds coexist. During fermentation, considerable microbial diversity is observed, as evidenced by the presence of several species belonging to different genera and of strains of the same species. As a result of spontaneous fermentation, raw materials such as meat and fat quickly deteriorate and turn into microbiologically stable end products characterised by a certain organoleptic profile improved by adding sodium chloride and drying the product [5,6]. Ripening is accompanied by significant changes in the protein components of raw meat: the tissue enzymes and microorganisms become more active, which destroys the cellular structure of muscle tissue and leads to proteolysis, when the content of free amino acids can double [7]. Solubilisation and gelation of myofibrillar proteins play an important role in the formation and development of the structure of fermented sausages. In particular, this process is largely influenced by the salt concentration in minced meat and the decrease in pH after lactic acid fermentation [8]. The Irish researchers observed a higher degree of proteolysis in salami made using a composition of the cultures *L. sakei* LAD and *S. carnosus* MC, as compared with the control. Thus, the total content of free amino acids in the finished product was 1292 mg per 100 g of dry matter, which was 1.7 times more than in the control. Accordingly, there was a more intense hydrolysis of myofibrillar proteins, especially myosin and actin [9].

The group of technologically useful microorganisms includes the following families: *Lactobacillales*, *Aerococcaceae*, *Enterococcaceae*, *Lactobacillaceae*, *Leukonostocaceae*, *Streptococcaceae*, and the denitrifying cocci *Staphylococcaceae Micrococcaceae*. Most species of the genus *Lactobacillales* consume nutrients and require a medium rich in B vitamins, amino acids, nucleic acid derivatives, fatty acids, mono- and disaccharides, etc. to grow. Some may use salts of organic acids, such as citrates [10]. According to [11], the proteolytic activity of microorganisms is mainly directed to the secondary proteolysis of oligopeptides, which leads to the accumulation of low-molecular-weight peptides and free amino acids. These compounds have a positive effect on the formation of the taste and aroma of the product and result in its specific sensory characteristics. Delicacies acquire an exquisite taste and aroma due to the proteolytic and lipolytic activity of the staphylococci species *S. xylosus*, *S. carnosus*, and the lactobacilli *Lactobacillus pentosus* [12,13]. During fermentation and ripening, the proteolytic activity of these cultures extended to both sarcoplasmic and myofibrillar proteins. Besides, a significant intensification of proteolysis in sausages during storage was recorded. At the beginning of fermentation, all samples were similar in their content of free amino acids, but the finished products differed significantly due to the specific properties of the starter strains.

It was shown [14] that the proteolytic activity of the strains *L. curvatus* CECT 904 and *L. sake* CECT 4808 was determined by two proteinases, which cleaved the five sarcoplasmic proteins of the raw material into hydrophilic and hydrophobic peptides. The *L. curvatus* strains were characterised by high proteolytic activity, while the *L. sake* strains formed a wider range of free amino acids [14]. A high degree of proteolysis of the bacterial composition consisting of the strains *L. sakei* LAD and *Kocuriavarians* FT4 was observedwhen manufacturing pork ham. In the sample with this preparation added, more low-molecular-weight peptides and free amino acids accumulated, as compared with the control (containing no bacterial preparation) [15].

Fermented sausages retain their nutritional value for a long time and meet the current requirements towards meat products. Besides, under certain conditions, microorganisms of bacterial preparations contribute to an increase in the biological value of sausages due to the biosynthesis of enzymes, proteins, vitamins, and essential amino acids. Establishing the laws of transformation of raw meat proteins under the action of enzyme and bacterial preparations and using them in production allow obtaining a finished product with high nutritional and biological value.

Purpose and objectives of the study. The purpose of this work was to investigate how the enzyme and bacterial preparations affected the accumulation of free amino acids in the composition of fermented meat products during their ripening.

To achieve the purpose, it was necessary to accomplish the following **objectives**:

1. To investigate the effect of the bacterial preparation *Iprovit-Lakmik* on the accumulation of free amino acids during the ripening of dry-cured sausage.

2. To investigate the effect of the bacterial preparation *Iprovit-MKS* and the enzyme preparation *Protolad* on the conversion of proteins in dry-cured balyks (fillets) from pork and beef.

