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Effects of the Marinating Process on the Quality of the Domesticated Reindeer (Rangifer Tarandus) By-products

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Abstract

The development of methods for the complete and complex processing of raw food materials is one of the main ways to achieve the efficiency of its use: reduce production costs, expand products range and increase products demand. Over the last years, growing attention is paid to the search and development of new technologies of the processing of non-traditional and underutilized types of food materials, such as meat and by-products from alternative animal species. The research was aimed at studying the influence of the marinating process on the quality of the newly developed food product. The object of research was the tongue of domesticated reindeer, the underutilized raw materials of the Kola Peninsula. Product samples were taken in 2012-2016 on the basis of the agricultural production cooperative "Tundra", research was carried out on the basis of the Department of Food Production Technologies of the Federal State Budgetary Educational Institution of Higher Education "Murmansk State Technical University". The effects of marinating and duration of heat treatment on the quality of the product samples was studied. The parameters characterizing the generalized indicator of quality were selected - organoleptic (appearance, flavor and taste), physical (cutting force) and microbiological. The optimal composition of the marinade is proposed. The technology of culinary processing of the domesticated reindeer tongue was optimized.

Keywords: reindeer by-products, marinating, technology optimization

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1. Introduction

According to climatic conditions criteria more than 10 million km^2 of Russian Federation can be classified as territories of the Far North and equivalent territories, which makes up more than 64% of the total area of the country [1, 2]. Poor transport accessibility and extreme conditions impose restrictions on the development of these regions [3].

The concept of food security in these regions is based on a combination of the development of agricultural and commercial production, as well as on the products import.

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The developement of traditional industries (reindeer husbandry, fishing, hunting) can increase output, reduce transportation costs, retain employment among the indigenous peoples of the Northern regions. For which these industries are vital. In this regard, the problem of usage of the new types of raw food materials of animal origin as sources of valuable nutrients is of particular relevance. One of these sources is the by-products of domesticated reindeers [3--6].

The weight of reindeer by-products varies from 20 to 23% of the live weight of the animal. Next by-products are obtained from reindeers: liver, heart, kidneys, tongue, blood, stomach, intestines, etc. Almost all of the by-products have a high nutritional value, but especially the liver, heart, kidneys, tongue and brain [7, 8].

Some people prefer not to include meat and by-products from wild animals in their diet, due to the fact that they have a specific flavor and taste. That also applies to reindeer meat and by-products. The selection of optimal processing conditions for creating a soft consistency in combination with a decrease in the intensity of the specific aroma and taste of the by-products can significantly increase their popularity. It is known that the marination with organic acids and spices improves the organoleptic characteristics of processed raw products [9--14].

In the course of this work, the effect of the marination with different amounts of apple vinegar and the duration of heat treatment on the organoleptic and rheological parameters of the deer tongue was studied.

2. Methods and Equipment

2.1. Cutting force

Determination of the structural and mechanical characteristics of the studied object were carried out on a gelometer "Food checker" R-1180, a complex of testing device and measuring device, equipped with a recording device (recorder). The principle of operation of the device is based on the determination of the magnitude of the load applied to the product sample [15].

Parameter ``cutting force" evaluates the quality of the structure of the product depending on the force (g) required to cut the product of a given cross section.

To prepare the samples the boiled tongue was cut into pieces as follows: the tongue (having a conditionally cylindrical shape) was cut across into three parts, the root of the tongue and the front third (the tip of the tongue) were removed. The middle part of the tongue was cut across into pieces of 15 mm wide. From the obtained pieces central part with a width of 15 mm were cut. Thus, the shape of the standard samples was close to the box with a length equal to the diameter of the tongue, width and height of 15 mm.

A sample of the product was placed on the working table of the device so that the center of the sample was under the cutting organ, and the structural fibers were perpendicular to it. The load on the working body was applied until the product was cut to a predetermined depth, after which the maximum readings were taken on the scale of the device or on the peak on the chart paper of the recorder.

As a cutting instrument, the interchangeable nozzle in the form of a knife was used; the cutting depth was set to 10 mm.

2.2. Sensory parameters

The assessment of organoleptic characteristics was carried out on samples that underwent heat treatment. The duration of the heat treatment was set in accordance with the experimental design. The temperature of the heat treatment was 98 ± 2 °C. The following indicators were evaluated: appearance, aroma and color. The assessment was made by a commission consisting of 10 people, members of the university department. The evaluation was carried out on a five-point scale. All samples were assigned identification numbers to uniquely identify each anonymized sample.

