Development of technology for meat products enriched with essential trace elements

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Abstract. One of the directions of development of food components in the composition of meat products is proposed to use bee products as a source of vitamins, macro-, micronutrients, enzymes, hormones, amino acids, etc. the chemical composition and therapeutic and preventive properties of bee pollen have been Studied. The article presents the results of research on dried whole-muscle snack foods-jerks enriched with bee pollen. The formulation and technology of jerk has been developed. The operation modes of drying the product, which are in the range of 45–47 ° C, are justified, which allow preserving the activity of enzymes, hormones, and vitamins. The total chemical composition of the product, energy value, active acidity, water activity, vitamin and mineral composition of individual indicators were determined.

1. Introduction

The main directions of the state policy in the field of healthy nutrition of the population of the Russian Federation provide for the development of technology for the production of qualitatively new food products with a complex raw material composition. Modern food products are excessive in calories and deficient in vitamins and trace elements, which helps to reduce the adaptive potential of the population.

An effective method for correcting dysmicoelementosis and avitaminosis of the population is the development and widespread use of products enriched with a vitamin and mineral complex based on natural components. Production of meat products enriched with bee products using the fermentation process allows you to get biologically complete and safe products that have functional properties.

In this regard, the development of technology for dried meat jerks enriched with bee pollen, intended for the prevention of vitamin and mineral deficiency, is relevant.

The purpose of this work: is to develop the technology of raw whole-muscle product from poultry meat enriched with bee pollen for preventive nutrition.

Tasks:
1) assessment of the biopotential of bee pollen;
2) development of a technological scheme for the production of fermented dried jerks from poultry meat enriched with bee pollen;
3) determination of quality indicators: total chemical composition of the product (moisture, protein, fat, ash), active acidity pH, water activity aw, product yield;
4) determination of the content of vitamins and minerals as proof of the safety of biologically active substances after processing the product and improving its vitamin and mineral composition.
2. **Rationale for choosing a food additive**

Bee pollen - flower pollen, processed by bees with honey and their enzymes, and then compacted into a honeycomb (see figure 2). Under the influence of enzymes of bee pharyngeal glands and honey, pollen undergoes enzymatic fermentation with the formation of lactic acid, which results in pollen, which is a valuable protein feed for bee larvae. The literature data on the chemical composition of bee pollen are presented in table 1. Bee pollen also has therapeutic and preventive properties: it increases the immune system, improves blood formation, brain function, cardiovascular system, body tone; it is useful for diseases of the gastrointestinal tract, liver, kidneys, and thyroid gland. Bee pollen has a rejuvenating effect [1].

| Nutrient                | quantity per 100g | Nutrient                | quantity per 100g |
|-------------------------|-------------------|-------------------------|-------------------|
| Proteins (g)            | 21-30             | Vitamin K, phylloquinone (mcg) | 130               |
| Fats (g)                | 1.58              | Vitamin PP, (mg)        | 20                |
| Carbohydrates (g)       | 34                | Calcium, Ca (mg)        | 750               |
| Dietary fiber (g)       | 1                 | Magnesium, Mg (mg)      | 420               |
| Lactic acid (g)         | 3.1               | Natrium, Na (mg)        | 840               |
| beta Carotene (mg)      | 112               | Kalium, K (mg)          | 1750              |
| Vitamin A, (mcg)        | 50                | Phosphorus, P (mg)      | 840               |
| Vitamin B1, thiamine (mg) | 3.5             | Chlorine, Cl (mg)      | 64                |
| Vitamin B2, Riboflavin (mg) | 2               | Sulfur, S (mg)          | 70                |
| Vitamin B5, Pantothenic (mg) | 8               | Ferum, Fe (mg)          | 1.2               |
| Vitamin B6, pyridoxine (mg) | 1.5             | Zinc, Zn (mg)          | 1.5               |
| Vitamin B9, folates (mcg) | 600            | Cuprum, Cu (mcg)       | 12                |
| Vitamin C, ascorbic acid (mg) | 175            | Chrome, Cr (mcg)       | 21                |
| Vitamin E, alpha tocopherol, (mg) | 170          | Bor, B (mcg)            | 56                |

*Note. The table is based on data from literature sources [2], [3], [4], [5].*

3. **The object of the study**

The object of the study served as a cold snack – jerky, fortified with bee pollen. Jerks (see figure 2) are pieces of dried meat dried in special conditions. Jerky can be consumed as an independent product and as a snack. The main technological operation of this product is drying in the temperature range of 43-70 °C. To preserve the useful properties of the product, it is recommended to dry at 43-47 °C. During the technological process, it is necessary to strictly observe the production modes and sanitary and hygienic requirements.