Research materials and methods

The enzyme preparation *Protolad* is a bacterial protease preparation obtained by directed fermentation of the selection strain *B. subtilis* with subsequent purification. The manufacturer is the enzyme preparations plant ENZIM (Ladyzhyn, Ukraine).

The bacterial preparation *Iprovit-MKS* is a lyophilised symbiotic composition of the lactic acid bacteria strains *Lactobacillus plantarum* and *L. rhamnosus* and staphylococci *Staphylococcus simulans* [16].

The bacterial preparation *Iprovit-Lakmik* is a lyophilised symbiotic composition of the lactic acid bacteria strains *L. plantarum*, *L. rhamnosus*, and *L. casei* and micrococcus *Micrococcusvarians* (manufactured by the Food Resources Institute of the National Academy of Agrarian Sciences, Kyiv, Ukraine) [17].

The preparation *Iprovit-Lakmik*was used to manufacture dry-cured sausage according to the formulation for the sausage *Zhytomyrska*. The sausage mince was prepared from low-fat beef and pork and fatback. According to the directions for use, the bacterial preparation *Iprovit-Lakmik*, in the amount 0.05% of the mince volume, was added at the stage of mincing low-fat raw meat in a meat cutter. The mince was mixed for 3–5 minutes, and then fatback, sugar, spices, and sodium nitrite solution were added [18]. The control was sausage made without the bacterial preparation. The corresponding samples were designated E (sausage with the preparation *Iprovit-Lakmik* added) and C (control sausage with no biological preparation). Fermentation was carried out in an experimental climatic chamber with controlled temperature parameters. The temperature in the chamber was gradually reduced from (20±2)°C to (11±1)°C during 20 days.

The preparations *Protolad* and *Iprovit-MKS* were used to manufacture a dry-cured product from pork and beef according to the formulation for balyk *Darnitskyi*. The raw meat for balyks was the dorsal muscle of pork and beef.

The preparations were added to the brine (3.8% of table salt, 2% of glucose, and0.02% of sodium nitrite).

Protolad was introduced into the brine in the amount 0.01% of the raw material weight (PP_f sample for pork, BP_f sample for beef). The control samples without the enzyme preparation were designated as PC (pork), BC (beef).

The preparation *Iprovit-MKS* (0.5 g of dry preparation per 1 kg of raw meat) was added at the injection stage. The corresponding samples were designated BP and SP. The controls were beef and pork samples with no bacterial preparation added (BC and PC respectively), with the initial meat raw materials designated P (pork) and B (beef).

The prepared brine, in the amount 20% by weight of pork and 30% by weight of beef, was injected with a needle injector, after which the meat was kept in brine for 48 at 8–10°C under stationary conditions. The raw meat was fermented in an experimental climatic chamber for 10–13 days.

The amount of free cyclic amino acids was determined by the Hull method [19], and acyclic amino acids were quantified using a ninhydrin reagent according to the modified Gomez method (λ=502 nm) [20]. The amino acid composition of the samples was studied on an LC2000 analyser (Biotronik). Proteins were hydrolysed with hydrochloric acid by the method [14] using 6n HCl obtained by diluting concentrated acid with distilled water in the ratio 1:1. 50 mg of the sample was transferred to the bottom of atest tube so that no material remained on the walls, and 3 cm^3 of 6n HCl was added to the tube. The tube was carefully stoppered, placed in the hydrolysis unit, and left at 110°C for 24 hours. After hydrolysis, the tubes were cooled down. The contents of a test tube were filtered into a flask under gravity. The acid was evaporated in a vacuum rotary evaporator at 40°C. The dry residue was dissolved in buffer and analysed. Amino acids were identified by comparing the retention times with a mixture of amino acid standards.

To eliminate errors that might occur when determining the parameters under study, and to evaluate the results objectively, all experiments were carried out in triplicate. The numerical data obtained were processed statistically using the software Statistica. The results were expressed as the mean ± standard deviation for each test group. The significance of the results was determined by the significance level P<0.05.

Results of the research and their discussion

The level of free amino acids is an important indicator of the degree of ripening of fermented products, since they are responsible for the specific flavour of the finished fermented products, and are the precursors of aromatic compounds. In general, during ripening of fermented meat products, changes in the quantitative and qualitative composition of free amino acids are due both to proteolysis and to the biosynthetic activity of microorganisms [21-24].