2.3. Microbiological parameters

To determine the safety level of the cooked product, as well as the semi-finished product, the microflora of the samples were studied: the number of mesophilic aerobic and facultative anaerobic microorganisms (MAFAM); colibacillus bacteria; Staphylococcus aureus (S. aureus); pathogens, including Salmonella, Proteus and L. monocytogenes presence. The determination was carried out according to standard methods.

2.4. Mathematical processing of the results

The search of the optimal conditions for the process under study was carried out by constructing a mathematical model with subsequent analysis. Preliminarily, optimization criterion (Y) and factors (X1, X2) that have a significant impact on the course of the processes were selected. The study of the response function began with the formulation of a series of experiments that made it possible to determine the region of the optimum. The response surface in this region was approximated by the regression equation.

The construction of experiment plan began with the selection of points of a full-factor experiment (PFE). The required number of PFE points (N_1), were determined by the formula (1):

$$N_1 = 2^k, \tag{1}$$

where 2 - the number of levels of variation of factors; k - the number of factors.

The required number of «star» points (N2) was determined by the formula (2):

$$N_2 = 2 \cdot k. \tag{2}$$

The location of the «star» points relative to the center of the experiment was determined by the magnitude of the "star" shoulder, which was calculated by the formula (3):

$$a = 2^{k/4}. \tag{3}$$

The verification of the obtained mathematical model adequacy was assessed using the Fisher test (F-test). The generalized characteristic of the object quality (Y_g) was calculated with formula (4):

$$Y_g = \frac{\sum B_1 \cdot SF_1}{\sum B_{max} \cdot SF_1} \cdot 100, \tag{4}$$

where B_1 - the average score of a single parameter; SF - significance coefficient.

The surface of the response function is graphically presented on Figure 1.

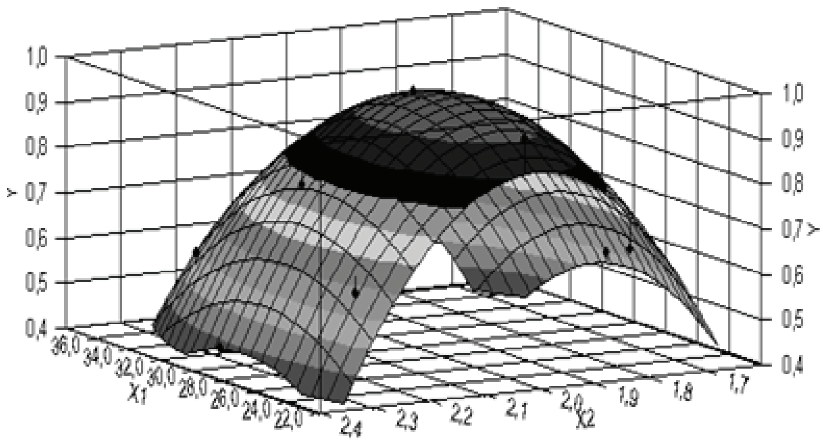

Figure 1: Surface of the response function.

The results were mathematically processed using the Datafit 9.0 computer program. Statistical processing of the results was carried out by nonlinear regression.

3. Results

Table 1: Experiment planning matrix.

X_1, g	X_2, h	Y_1	Y_2, kg	Y_g
Two-factor experiment				
25	1,75	0.69	0.2167	0.64
35	1,75	0.61	0.1933	0.66
25	2,25	0.47	0.1633	0.61
35	2,25	0.48	0.1533	0.58
«Star» points				
23	2,00	0.87	0.1717	0.94
37	2,00	0.54	0.1667	0.67
30	1,65	0.77	0.2650	0.56
30	2,35	0.37	0.1500	0.44
Central points				
30	2,0	0.94	0.1708	0.96
30	2,0	0.94	0.1708	0.96
30	2,0	0.94	0.1708	0.96

To determine the optimal parameters of the tongue marinating process and the duration of the heat treatment, a two-factor experiment plan was developed.

The response function was a generalized numerical characteristic of the quality of the product (Y_g) that included the level of quality of the finished product (Y_1) in fractions of a unit and the maximum cutting force (Y_2) in kilograms. Variable factors were the mass of apple vinegar for marination (X_1) in grams and the thermal treatment (X_2) in hours.

Factors fixed at a constant level: the mass of raw product is 127 g, the temperature during the marination is 4 ± 2 °C, the duration of marination.

As central values X_1 = 30 g of 3 % apple vinegar, X_2 = 2 hours were taken. Influencing factor X_1 ranged from 23 to 37 in increments of 5 g. Influencing factor X_2 ranged from 1.65 to 2.35 hours in increments of 0.25 hour. The obtained changes in influencing factors can be written as follows: X_1 (23; 25; 30; 35: 37), X_2 (1.65; 1.75; 2; 2.25; 2.35).

The experiment planning matrix is presented in table 1.

