



Model Minced Poultry Meat Biomodification with Starter Cultures

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Abstract: *Dry-cured and raw smoked sausages have always been in great demand among the population. However, the long and complicated technological process results in the high cost of the finished product. In this regard, there is a need for developing and introducing new types of gourmet products with high nutritional and physicochemical properties. Implementation of this task requires a systematic approach. The paper presents a study of the influence of starter cultures on poultry raw meat. The research involved white and red raw chicken meat separately. For preparing model mince, raw meat was ground in a frozen meat cutter with 3 mm mesh diameter, subjected to biomodification, and placed into the edible coating. At each stage of the process, the most important technological parameters were monitored, such as pH, accumulation of lactic acid, and the growth of microorganisms in the model mince. The results of the study indicate, by the main indicators, more complete biomodification by Almi 2 starter cultures.*

Keywords: *raw meat, biomodification, poultry meat, microflora, ripening.*

I. INTRODUCTION

Proper and adequate nutrition is one of the most important factors that determine the health of the population [1]–[4]. One of the main strands in the State Policy of Russia in the area of healthy nutrition is developing high-quality and safe food products [5]. The necessary prerequisites for increasing the production of meat products and improving their quality are improving the efficiency of using raw material resources, reducing the losses, and broadening the range of products [6], [7]. In the poultry processing industry of our country, a wide range of products made of poultry meat has been introduced and produced, but there are virtually no gourmet food products made of poultry meat in the market, particularly, dry-cured products [8], [9].

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This is explained by the complexity of the technological process, and the low stability of the quality characteristics of the products made of poultry meat during production and storage.

The situation in the Russian market requires broader and more diverse range of meat products [10], [11]. Therefore, an important task is providing high-quality products made of poultry meat to the consumer market, and developing the technology.

Dry-cured products take a special place in sausage production [12], [13]. The process is long and labor-consuming. The production process consists in preserving the meat through a combination of brine treatment, fermentation, and drying [14], [15]. During meat maturation, various complicated processes occur, such as physicochemical and biochemical processes, and transformation of the flora, which create the distinctive taste, color, flavor, and texture [16]–[19].

Today, the range of products made of poultry meat includes over 700 positions; however, there are very few dry-cured products made of poultry meat in the stores due to the complexity of poultry meat biomodification. The connective tissue in poultry meat has less strength than in the meat of slaughtered cattle, therefore, it changes during maturation and hydrolysis upon heat treatment much faster. Proteins of poultry meat contain essential amino acids in the quantities close to human needs [20]–[22].

In the technology of producing dry-cured and raw smoked sausages, starter cultures are used for intensifying the process of maturation. A considerable contribution to studying the microflora of raw smoked and dry-cured sausages and the intended use of the microflora has been made by foreign scientists [23]–[26]. The authors have shown the positive effect of the mixture of lactic acid microbes *Ped. cerevisiae* and *Str. lactis*, and of the mixture of *M. aguatilis* and *M. aurantiacus* on forming the taste, the aroma of the sausages, and on shortening the technological process.

Many authors state that during the cultivation of specially selected strains of several microorganisms (streptococci and bacilli), more lactic acid, volatile fatty acids, carbonyl compounds, and other products are formed than during cultivation of each strain separately [27]–[29]. It should be noted that the lactic acid microbes cultivated in brines during multiple passages acquire denitrifying properties [30], [31].

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Positive results in stabilizing the process of sausage ripening, speeding up drying, and forming the aroma and the taste due to the formation of carbonyl compounds and other substances with the use of a starter culture consisting of a mixture of three streptococci – *Str. lactis*, *Str. diacetylactis*, and *Str. Paracitrovorus* – were obtained by Slepkykh. Along with the microflora, the organoleptic properties of the finished product are influenced by sausage smoking and ripening [32]-[34]. The purpose of the study was studying the degree of model poultry meat mince biomodification based on the acidity analysis and the starter microflora development.

II. MATERIALS AND METHODS

Experimental studies were performed at the laboratories of the Department of Technology of Livestock Products Storage and Processing, Department of Biotechnology, Biochemistry, and Biophysics of the Kuban State Agrarian University, Argus Testing Center, and the Agrobiodiversity Scientific Training and Production Complex.

To achieve the main task, the effect of three bacterial starter cultures (PB-MP, Almi 2, and Bactoferm T-SPX) on the functional and technological properties of model mince of separately white (breast) and red (thigh) poultry meat was comparatively studied.