Study of the effect of the bacterial preparation Iprovit-Lakmik *on proteolysis during the ripening of dry-cured sausage.*

Manufacture of dry-cured and raw-smoked sausage scan involve using the bacterial preparation *Lakmik*, the microorganisms of which have high biochemical and antagonistic activity against indicator microflora. Micrococci have high proteolytic, nitrite-reducing, catalase, and proteolytic activity [18].

Experimental batches of dry-cured sausages were made in a semi-industrial environment in accordance with the formulation for sausage *Zhytomyrska*. The functioning of the bacterial preparation *Iprovit-Lakmik*was compared with the control (sausage without the bacterial preparation).

It has been found that each product had its own characteristics of the qualitative and quantitative accumulation of free amino acids.

The content of free amino acids was studied in finished fermented sausages (Fig. 1). In the group of cyclic amino acids (CA), there is a significant amount of alanine and leucine, which formed a sweetish taste.

In the group of monoaminodicarboxylic (MADC) amino acids, the highest was the content of glutamic acid, which imparts a sour taste to the product.

In the group of diaminomonocarboxylic (DAC) acids, lysine predominated, which formed the specific meat taste of dried meat.

By the end of ripening, in the group of monoaminomonocarboxylic (MACA) amino acids, alanine and serine accumulated, giving the product a sweetish taste.

In all the samples, there was recorded a low amount of cysteine, which stabilises the colour of a product and improves its appearance.

According to the literature, *L. plantarum* is able to hydrolyse peptides with the accumulation of free amino acids, in particular, alanine, leucine, and glutamic acid [25-27].

It has been found that during ripening, the total amount of free amino acids increased significantly in the experimental and control samples of sausage. Thus, in the experimental sample, their concentration was higher than in the control. As for cyclic amino acids, on the 20th day of ripening, their level in C increased by 2 times, while in E by2.4 times. In the sausage with the preparation *Iprovit-Lakmik*, the largest amount of acyclic amino acids was formed (13times as much, compared with the initial content), while in the control, only5 times as much. These differences in the accumulation of cyclic, diaminomonocarboxylic, monoaminodicarboxylic, and monoaminomonocarboxylic amino acids, too, indicate the specific character of the proteolytic process in sausages made using bacterial preparations.

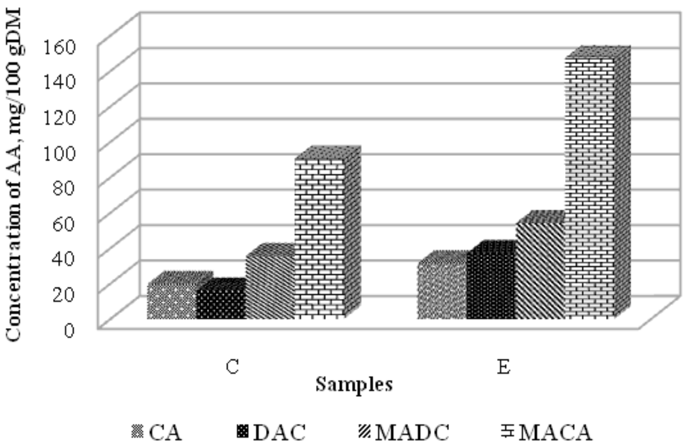

Fig. 1. Content of free amino acids in finished dry-cured sausages (C – control, sausage without a biological preparation, E – sausage with the preparation *Iprovit-Lakmik*, CA –*cyclic amino acids*, DAC –*diaminomonocarboxylic acids*, MADC –*monoaminodicarboxylic amino acids*, MACA–*monoaminomonocarboxylic amino acids*)

When comparing the ratio between essential and non-essential free amino acids, it should be noted that in the finished experimental sausages (on the 20^{th} day), an increase was observed not only in the absolute amount of essential amino acids (Table 1).

Thus, the experimental sausage was higher in non-essential amino acids forming a specific meat taste (glutamic acid, alanine proline, and serine), compared with the control. In the finished products, there were more essential and non-essential amino acids formed in the test samples (respectively, by 2.5 times and by 1.9 times) than in the control.

