The technology of meat snacks using CO2 spice extracts in their formulations

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Abstract. In this research work, the technology for meat snacks with increased antioxidant activity has been developed due to the use of CO2-extracts of dry spices of the same name in their formulations. The authors have determined the physicochemical parameters of CO2-extracts; in particular, the ether and acid numbers, refractive indices, density, solubility. Dry matter content have been determined. Applying computer modeling, formulations of meat snacks (thins) with high antioxidant activity have been developed, which amounted to 425 for CO2-extract of basil; 483 - for CO2-extract of coriander; 435, 420, 430 - for CO2-extracts of marjoram, black allspice, and paprika, respectively. The work also defines the conditions for the sorption on edible salt affected by CO2-extracts for the purpose of using in meat thins technology.

1. Introduction

Currently, in the Russian Federation, as well as throughout the world, diseases of the cardiovascular system are the most common and fatal. At the same time, regardless of the changes taking place in society, the main indicator of the well-being of any country is the state of health of its population. In these conditions, the problems of human health, the prevention of morbidity, the protection and promotion of public health, the improvement of the environment are of particular relevance [1].

Heart disease claims more than 17 million lives every year. Heart problems are increasingly evident at a young age. The main reasons for them are genetic predisposition and an unhealthy lifestyle. Doctors, and not without reason, blame the patients themselves for everything: smoking, large amounts of fatty food in the diet and, conversely, insufficient intake of vegetables and fruits. Excess weight and physical inertia are risk factors that aggravate the problem. The most important thing in the prevention of diseases of the heart and blood vessels is proper nutrition. Only a growing body needs fatty foods that contain cholesterol. After 30 years, these unnecessary substances are deposited in the vessels.

According to the general principles of rational nutrition, the proportion of all fats in the total energy value of food should be 30 percent or less. The proportion of animal fats should be no more than 1/3 of the total amount of fat consumed, limiting the daily intake of cholesterol less than 300 mg, increased consumption of mono- and polyunsaturated fats (vegetable origin) and sea fish. There should be an increased intake of carbohydrates found in fresh fruits, cereals and vegetables; for hypertensive patients and overweight persons - additionally reduce the intake of salt to 5 g or less per
day; limit alcohol intake. For people with excessive weight there must be restriction of calorie intake. Also, an important role is played by non-observance of technological regimes for the production of food of animal origin (freezing, numerous processing).

One of the most important foods in human nutrition is meat and meat products, in the assortment of which dried and dry-cured are distinguished. Cured meat has been known since ancient Egypt - it is the most nutritious meat product prepared by drying. The drying process helps to remove moisture, stabilize quality and thereby increase the shelf life of the product without special temperature conditions (cooling, freezing). Drying is the most well-known and widespread method of preserving food products, which is simple and affordable, while maintaining the entire nutritional value of food products, in particular meat.

2. Materials and methods
The following products were selected as the objects for this research: beef meeting the requirements of GOST 33818-2016 “High-quality beef”, pork meeting the requirements of GOST 31476-2012 “Pigs for slaughter. Pork in carcasses and semi-carcasses”, CO2-extracts of allspice, paprika, basil, marjoram, coriander meeting the requirements of TU 9169-001-10140736-03. The determination of the total chemical composition of meat products was carried out according to generally accepted methods. Determination of the mass fraction of protein is carried out by the Kjeldahl method according to GOST 25011-2017; determination of the mass fraction of fat - by the Soxhlet method in accordance with GOST 23042-2015; determination of the mass fraction of total ash in accordance with GOST 31727-2012 (ISO 936: 1998). The main physical and chemical indicators were determined according to the methods of GOST 14618.7-78. “Volat ile oils, aromatic substances, and intermediates of their synthesis. Methods for the determination of acids, acid anhydrides, and ethers”. Amino acid composition is defined in accordance with GOST 34132-2017 - on an automatic amino acid analyzer AAA 400 according to the attached instructions by the method of classical ion exchange chromatography. Organoleptic assessment was performed according to GOST 9959-2015. The biological value of proteins was determined by the calculation method according to the recommendations of Academician N.N. Lipatov using the Biocen software. Moisture-binding and water-holding capacities of semi-finished and finished products were determined by the method of G. Grau and R. Hamm.

3. Results
One of the most important factors determining the health of the population is healthy nutrition. It provides a connection between the external and internal environment of the body, the normal life of children and adults, helps prevent various diseases, and prolongs life. Food products are a whole complex of substances, which include amino acids, fatty acids, carbohydrates, mineral compounds, etc. that perform certain functions in the human body. As ever before, meat and meat products occupy a significant place in the structure of people's diets. The purpose of this scientific work is to study the possibility of using CO2-extracts in the technology of meat snack production [2].

