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Production of Raw Smoked Beef Products Using Lactobacilli

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Abstract

This article presents the results of a study on the use of fermented milk microorganisms *Lactobacillus curvatus* (strain BSC002), *Lactobacillus sakei* (strain BSC030) and *Lactobacillus fermentum* (BSC010) in the production of raw smoked beef products from calves of Kalmyk cattle who were 24 months old. It was shown that the use of lactocultures allowed intensifying the biochemical processes that occur during salting and ripening of the meat. The findings indicated a positive effect of lactic acid microflora on the process of formation of taste, aroma and colour of the meat products. Changing the pH of the product showed that the use of lactobacilli would help to reduce the salting process; the prototype had an elastic and stable consistency on the sixth day compared with the control sample, which reached the corresponding characteristics only on the 10th day. The optimal volume of lactobacilli in beef from a technological point of view was 5% by weight of raw materials. Such a volume had a positive effect on increasing the moisture-binding capacity of meat by 3.3%, which allowed the yield of the product to increase by 6.7%. The introduction of lactobacilli in beef improved the appearance and juiciness of the finished product, and enhanced the tenderness, which allowed this product to be sold at a higher price and accordingly increased the profitability of its production by 17.6%. Production technology for uncooked smoked meat products of the highest category “Holiday Beef” were developed.

Keywords: lactobacilli in meat products, raw smoked beef, ripening beef, starter crops.

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1. Introduction

Raw smoked beef products are a delicatessen product and occupy a significant market share in meat products. At the moment, an integral component in the technology of their production is increasing the starter cultures use, in the structure of which lactobacilli are significant [1]. Starter cultures have high functional activity. They intensify the technological process, accelerate the ripening, salting, heat treatment of meat.

Moreover, products using lactic acid microflora have high consumer characteristics, excellent presentation and lower cost in comparison with products of traditional production technologies [2]. Lactobacilli are known to be normal microflora of the human gastrointestinal tract, for example, strains of lactobacilli such as L. Gastricus, L. kalixensis, L. ultunensis and others were found in the stomach of healthy people [3]. In the colon, they are represented by the species: Lactobacillus casei, Lactobacillus plantarum, Lactobacillus salivarius, and others [4]. These microorganisms play an essential role, they stimulate the regeneration of the mucous membrane of the gastrointestinal tract, activate phagocytosis, the synthesis of lysozyme, interferons and cytokines, produce several hydrolytic enzymes, in particular, lactose, which breaks down lactose [5]. Thanks to lactobacilli, the acidity of the colon is constantly maintained at 5.5–5.6 pH [6]. Due to their proteolytic activity, lactobacilli form collagenases and elastases, they increase the tenderness of meat raw materials with a high content of connective tissue proteins causing swelling of collagen and, thus, contribute to loosening of the tissue and hydrolysis of low molecular weight bonds. By reducing the reaction of the medium, they increase the activity of intracellular cathepsin enzymes [7]. The use of lactobacilli in the technology of meat products allows creating products of practical orientation, for the correction of various deviations in the functioning of the human gastrointestinal tract [8]. Studying the issue of improving the technology for the production of raw smoked beef products using lactobacilli is an urgent task of science and practice.

2. Methods and Equipment

The work aimed to develop the technology of raw smoked meat products from beef using lactobacilli. For this goal, the following tasks were set:

- determination of the list of crops and their volume for inclusion in raw meat;

- establishing the nature of the influence of lactobacilli on the physicochemical, microbiological and organoleptic characteristics of the meat product;

- assessment of the economic effect of the use of lactic microorganisms in the technology of raw smoked beef.

The studies were conducted in the laboratories of the Don State Agrarian University. The following cultures were selected for the studies: Lactobacillus curvatus (strain BSC002), Lactobacillus sakei (strain BSC030) and Lactobacillus fermentum (BSC010) in capsules of 3 billion CFU. Using these cultures, samples of uncooked meat product “Holiday Beef” were produced from the hip cut of a beef carcass of a Kalmyk bull killed at the age of 24 months using lactocultures in the recipe. Among the many

other lactobacilli, the above bacterial cultures most actively show their acid-forming properties in the production of raw smoked meat products [9-12]. Below is a diagram of the experiment (Fig. 1).