The implementation of the experimental design and processing of the obtained data allowed obtaining the following regression equation (5), which adequately describes the effect of the changes in the amount of apple vinegar and the duration of heat treatment on the generalized numerical quality characteristic:

$$Y = a + b \cdot X_1 + c \cdot {X_1}^2 + d \cdot X_2 + e \cdot {X_2}^2. \quad (5)$$

With an average probability of 95%, the following coefficients of this equation were obtained: a = -16.98; b = 0.19; c = -0.00342; d = 15.29; e = -3.86. Fisher's criterion was 10.93.

Substituted these values into the regression equation, we obtained the following dependence (6):

$$Y = -16,98 + 0,19 \cdot X_1 - 0,0342 \cdot {X_1}^2 + 15,29 \cdot X_2 - 3,86 \cdot {X_2}^2. \quad (6)$$

As a result of microbiological research of samples that underwent heat treatment, the dynamics of the number of microorganisms was revealed during storage for 48 hours at a temperature of 4 ± 2 °C. The MAFAM indicator of the product did not exceed the established standards for two days of storage and on the third day of storage did not exceed 7.5×10^3 CFU / g. Bacteria of the Escherichia coli group (BCC), Staphylococcus aureus (S. aureus), pathogens, including Salmonella, Proteus and L. monocytogenes, were not detected.

4. Discussion

Differentiating the resulting equation (6) and analysis of the response surface of the function shown on Figure 1 allows concluding that the extremum point is located at the intersection of the X_1 axis with coordinate 27.7 and X_2 axis with the coordinate 1.98, that is, to obtain the test product with optimal physicochemical and organoleptic characteristics, it is necessary to introduce 27.7 g of apple vinegar and threat the product for 1.98 hours.

Profilograms for a sample of a selected central point and a sample with optimal values of X_1 and X_2 are presented in Figure 2 and Figure 3.

Sample with optimal values of X_1 and X_2 has higher organoleptic characteristics compared to the sample with central values of X_1 and X_2 parameters. The sample with central values had a slight taste of vinegar; therefore, the sample with optimal values had a higher taste score. In both samples, the consistency was tender, dense, moderately elastic, but the sample with optimal values had a higher consistency score, since the content of apple vinegar in it was lower, therefore its consistency was denser. The appearance of both samples was close and both of them got the highest score.

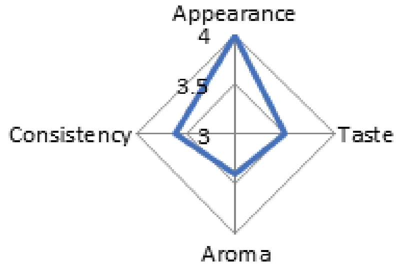

Figure 2: Quality profile of product in central point.

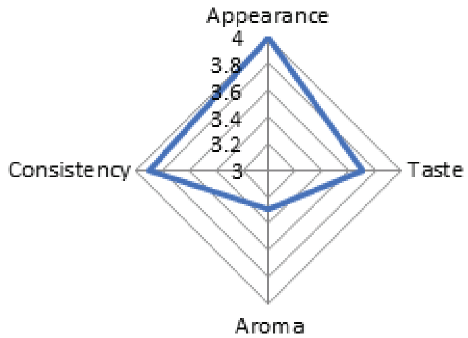

Figure 3: Quality profile of product in optimum point.

5. Conclusion

In the course of this work, by setting up an experiment, the data necessary to clarify the optimal technological conditions for marinating deer tongue (the content of vinegar in the marinade and the heat treatment time) were obtained.

As a result of the study conducted using the gelometer and mathematical processing of the results, we determined the dependence of the generalized quality characteristics of pickled deer tongue on the amount of apple vinegar and the heat treatment time. Based on the data obtained, the following parameters can be recommended: the amount of apple vinegar - 27.7 g and the duration of the heat treatment - 1.98 hours. At these values, the semi-finished product had a soft consistency, a moderate aroma of spices; vinegar gave the tongue a slightly tangible sour taste, while the specific aroma inherent to wild animals was absent.

With microbiological analysis, we also determined the dynamics of the number of microorganisms in the finished product. The cooked product corresponded to the requirements of regulatory documents for two days of storage and on the third day of storage, the MAFAM indicator of the finished dish did not exceed the established standards [13, 16].

The choice of the method of heat treatment of the tongue and the selection of the ingredients of the marinade helped to slow down the growth of microorganisms.

It should also be noted that the graphical model of the experiment does not fully reflect the dependence of the numerical characteristic. It is recommended to continue research in this area and conduct experiments, expanding the range of variation of the parameters.

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Conflict of Interest

The authors have no conflict of interest to declare.

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