CO2-extracts contain a lot of preservatives and antioxidants that increase the shelf life of any product [3]. They have the richest component composition: organic acids, fat-soluble vitamins, and provitamins (A, D, E, K, F), fats, including polyunsaturated fats, sterols and sterols, plant hormones, flavonoids, volatile oils and many other substances. Extracts obtained from spicy aromatic plant raw materials are successfully used as food flavorings. In terms of taste and aroma, the quality of most extraction oils is rated higher than the quality of steam-distilled essential oils. This is due to the fact that the composition of the extraction oils includes natural fixatives, flavoring and many other substances that are not found in steam distilled oils or are contained in insignificant quantities. Their use in industry makes it possible to obtain food products of higher quality [4, 5].

The development and unification of methods for the study of spicy-aromatic substances are one of the prerequisites and implementation of the most important problem - improving the quality. Therefore, the accumulation of information related to spicy-aromatic raw materials and their
transformations is very important. The main physicochemical indicators of CO₂-extracts of spices include acid and ether numbers, which were analyzed (Table 1).

Table 1. Some physicochemical indicators of CO₂-extracts

| Indicator                        | CO₂-extract               |
|----------------------------------|---------------------------|
|                                  | Allspice | East Indies basil | Paprika | Coriander | Marjoram |
| Acid number, mg KOH, no more than| 6.21     | 5.15              | 3.18    | 3.38      | 4.13     |
| Ether number, mg KOH, no more than| 19.8     | 37.2              | 18.7    | 15.4      | 28.3     |

Large values of acid numbers of CO₂-extracts from roots, stems and leaves can be explained, apparently, by enzymatic processes occurring in the raw material during its storage. The low acid numbers of the extracts show that the extracts from the fruits of these plants are in this respect more suitable for long-term storage. The high ether numbers of most CO₂-extracts are a consequence of the high ether content in the fat-containing fractions of the extracts and non-glyceride ethers. Further, the refractive indices, density, and solubility of CO₂-extracts were determined in the work (Table 2).

Table 2. Some physical indicators of CO₂-extracts

| Indicator                        | CO₂-extract               |
|----------------------------------|---------------------------|
|                                  | Allspice | East Indies basil | Paprika | Coriander | Marjoram |
| Refraction index at 20°C         | 1.519-1.575 | 1.381-1.387 | 1.482-1.484 | 1.331-1.357 | 1.343-1.352 |
| Density at 20°C, g/cm³           | 0.960–1.050 | 0.958–1.240 | 0.922–0.938 | 0.880–0.910 | 0.801–0.825 |
| Complete solubility in proportion| In vegetable oil (1:10) with heating | In vegetable oil, acetic acid | In acetic acid, vegetable oil | In acetic acid, vegetable oil | In acetic acid, vegetable oil |
| Dry matter content, %            | 74.8     | 81.7              | 80.3    | 76.8      | 92.3     |

Incomplete solubility of CO₂-extracts in alcohol, in acetic acid is explained by the presence of fat-like substances in the extract. The low solubility of extracts in alcohol is determined by the presence of sparingly soluble fatty oil and waxes in their composition.

Antioxidants are substances that block the formation of highly active free radicals or help to "cleanse" the cells of the body from them. They prevent or slow down oxidation by molecular oxygen; protect biological substrates from spontaneous oxidation. The method for determining the content of antioxidants consists in measuring the electric current arising from the oxidation of the test substance (or mixture of substances) on the surface of the working electrode at a certain potential and comparing the received signal with the signal of the standard (quercetin) measured under the same conditions. The prepared sample is taken with a medical syringe of 1 cm³ of capacity and the dosing loop is washed, while the dosing valve is in the “input" position. 5 consecutive measurements of the signals (area of the output curve) of the test solutions are carried out. The arithmetic mean of 5 measurements is taken as the result (standard deviation is not more than 5%). Calculation of CA (mg/dm³) of the test sample is carried out according to the calibration graph of quercetin (Table 3).

By the method of amperometric detection, we analyzed the antioxidant activity of CO₂-extracts of basil, coriander, allspice, marjoram, paprika. It has been proved that coriander CO₂-extract has the maximum antioxidant activity. Based on the data of the analysis of the antioxidant activity of a number of natural products, it can be stated that the antioxidant activity of CO₂-extracts is high. The discovered high antioxidant activity of CO₂-extracts in combination with previously discovered
properties determines the prospects of their use in various prophylactic products and in the form of biologically active additives.

Table 3. Antioxidant activity of \( \text{CO}_2 \)-extracts

| \( \text{CO}_2 \)-extracts       | Antioxidant activity compared to \( \alpha \)-tocopherol acetate, g/dm\(^3\) |
|-------------------------------|----------------------------------|
| \( \text{CO}_2 \)-extract of basil | 425                              |
| \( \text{CO}_2 \)-extract of coriander | 483                              |
| \( \text{CO}_2 \)-extract of marjoram | 435                              |
| \( \text{CO}_2 \)-extract of allspice | 420                              |
| \( \text{CO}_2 \)-extract of paprika  | 430                              |

At the department of technology of products of animal origin, experimental studies were carried out to study the sorption of \( \text{CO}_2 \)-extracts of allspice, marjoram, basil, coriander, paprika on edible salt using gas piezosensors. Experimental studies were carried out using a setup consisting of a detection cell, piezoresonance sensors, a frequency meter, and a compressor. After carrying out the sorption process and fixing the results, it was assumed that, upon excitation with an alternating current, the change in the natural resonance frequency of the crystal oscillations (8-10 MHz) is determined by the change in the mass on its electrodes.