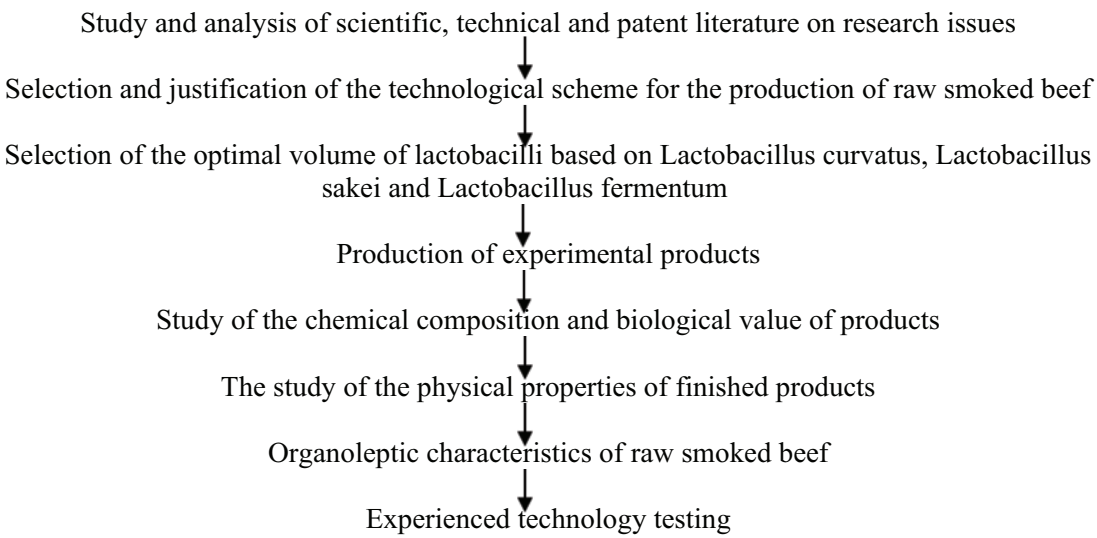

Figure 1: Scheme of experience.

The starting mixture of lactobacilli was as follows: the bacterial strains Lactobacillus curvatus (strain BSC002), Lactobacillus sakei (strain BSC030) and Lactobacillus fermentum (BSC010) were dissolved in water at a ratio of 1: 2.5 with a temperature of 20 ° C and added one part was kept and dextrose, mixed 30 minutes. After that, the starting mixture of lactobacilli was made as part of a syringe brine, which contained 3% salt, 0.025% sodium nitrite and 1% sugar into the portion of the hip cut of the beef carcass in a volume of 2.5, 5, and 7.5% by weight of the raw material. The control was a sample without the use of lactobacilli.

Product development was carried out according to the scheme below (Fig. 2).

3. Results

It was found that with the introduction of lactobacilli into experimental samples in an amount of 7.5% compared with a volume of 5%, significant changes in their growth were not observed. At the same time, their number was an order of magnitude higher in contrast to the third sample, in which the volume of lactobacilli was 2.5% by weight of the raw material. We came to the conclusion that the optimal volume of Lactobacillus curvatus lactic cultures introduction (strain BSC002), Lactobacillus sakei (strain BSC030) and Lactobacillus fermentum (BSC010) from a technological point of view is 5% of the mass of raw materials (Table 1).