To determine the degree of the effect on the model system of the introduced starter cultures, the authors used the model mince that consisted of white and red chicken meat crushed in a frozen meat cutter with 3 mm mesh diameter. The starter cultures were activated and dosed following the

recommendations of the manufacturers. The mince was placed into the 40 mm diameter beef round. The formed loaves were allowed to settle for five days at 3 ± 1 oC, 87 ± 2 % relative humidity, and 0.1 m/s air speed. After that, the sausage loaves were subjected to drying in the following conditions: during the first day, the temperature was 18 – 20 oC, the humidity was 82 – 83 %, and the air speed was 0.05 – 0.1 m/s; during the second day, the temperature was 16 – 18 oC, the humidity was 75 – 77 %, and the air speed was 0.05 – 0.1 m/s. Starting with the third day, the temperature in the drying chamber was reduced by 1 oC to 12 oC with the humidity of 72 – 75 %, and the air speed of 0.1 m/s. Drying was continued until the moisture content in the sausage loaves reached 40 %.

The pH value was determined on universal ionometer pH-150M according to GOST R 51478-99 [35]. The number of mesophilic aerobic and optionally anaerobic microorganisms was determined according to GOST 10444.15-94 [36]. Mass changes in the raw materials were determined by weighing on a weighing machine, and as the ratio to the weight of the initial raw material in percent. The quantity of lactic acid was analyzed on a Kapel 105-M device.

III. RESULT AND DISCUSSION

At the base of STPC Agrobiotekhpererabotka, the poultry meat mince was developed according to the method stated above. At each stage of the process, the growth of the starter microflora was analyzed. The results are shown in Table 1.

Table 1: Changes in the microflora of the dry-cured sausages

Objects of the study		The quantity of lactic acid microflora in 1 g of the product			
		Reference	Starter cultures		
			Almi 2	PB-MP	T-SPX
Raw meat brine treatment	white meat	<30	–	–	–
	red meat	<30	–	–	–
Mince before settlement	white meat	6.1×10^2	1.5×10^5	1.3×10^4	1.4×10^4
	red meat	5.8×10^2	1.8×10^5	1.1×10^4	1.7×10^4
Mince after settlement	white meat	3.0×10^2	1.0×10^6	4.7×10^4	1.4×10^5
	red meat	4.0×10^3	1.2×10^6	2.4×10^4	6.1×10^4
Drying					
5 days	white meat	1.6×10^4	5.0×10^6	1.1×10^5	5.6×10^5
	red meat	1.6×10^4	5.6×10^6	9.1×10^4	3.2×10^5
10 days	white meat	3.1×10^4	1.6×10^7	1.7×10^5	1.6×10^6
	red meat	2.8×10^4	2.0×10^7	3.2×10^5	2.3×10^6
15 days	white meat	2.8×10^4	4.0×10^7	1.3×10^5	1.5×10^6
	red meat	1.9×10^4	6.3×10^7	2.6×10^5	1.8×10^6
20 days	white meat	1.4×10^4	3.0×10^7	7.9×10^4	6.3×10^5
	red meat	1.4×10^4	5.6×10^7	1.8×10^5	1.2×10^6
25 days	white meat	6.0×10^3	1.4×10^7	5.5×10^4	3.1×10^5
	red meat	7.2×10^3	2.5×10^7	1.1×10^5	5.6×10^5

The obtained data indicate the active development of the lactic acid microflora in the mince with bacterial preparation Almi 2. Throughout the entire process, from the moment of introducing bacterial cultures, the quantity of lactic acid microflora in the mince with preparation Almi 2 was higher by one to two orders, compared to the level of lactic acid microflora in the mince with preparations PB-MP and T-SPX.

Lactic acid microflora spontaneously getting into the mince (in the reference samples) developed slowly, since in the

initial stage (prepared mince), its quantity was 5.8×10^2 – 6.1×10^2 ; its maximum quantity increased to 2.8×10^4 after 10 days of drying. In the subsequent period of drying, a gradual decrease in the number of lactic acid bacteria was noted in the reference samples, and after 25 days of drying, 6.0×10^3 – 7.2×10^3 lactic-acid bacteria were found in 1 g of the mince.

The introduction of starter bacterial cultures allowed increasing the level of lactic acid microflora in the prepared mince by 2 – 3 orders.

In the samples with the Almi, 1.5×10^5 – 1.8×10^5 lactic-acid bacteria in 1 g of prepared mince were found; in the process of settling, the accumulation of lactic acid microflora with Almi 2 starter was more intensive, and the maximum growth of lactic-acid bacteria was noted after 15 days of drying. In the subsequent drying periods, the quantity of lactic-acid bacteria reduced, but not too significantly, and until the end of drying (25 days) remained at the sufficiently high level of 1.4×10^7 – 2.5×10^7 .