S. Fadda *et al.* showed similar results, namely that inoculation of *L. sake* into raw meat resulted in a greater release of free amino acids. In general, the viability of these cells leads to the breakdown of the protein during the ripening of dry fermented sausages, and to an increase in the concentration of free amino acids [15].

Study of the effect of the bacterial preparation Iprovit-MKS *and the enzyme preparation* Protolad *on proteolysis during ripening of dry-curedbalyk.*

It has been proved that various parameters of treatment (relative humidity and temperature) and its duration will affect biochemical reactions, namely the formation of free amino acids, and will make it difficult to compare the results of studying fermented balyks treated with the enzyme and bacterial preparations. The use of enzyme preparations in the processing of raw meat makes it possible to accelerate a number of biochemical reactions and intensify the course of processing, accelerating the softening of tissues and improving their tenderness at low temperatures [28].

The use of an enzyme preparation activates the breakdown of muscle tissue proteins, increases the pool of free amino acids, in particular, of those responsible for the flavour and aromatic bouquet of finished products (see Fig. 2).

On the 10^{th} day of fermentation, the test samples containing the enzyme preparation increased in total cyclic amino acids by 3.7 times (pork balyks, PP_f) and by 1.1 times (beef balyks, BP_f), and in monoaminomonocarboxylic amino acids by 3.7 times and 3.5 times respectively.

The content of essential amino acids in the samples PP_f and BP_f increased by 1.7 times and 3.4 times respectively, and that of non-essential amino acids by1.4 times and 1.3 times respectively, as compared with the control.

A study of how bacterial preparation *Iprovit-MKS*affects the transformation of pork and beef proteins has shown that during ripening, the protein components of meat raw materials change significantly due to the activity of meat tissue enzymes and microorganisms, which determines a certain course of biochemical processes. Free amino acids, as well as other metabolites associated with the vital activity of microorganisms, play a significant role in the formation of the flavour and aromatic bouquet of fermented products. The content of amino acids was studied at the beginning of fermentation and in the finished products (Fig. 3).

Table 1 – Quantitative composition of free amino acids in the sausages

Quantity	Control		Experiment	
	mg/100 g DM	% of total content	mg/100 g DM	% of total content
Essential amino acids	54.88±8.32*	32.9±3.2	111.17±11.1	39.3±3.4
Non-essential amino acids	112.14±14.38	67.1±6.2	171.71±16.04	60.7±6.7

* Values are presented as the mean ± standard deviation of triplicates

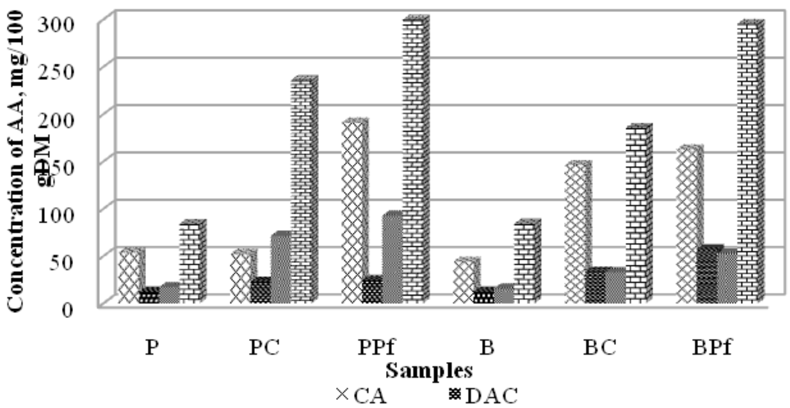

Fig. 2. Content of free amino acids in finished dry-cured products with the enzyme preparation *Protolad* added(the initial raw materials: pork (P), beef (B);after 10 days'ripening: PC – pork with no preparation, BC – beef with no preparation, PP_f – pork with the preparation, BP_f – beef with the preparation, CA – *cyclic amino acids*, DAC – *diaminomonocarboxylic acids*, MADC – *monoaminodicarboxylic aminoacids*, MACA –*monoaminomonocarboxylic amino acids*)

It should be noted that a significant increase in the diaminomonocarboxylic acids lysine and arginine was only recorded for the variants with *Iprovit-MKS*: respectively, in the pork balyk, by 2.0 and 1.7 times, in the beef balyk, by 6.0 and 2.4 times.