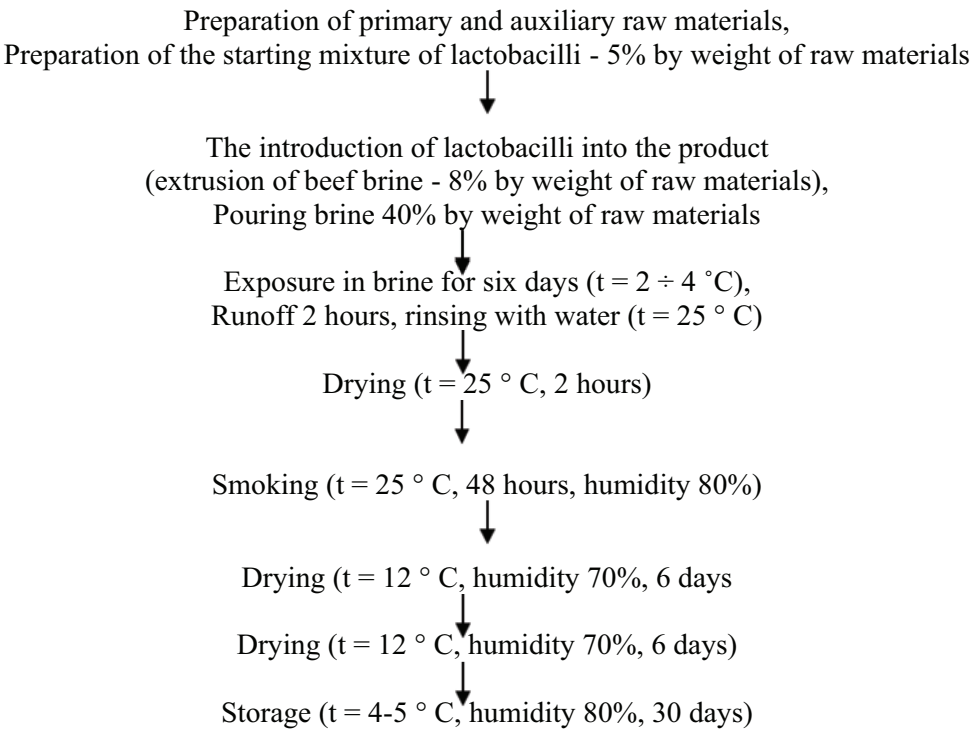

Figure 2: Flow chart for the production of raw smoked beef with Lacto cultures.

TABLE 1: Growth in the number of microorganisms in the process of salting raw materials.

The volume of lactobacilli introduced into the cut,% to the mass of raw materials	The number of cells on the 6th day of salting of raw materials, CFU / g		
	Lactobacillus curvatus	Lactobacillus sakei	Lactobacillus fermentum
7.5	$5.1*10^6$	$4.7*10^5$	$7.4*10^6$
5	$4.9*10^7$	$4.5*10^6$	$7.2*10^7$
2.5	$2.9*10^7$	$2.5*10^6$	$3.1*10^7$

Thus, increasing the volume of introduced lactobacilli, we noted a constant growth of the studied cultures, differences in growth were observed only between them - Lactobacillus curvatus (strain BSC002), Lactobacillus sakei (strain BSC030) and Lactobacillus enzyme. These data were explained by the nature of their life and genetic features [13].

As the results of studies of the physical properties of the developed meat products show, the introduction of lactic acid microorganisms in an amount of 5% by weight of raw materials makes it possible to increase the yield of raw smoked beef by 6.7% (Table 2).

At all stages of the technology of production of raw smoked beef in the control and experimental samples, a decrease in pH was observed. At the same time, the acidity of the test sample was the smallest by the sixth day, while the control sample reached

this value on the 10th day. It follows that the use of Lacto cultures helps to reduce the process of salting and ripening of beef. It was also found that the prototype had a more elastic and stable consistency by the sixth day compared with the control sample, which reached the corresponding characteristics only on the 10th day. An increase in the moisture content was also detected in the prototype, and this indicates that lactobacilli positively affect the increase in the moisture-binding ability of raw meat - by 3.3% (Table 3).

Table 2: Physical Indicators of Raw Smoked Beef.

Indicators	"Holiday beef"	"Holiday beef" with the addition of bacterial starter culture 5% by weight of raw materials
Mass fraction in finished products,%		
Table salt	3.1±0.31	3.0±0.35
Acid number, mgKOH / g	1.03±0.25	1.08±0.34
Yield,%, to the mass of unsalted raw materials	79.8	86.5

Table 3: Studies of the chemical composition and biological value of raw smoked beef.