From bacterial preparations PB-MP and Bactoferm T-SPX, lactic-acid bacteria developed more intensively in sausage mince with the T-SPX preparation. First, in the initial mince, the quantity of lactic acid bacteria was an order lower than in the mince with the Almi 2 starter. This difference in the level of lactic acid bacteria in the mince was preserved in the subsequent stages of the process, reaching a maximum of 1.5×10^6 – 1.8×10^6 after 15 days of drying. In the subsequent periods of sausage drying, the

number of viable lactic-acid bacteria decreased.

In the mince with bacterial culture PB-MP, the microorganisms developed less intensively than in the mince with the two previously discussed cultures, but the overall development of lactic-acid bacteria in the mince with this starter was similar to the development of that of Almi 2 and T-SPX, but at a lower quantitative level.

The more intensive growth of the lactic acid microflora in the mice with preparation Almi 2, compared to cultures PB-MP and T-SPX, may be explained by greater adaptability of the microorganisms in the Almi 2 starter to the meat medium, good synergism, and the ability to decompose the glycogen remaining after glycolysis.

Due to the peculiarities of autolysis in white and red muscles of broiler chickens, the breakdown of glycogen was more intensive in the chest (white) muscles than in the thigh muscles (red muscles) with the appropriate formation of lactic acid and different decrease in pH [33].

The initial raw material that consisted of red and white muscles had different content of lactic acid (Fig. 1 and 2).

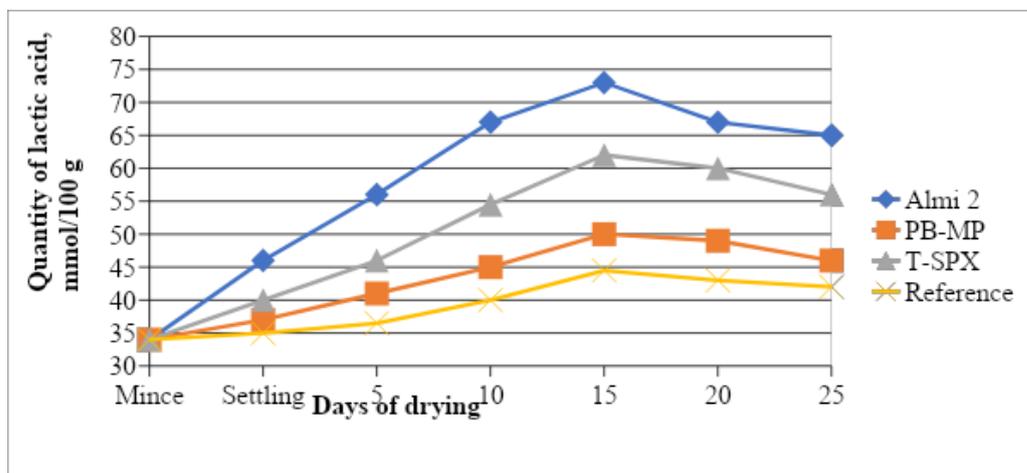


Fig. 1: Changes in the content of lactic acid in the mince of white meat

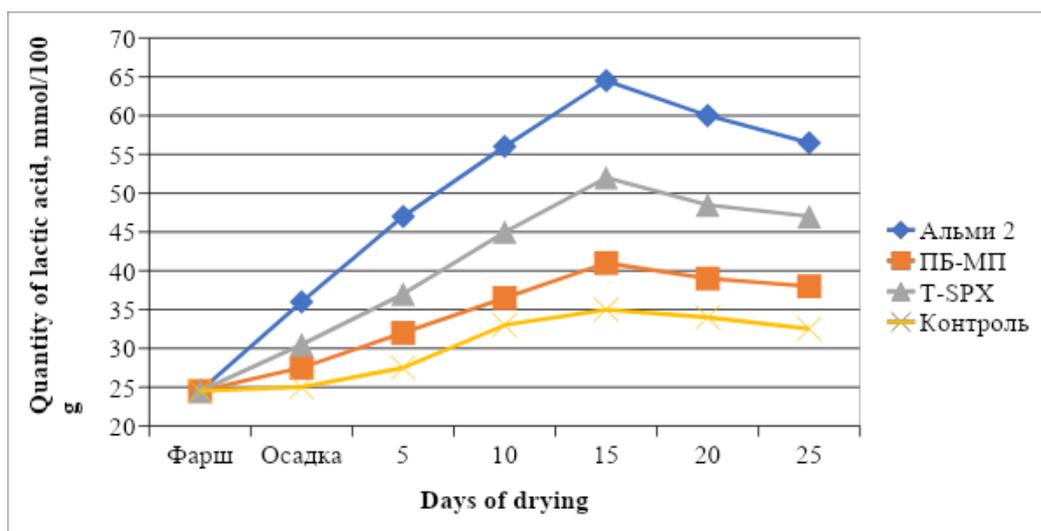


Fig. 2: Changes in the content of lactic acid in the mince of red meat

A higher level of lactic acid was characteristic of white (breast) muscles, resulting in a lower pH in these muscles. As a result of lactic microflora activity, lactic acid was produced.