In particular, the content of such essential amino acids as methionine+cystine, threonine, and valine increased in the products. Thus, the newly developed product is characterised by greater nutritional value due to the total percentage of essential amino acids (valine, isoleucine, methionine, and cystine), which the control pork sample is poor in.

As can be seen from the data obtained (Table 2), the microbiota of the bacterial preparation *Iprovit-MKS* increases the pool of free amino acids. Since free amino acids are directly absorbed into blood, it can be assumed that the biological value of products made with the use of *Iprovit-MKS* will be higher.

The results of the quantitative determination of free amino acids in the fermented meat samples with the starter culture *Iprovit-MKS* are presented in Table 2.

During ripening, the total essential acids increased significantly in the variants with the bacterial preparation *Iprovit-MKS*: by 32% in the beef balyk and by 20% in the pork balyk, where their amount reached, respectively, 250.25 and 324.44 mg/100 g of dry matter. In the control variants, the final content of essential amino acids was almost the same as their initial content in the pork samples, and slightly grew in the beef samples. As to the spectrum of amino acids at the end of ripening, all samples showed accumulation of proline, phenylalanine, tyrosine, and a decrease in histidine.

The balyk PP significantly increased in the content of valine, glutamic acid, threonine, glycine, and serine, while BP was characterised by a significant increase in methionine, phenylalanine, lysine, proline, isoleucine, and glutamic acid. The general ripening dynamics of all balyks was characterised by accumulation of cyclic amino acids, diaminomonocarboxylic acids, monoaminodicarboxylic amino acids, and monoaminomonocarboxylic amino acids. The latter showed an increase in their absolute content.

Thus, the use of bacterial preparations has made it possible to reveal variations in the composition of free amino acids in fermented products, which indicates differences in the metabolic activity of the cultures. The free amino acids that predominated at the end of fermentation were glutamic acid and alanine, which contributed to the desired flavour. In general, these results for fermented products were similar to those previously reported for dry sausages [29,30].

Besides, an increase in the pool of free amino acids results in higher biological value of the finished product.

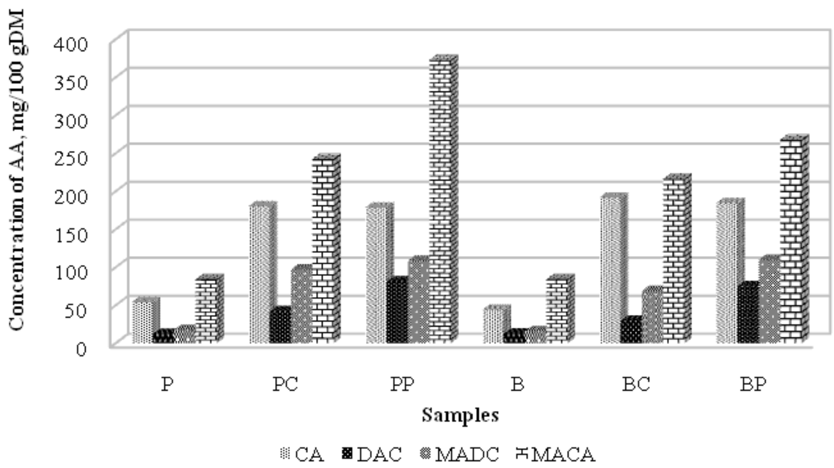

Fig. 3. Content of free amino acids in finished dry-cured products with the addition of the starter culture *Iprovit-MKS*. (Initial raw materials: pork (P), beef (B); after 13 days' of ripening: PC – pork with no preparation, BC – beef with no preparation, PP – pork with the preparation, BP – beef with the preparation, CA –cyclic amino acids, DAC – diaminomonocarboxylic acids, MADC – monoaminodicarboxylic amino acids, MACA –monoaminomonocarboxylic amino acids)

Table 2 – Quantitative composition of free amino acids in dry-cured products (n=3)

Amino acids	P	After ripening		B	After ripening	
		PC	PP		BC	BP
	mg/100 g of dry matter					
Essential amino acids	154.76*	205.91	324.44	78.6	211.18	250.25
Non-essential amino acids	366.56	382.42	469.7	423.82	305.15	413.97

* Values are presented as the mean ± standard deviation of triplicates
Initial meat raw materials: pork (P), beef (B); after 13 days of ripening: PC – pork with no preparation, BC – beef with no preparation, PP – pork with the preparation, BP – beef with the preparation

Conclusion

1. The characteristic differences in the course of biochemical processes in dry-cured sausages made without and with the bacterial preparation *Iprovit-Lakmik* have been determined. It has been shown that the addition of the bacterial preparation *Iprovit-Lakmik* to raw meat led to biochemical transformations with the generation of significant amounts of free amino acids (by 115.86 mg/100 g of dry matter more than in the control).