![Figure 1. Bee pollen](image1)

![Figure 2. Jerky “Otradnye”](image2)
4. Development of a technological scheme for the production of jerks from poultry meat enriched with bee pollen

The diagram of the process of preparation of a jerky "Otradnye" is presented in figure 3.

The production method is carried out as follows: boneless poultry meat (breast fillet) is cut across the fibers into pieces in the form of straws from 25 to 75 mm long, 5-7 mm thick. Previously, the parchment is dried at a temperature not higher than 45 °C for 3-4 hours until a humidity of 15% is reached, and crushed to the consistency of a powder. Sliced poultry meat is mixed with table salt, ground black and red pepper and bee pollen powder (in an amount of 2%), kept at a temperature of 10-15 °C for 1-2 hours. Then the marinated pieces of meat are laid out on grids and dried for 9-11 hours, at a temperature of 45-47 °C and a speed of air masses of 2-3 m/s. Then the product is packed under vacuum or in a gas environment, marked according to the requirements of the technical regulations of the Customs Union. The humidity of the finished product is 20-22%, the water activity (aw) is in the range of 0.78-0.85, the active acidity (pH) is 4.8-5.5 (table 2). The product yield is 30-33%. Recommended shelf life of jerks is at a temperature not higher than 24 °C for 4 months [6].

5. Materials and methods

![Figure 3. Scheme of production of a jerky "Otradnye"](image)

The research was carried out using the following methods:
1) Chemical composition of the product:

1.1) Determination of moisture according to GOST 9793-2016. Meat and meat products. Methods for determining moisture by drying the hitch to a constant weight in a drying Cabinet at a drying temperature of 100-105 °C.

1.2) Determination of fat content according to GOST 23042-2015 by soxlet method.

1.3) Content of mineral substances-ash by dry mineralization of samples in a muffle furnace at a temperature of 550±25°C according to GOST 31727-2012 (ISO 936: 1998). Meat and meat products. Method for determining the mass fraction of total ash.

1.4) Protein Content by the Kjeldahl method according to GOST 25011-2017. Meat and meat products. Methods for determining protein.

2) The Energy value is calculated by:

3) Active acidity by pH - potentiometric method.

4) Water Activity aw - cryoscopic method.

5) Output of the finished product-by calculation.

6) Determination of vitamin content:

   6.1) B vitamins (B1, B2, B3, B5, B6, B9, B12) – according to GOST R 55482-2013. Meat and meat products. Method for determining the content of water-soluble vitamins.

   6.2) Determination of fat-soluble vitamin A according to GOST R 54635-2011. Functional food products. Method for determining vitamin A.

   6.3) Determination of fat-soluble vitamin E according to GOST R 54634-2011. Functional food products. Method for determining vitamin E.

7) Determination of mineral content: Determination of calcium, iron, magnesium, potassium, sodium, and zinc by atomic absorption spectrometry. GOST 32343-2013 (ISO 6869:2000).

6. Discussion of results

   Table 2 shows the results of determining the chemical composition and physical and chemical properties of the product.

   Jerky "Otradnye" represents protein-lipid concentrate, enriched with vitamins and trace elements. The caloric content of the product is 412 kcal.