Indicators,%	"Holiday beef"	"Holiday beef" with the addition of bacterial starter culture 5% by weight of raw materials
Mass fraction of moisture	59.9±3.35	63.2±4.22
Mass fraction of protein	18.6±1.48	17.1±1.11
Mass fraction of fat	18.3±1.21	16.6±1.32
Mass fraction of ash	3.2±0.15	3.1±0.16
Moisture retention	65.8±2.36	71.3±2.11
pH, units	6.0±0.35	5.7±0.25

During the storage of raw smoked beef, it was found that the prototype, by the 30 days of storage, was inferior to the control 1 g of the product by $0.2x10^2$ CFU / g in terms of the number of mesophilic aerobic and facultative anaerobic microorganisms, which proves the promise of using lactic microorganisms in the production of raw smoked meat products [14] (Table 4).

We use of lactobacilli contributed to the formation of high organoleptic characteristics. More intense staining and pronounced aroma were observed in uncooked smoked beef made using lactic acid microorganisms. The prototype exceeded the average score by a score of 1.5 over the control.

Calculations of economic efficiency prove the effectiveness of the use of lactobacilli in the production of smoked beef (Table 5).

Thus, the introduction of lactobacilli based on cultures of Lactobacillus curvatus (strain BSC002), Lactobacillus sakei (strain BSC030) and Lactobacillus fermentum (BSC010) in an amount of 5% by weight of raw materials, allows increasing the yield of raw smoked beef by 6.3%, improve the appearance, juiciness and taste that allows selling this product at a higher price and accordingly increase the profitability of its production by 17.6%.

4. Discussion

There is information that the main technological properties of lactic acid microorganisms include: fermentation of carbohydrates with the formation of lactic acid, reduced ripening time, increased yield of the finished product and extended shelf life, denitrification, salt tolerance, resistance to sanitary microflora, the synthesis of microbial origin preservatives; proteolysis and the formation of flavour compounds [15-21]. These statements were fully confirmed by the presented study based on the results of physicochemical, physical, microbiological and organoleptic indicators of production. The question can only be in the choice of certain strains of cultures for use in the target bacterial sourdough. In this case, the choice should be based on the nature and type of raw material for which Lacto cultures will be used.

Table 4: Microbiological parameters of raw smoked beef.

Product sample	Shelf life	Amount of mesophilic aerobic and facultative anaerobic microorganisms, CFU / g	Product mass (g), in which			
			Bacteria of the group of Escherichia coli Sulfite-reducing clostridia	Staphylococcus aureus	Staphylococcus aureus	Pathogenic microorganisms, including Salmonella
Control	10 days and	0.3 x 10^2	no	no	no	no
	30 days	0.5 x 10^2	no	no	no	no
Experience	10 days and	0.2 x 10^2	no	no	no	no
	30 days	0.3 x 10^2	no	no	no	no

Table 5: Calculation of the economic efficiency of production of raw smoked beef at prices of 2020

Current costs of production, the effectiveness	"Holiday beef"	"Holiday beef" with the addition of bacterial starter culture 5% by weight of raw materials
The total cost of 1 kg, USD	8.35	7.28
Sale price 1 kg, USD	10.0	10.0
Profit per 1 kg, USD	1.65	2.72
Profitability,%	19.7	37.3

5. Conclusion

As a result of the studies, the feasibility of using the lactobacillus microorganisms Lactobacillus curvatus (strain BSC002), Lactobacillus sakei (strain BSC030) and Lactobacillus fermentum (BSC010) in the technology of raw smoked meat products from beef is substantiated. We recommend wider use of starter cultures based on lactobacilli for enterprises seeking to increase the profitability of production and intensify the technological process of production of smoked meat products while maintaining a high level of product quality.

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Conflict of Interest

The authors have no conflict of interest to declare.

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