2. It has been proved that the enzyme preparation *Protolad* activates the breakdown of muscle tissue proteins and increases the pool of free amino acids. The content of essential amino acids in the samples (PP_f) and (BP_f) increased by 1.7 times and 3.4 times respectively, and that of non-essential amino acids by1.4 times and 1.3 times respectively, as compared with the control.

3. In the samples with the bacterial preparation *Iprovit-MKS*, the total amount of free amino acids (both essential and non-essential) increased significantly: by 32% in the beef balyk and by 20% in the pork balyk.

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АМІНОКИСЛОТНИЙ СКЛАД М'ЯСНИХ ПРОДУКТІВ, ОБРОБЛЕНИХ ПРЕПАРАТАМИ МІКРОБНОГО ПОХОДЖЕННЯ

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Анотація. Ферментація у технології сиров'ялених м'ясних продуктів сприяє створенню виробів із високими сенсорними характеристиками та тривалим терміном зберігання. Метою даної роботи було дослідженя впливу бактеріальних та ензимного препаратів на накопичення вільних амінокислот у складі сиров'ялених м'ясних продуктів. У роботі досліджено дію препарату «Іпровіт-Лакмік» на основі культур *L. plantarum, L. rhamnosus, L. casei, Micrococcusvarians* на накопичення вільних амінокислот упродовж визрівання сиров'яленої ковбаси, вплив бактеріального препарату «Іпровіт-МКС» на основі культур *Lactobacillusplantarum, L. rhamnosus, Staphylococcussimulans* і ензимного препарату Протолад, на протеоліз протягом дозрівання сиров'ялених цільном'язових продуктів зі свинини та яловичини. Ферментацію проводили в кліматичній камері за температури, яку регламентовано технологічним процесом прискореного визрівання ферментованих ковбас із застосуванням бактеріальних та ензимних препаратів. Стартову культуру «Іпровіт-Лакмік» додавали в кількості 0,05% до об'єму ковбасного фаршу, який готували відповідно до рецептури на сиров'ялену ковбасу «Житомирська». Препарат Протолад та «Іпровіт-МКС» додавали на стадіїін'єктуваннябалику «Дарницький». Контролем були зразки без препаратів. Амінокислотний склад білків визначали методом іонообмінної хроматографії на автоматичному амінокислотному аналізаторі «BiotronikLC2000», загальний вміст вільних циклічних амінокислот за методом Хулла та ациклічних – Гомеса – колориметрично. Встановлено, що кожний продукт після ферментації мав свої особливості щодо якісного та кількісного накопичення вільних амінокислот. Додавання препарату «Іпровіт-Лакмік» в м'ясну сировину забезпечувало спрямовані біохімічні перетворенння з утворенням значної кількості вільних амінокислот, що на 115,86мг/100 г сухої речовини більше ніж у контролі. Ензимний препарат Протолад позитивно впливає на хімічні, фізико-хімічні, характеристики солоних продуктів зі свинини та яловичини. Доведено, що його застосування активізує розщеплення білків м'язової тканини, збільшує пул вільнихамінокіслот. Вміст вільних амінокислот у дослідних зразках зі свинини та яловичини збільшився, в 1,7 раз та 3,4 рази, відповідно, а замінних – у 1,4 рази і 1,3 рази, відповідно, порівняно до контролю. У зразках з бактеріальним препаратом "Іпровіт-МКС" істотно зросла загальна кількістьамінокислот: на 32% для балика з яловичини і 20% – для балика зі свинини.

Ключові слова: ферментація, яловичина, свинина, м'ясні продукти, сиров'ялені ковбаси, ензимні препарати, бактеріальні препарати, протеоліз, амінокислотний склад.