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The most intensively lactic acid is formed as a result of the activity of the lactic microflora in the samples of mince with preparation Almi 2. In the process of settling, the content of lactic acid with preparation Almi 2 in the mince increased 1.3 – 1.5 times, with preparation T-SPX – 1.2 – 1.22 times. A small increase in the content of lactic acid after settling was noted in the reference sample and preparation PB-MP. In the process of drying up to 15 days, an increased content of lactic acid was noted in all samples. The greatest quantity of lactic acid by 15 days of drying was noted in the samples with preparation Almi 2, where the content of lactic acid, compared to the initial level, increased 2.25 times for the samples of white meat, and 2.65 times – for the samples of red meat.

In the sausages with preparation T-SPX by 15 days of drying, the content of lactic acid increased 1.62 times in the samples of white meat, and 1.9 times – in the samples of red meat. In the samples with preparation PB-MP, the content of lactic acid by this period increased 1.33 and 1.54 times, respectively. In the reference sample, an increase in the content of lactic acid was also noted, but to a much lesser extent. Based on these data, a higher acid-forming ability of the lactic microflora in preparation Almi 2 should be noted. Changes in the content of lactic acid in the production process of dry-cured sausages made of the meat of broiler chickens also determined the dynamics of active acidity (pH) changes (Fig. 3 and 4).