Based on the results of the studies carried out, chronofrequency diagrams and "Visual prints" of \( \text{CO}_2 \)-extracts applied to edible salt were built (Fig. 1-4).

![Figure 1. Chronofrequency diagram of edible salt with addition of 30 mcl/g of \( \text{CO}_2 \)-extract of basil](image1)

![Figure 2. Chronofrequency diagram of edible salt with addition of 30 mcl/g of \( \text{CO}_2 \)-extract of basil](image2)

![Figure 3. 30 mcl/g of \( \text{CO}_2 \)-extract of basil](image3)

![Figure 4. 30 mcl/g of \( \text{CO}_2 \)-extract of basil](image4)

Based on the results of the experimental studies, we have determined the recommended dosages of \( \text{CO}_2 \)-extracts during sorption on edible salt (Table 4).
Table 4. Recommended dosages of CO\textsubscript{2}-extracts of dry spices of the same name to edible salt, (mcl/g)

| CO\textsubscript{2}-extract  | Dosage, mcl/g |
|---------------------------|--------------|
| Basil                     | 35-45        |
| Marjoram                  | 25-35        |
| Coriander                 | 35-40        |
| Allspice                  | 25-30        |
| Paprika                   | 25-35        |

Next we have developed recipes for meat snacks, which are presented in Table 5.

Table 5. Recipes for meat thins, kg/100 kg

| Raw material | Recipe |
|--------------|--------|
|              | no1    | no2   | no3   | no4   | no5   | no6   |
| Prime beef   | 100    | 100   | 100   | –     | –     | –     |
| Nonfat pork  | –      | –     | –     | 100   | 100   | 100   |
| Allspice     | 0.1    | 0.1   | 0.1   | 0.1   | 0.1   | 0.1   |
| Paprika      | 0.1    | 0.1   | 0.1   | 0.1   | 0.1   | 0.1   |
| Basil        | 0.15   | –     | –     | 0.15  | –     | –     |
| Marjoram     | –      | 0.15  | –     | –     | 0.15  | –     |
| Coriander    | –      | –     | 0.15  | –     | –     | 0.15  |
| Total:       | 100    | 100   | 100   | 100   | 100   | 100   |

To improve the taste of beef and pork snacks, we propose to use domestic CO\textsubscript{2}-extracts of allspice, paprika, basil, marjoram, coriander. Also, CO\textsubscript{2}-extracts help to improve the microflora of finished products, reduce the total microbial contamination, due to their high antioxidant activity, they increase the safety of products and improve organoleptic characteristics, in particular, appearance, because there are no spices cores in the ready-made thins. To create recipe-component solutions, we also use the system of computer modeling of recipe-component solutions "Generic 2.0" (Table 6) [6]. This paper investigates the main qualitative and quantitative characteristics of raw meat (pork and beef), systematizes manufacturers’ data on the qualitative and quantitative characteristics of domestic CO\textsubscript{2}-extracts of dry spices of the same name.

Table 6. Meat thins recipes, kg/100 kg

| Raw material | Recipe |
|--------------|--------|
|              | no7    | no8   | no9   | no10  | no11  | no12  |
| Prime beef   | 100    | 100   | 100   | –     | –     | –     |
| Nonfat pork  | –      | –     | –     | 100   | 100   | 100   |
| Allspice     | 0.025  | 0.025 | 0.025 | 0.035 | 0.035 | 0.035 |
| Paprika      | 0.025  | 0.025 | 0.025 | 0.4   | 0.4   | 0.4   |
| CO\textsubscript{2}-extract of basil | 0.035 | – | – | 0.5 | – | – |
| CO\textsubscript{2}-extract of marjoram | – | 0.04 | – | – | 0.45 | – |
| CO\textsubscript{2}-extract of coriander | – | – | 0.038 | – | – | 0.45 |
| Total:       | 100    | 100   | 100   | 100   | 100   | 100   |

As a result of the research, the chemical and amino acid composition of meat raw materials and the finished product was detected. The biological value of the developed meat snacks was calculated, the antioxidant activity, refractive indices and optical density of CO\textsubscript{2}-extracts of spices were determined. The identification of aromatic substances in the finished meat thins was carried out using the "Electronic Nose" system. Based on computer modeling, recipe-component solutions for meat thins with improved organoleptic characteristics have been designed, industrial testing of the developed
recipes and modified technologies of new types of meat products has been carried out. The technical documentation has been developed and the economic effect from the introduction of the proposed technology has been calculated.

4. Conclusion
The developed technology of meat snacks contributes to the expansion of the range of natural meat products with high antioxidant activity due to the use of CO$_2$-extracts of spices in the formulations.

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