   Table 2. Chemical composition and physico-chemical properties of the product

| Water, % | Protein, % | Fat, % | Ash, % | Energy Value, kJ/kcal | Product Yield, % | Active Acidity (pH) | Water Activity (aw) |
|----------|------------|--------|--------|------------------------|------------------|---------------------|---------------------|
| 22.5     | 55.1       | 20.5   | 2.5    | 1732/412               | 31               | 5.78                | 0.819               |

The low pH value (5.8) of the product is due to the lactic acid content in the bee pollen. At this value of active acidity, there is no active reproduction of pathogens such as E. coli (growth optimum at pH 7.2-7.5), Staphilococcusauraeus (growth optimum at pH 7.0-7.5), Salmonellasp., Listeriamonocytogenes, Clostridiumperfringens (growth optimum at pH 7.2-7.4) [7, 8]. Growth and reproduction of neutrophilic microorganisms (pH 5.5-7.5) do not have a negative impact on the quality and safety of the finished product. The water activity of the product remained within the normal range for dried meat 0.75-0.85 throughout the storage period.

Table 3 shows the results of the study of the vitamin composition, table 4 shows the results of the study of the mineral composition of jerky without adding bee pollen (sample 1) and jerky enriched with bee in the amount of 2% (sample 2). Some vitamins and minerals that are quantitatively predominant in the product were selected to prove that the product is enriched with macro-and micronutrients.
Table 3. Results of the study of the vitamin composition of jerky

| Indicators | Content (mg / 100 g) | Sample 1 | Sample 2 |
|------------|----------------------|----------|----------|
| В1         | 0.03±0.05            | 0.04±0.05|
| В2         | 0.06±0.02            | 0.07±0.02|
| В3         | 6.32±1.26            | 6.69±1.34|
| В5         | 0.41±0.08            | 0.43±0.08|
| В6         | 0.31±0.08            | 0.35±0.08|
| В9         | 2.12 ±0.74, mcg      | 2.16±0.74, mcg |
| В12        | 0.18±0.06, mcg       | 0.19±0.06, mcg |

Research results have shown that the use of bee pollen in the recipe increases the content of vitamins in the finished product. For water-soluble vitamins В1, В2, and В12, the increase is 0.01 mg, 0.37 by 0.02 mg, В6 by 0.04 mg, and В9 by 0.04 mcg. Fat-soluble vitamin A increased by 0.05 mcg. These indicators characterize poliflora about the composition of the bee pollen. Processing modes did not have a negative impact on the safety of vitamins, which indicates the possibility of using bee pollen in the technology of dried jerky.

Table 4 presents the results of a study of the mineral composition of a jerky “Otradnye”

Table 4. The results of the study of the mineral composition of a jerky

| Indicators | Sample 1 mg/100g | Sample 2 mg/100g |
|------------|------------------|------------------|
| Mg         | 144.5            | 156.6            |
| Zn         | 20.8             | 28.8             |
| K          | 2206.8           | 3413.6           |
| Na         | 2537.7           | 2626.5           |
| Ca         | 33.5             | 47.0             |
| Fe         | 0.39             | 0.95             |

The results of research have shown that the enrichment of the jerky recipe with bee pollen increases the content of mineral substances. The content of potassium, the most predominant in bee pollen, increased by 1206.8 mg, and magnesium by 12.1 mg, which makes it possible to recommend the product for the prevention of cardiovascular diseases. The content of zinc increased by 8 mg, sodium by 88.8 mg, calcium by 13.5 mg, and iron by 0.55 mg, which indicates that the product is enriched with a vitamin and mineral complex. The results of research have shown that the enrichment of the jerky recipe with bee pollen increases the content of mineral substances. The content of potassium, the most predominant in bee pollen, increased by 1206.8 mg, and magnesium by 12.1 mg, which makes it possible to recommend the product for the prevention of cardiovascular diseases. The content of zinc increased by 8 mg, sodium by 88.8 mg, calcium by 13.5 mg, and iron by 0.55 mg, which indicates that the product is enriched with a vitamin and mineral complex.

7. Conclusion
The chemical composition and therapeutic and prophylactic properties of bee pollen were studied, allowing its use as a food additive in meat products, in the amount of no more than 2%. The technology of production of jerks enriched with bee pollen has been developed, which allows preserving the biological activity of enzymes, hormones, and vitamins. The chemical composition of the product was determined. the products are a protein-lipid concentrate with a high caloric content.
The product has been experimentally proven to be enriched with vitamins and minerals. The product is recommended for tourists, military personnel, emergency workers, and employees on long expeditions. Under these conditions, the body needs vitamins, minerals, and enzymes.

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