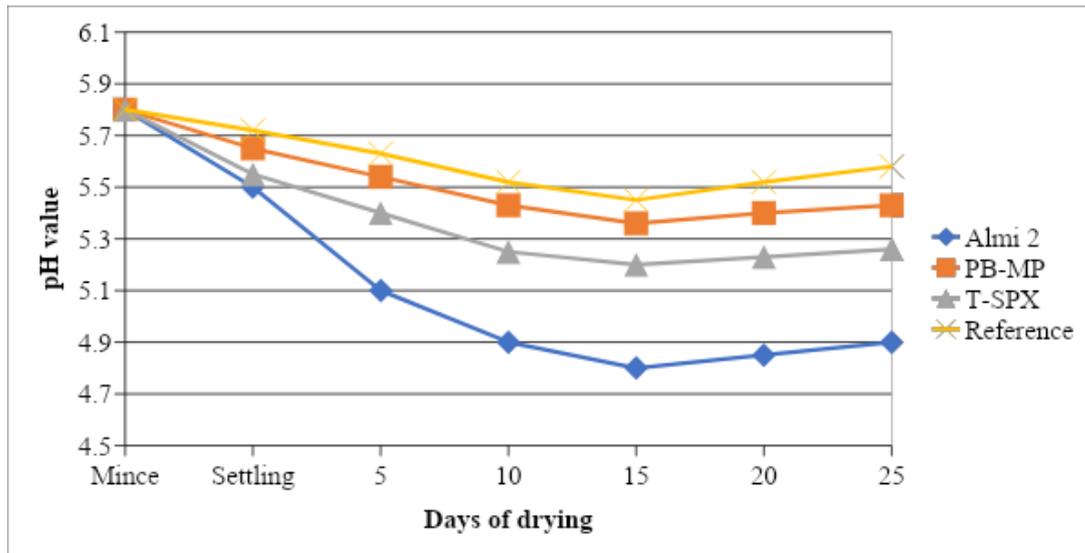


Fig. 3: Changes in the pH level of the sausages made of white meat

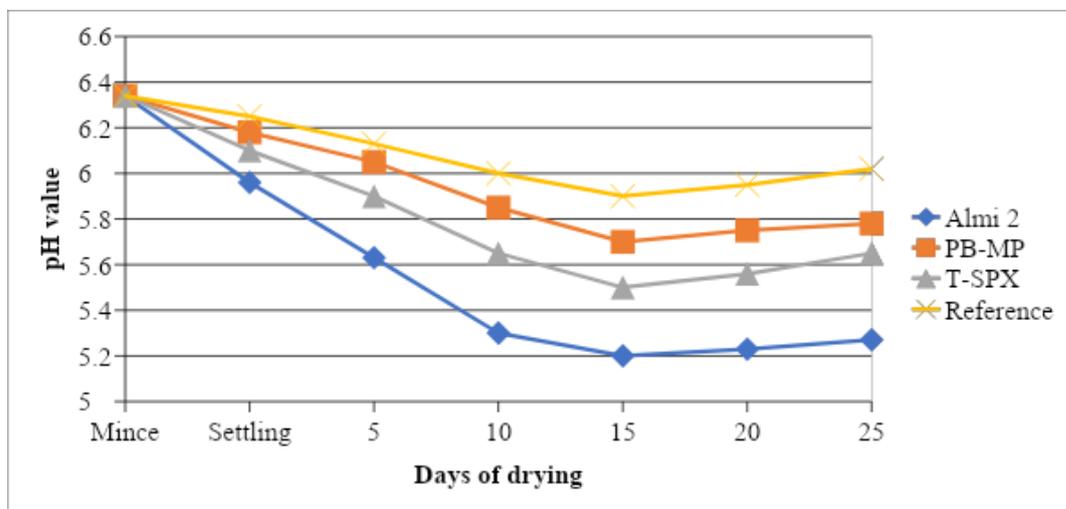


Fig. 4: Changes in the pH level of the sausages made of red meat

Different values of both lactic acid content and different pH values should be noted both in white (breast) muscles and in the red muscles (thigh muscles) at the initial stage. These differences were preserved in the samples of white and red meat throughout the entire technological process of producing dry-cured sausages. The most dynamic changes in the pH values were observed in the mince of sausages with bacterial preparation Almi 2. The pH values in the mince with this preparation reduced from 5.8 in the mince prepared from white meat, and from 6.34 in the mince prepared from red meat during the period of settling and

drying by 15 days, reaching the values of pH = 4.65 for the mince made from white meat and pH = 5.12 for the mince made from red meat.

By 20 days of drying, a slight increase in pH to 4.85 was observed in the mince of sausages made of white meat, and to 5.23 in the mince made of red meat, and an increase in pH values was noted after 20 days to 4.90 and of 5.27, respectively.

The intensity of changes in the pH values in the mince with bacterial preparation T-SPX was somewhat lower than those with preparation Almi 2. For instance, by 15 days of drying, the pH values in the mince made of white meat reached 5.2, and in the mince made of red meat – 5.50; in the mince of the sausages with bacterial preparation PB-MP, the pH values after 15 days of drying were high, and reached 5.36 in the mince made of white meat, and 5.7 – in the mince made of red meat. The tendency to increasing pH values in the mince with bacterial preparations PB-MP and T-SPX with further drying was also preserved. In the sausage mince made of white meat, after 25 days of drying, the pH values in the mince with starter culture T-SPX reached 5.26; in the mince made of red meat – 5.65. At the same time, in the mince made of white meat with bacterial preparation PB-MP, the pH values reached 5.43 and 5.78, respectively. In the sausage mince without starter bacterial cultures, similar dynamics of pH were observed, but only at higher pH values.

By 15 days of drying, in the mince made of white meat without bacterial cultures, the pH value reached 5.45, in the mince made of red meat – 5.90. With further drying, an increase in the pH values was observed in the mince made of white and red meat. For instance, by 25 days of drying, in the mince made of white meat, it reached 6.02.

IV. CONCLUSION

As a result of the studies, it has been found that starter culture Almi 2 ensures the more intensive formation of lactic acid and therefore leads to greater decrease in the pH values. Bacterial preparations PB-MP and T-SPX were inferior by these values to starting culture Almi 2. By the activity of lactic acid production and pH changes, starter culture T-SPX was in the second place, PB-MP – in the third place. In the reference sample of the sausages without starter cultures, the formation of lactic acid was less active, and therefore pH was at a higher level than in the mince in the sausages with starter cultures. Lower pH values in the mince made of white meat should also predetermine faster drying of the sausages made of white meat, since the pH values to a greater extent approach the isoelectric point of muscle proteins.

The main role in reducing the pH values is played by the formation of lactic acid due to the activity of the lactic microflora, but the pH values are influenced by the proteolysis processes in the mince, which result in the accumulation of low-molecular compounds that have alkali nature.

As a result of the studies, significant benefits of using starter culture Almi 2, compared to the cultures supplied by PB-MP and T-SPX, have been found in the growth rate of lactic acid bacteria and in the lactic acid production, lower pH values, formation of aroma and the taste, the structure, and the color of sausage meat.

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