A new product from Helix pomatia and the method of its production

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Abstract. The article considers and studies the need to find and develop new sources of protein, as well as biologically active substances, methods of their production and processing, used both for obtaining livestock products and in other areas of human economic activity. One of the most promising areas is snail farming, represented by edible species of land snails. This article covers the development of a method for obtaining a new type of raw material from Helix pomatia (grapevine snail) and the study of its qualitative characteristics. All studies were conducted according to standard, generally accepted and developed practice. As a result of the research work, a method for obtaining the grapevine snail lyophilizate was developed, tested, proposed and implemented, which contributes to an increased content of biologically active substances, better nutritional value and high quality of the obtained products with a long shelf life. The study of the quality indicators of the products obtained by the developed method took place in compared with well–known and long-established techniques: the use of a dehydrator at a temperature of +35°C and a drying cabinet at +105°C. The analysis of the chemical and amino acid composition of the compared products from the grapevine snail showed superiority in crude protein content within 2.1–2.9 % absolute, therefore, essential amino acids in Helix pomatialyophilizate. Thus, the effectiveness of the established method for obtaining the grapevine snail lyophilizate with the prospect of using it in various industries and areas of production activity has been proven.

1 Introduction

Protein deficiency, both directly in the diet and in feed for livestock, is a problem that modern humanity is currently facing. New proposed sources of animal protein are often characterized as an unstable form of storage that requires additional processing. There are well-known and generally accepted modern methods of processing agricultural raw materials: membrane methods (microfiltration, ultrafiltration, nanofiltration and reverse osmosis); acoustic methods; vibration impact; electrophysical methods (exposure via alternating electric current, laser, plasma and microwave radiation treatment, infrared and ultraviolet radiation, radiation treatment).

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In turn, the breakthrough innovative physical methods include radiological nanotechnology, membrane methods and ultrasound exposure.

All the listed processing methods are used for agricultural raw materials in the fields of seed production, dairy and meat industry, food (juice and chips production), fodder (beet pulp production), vegetable growing, and promote both separate and complex synergistic effects of filtration, concentration, purification, extraction, reduction of drying time, juice separation, disinfection, preservation of vitamins, reduction of the consumption of the initial raw materials and its contamination, acceleration of the technological process, reduction of fruit damage, increase in shelf life, regulation of chemical composition with an increase in sugar content, increase germination, acceleration of clarification and extraction, preservation of the original biological properties of raw materials, improvement of food safety, energy conservation and overall quality characteristics, marketability and competitiveness of the agricultural industry products.

The only common disadvantage of all the methods is the lack of widespread introduction due to insufficient implementation of the industrial plants production that ensures the functioning of the above methods.

Since the products from Helix pomatia are characterized by the content of a significant amount of total moisture, resulting in a short shelf life and rapid deterioration, the technological process requires the development of an additional method of production and processing.

2 Materials and methods

The purpose of the research work was to obtain Helix pomatialyophilizate as a ready-to-use product with high quality characteristics with a longer shelf life.

To achieve this objective, the following tasks were formulated:

- To develop a method for obtaining the grapevine snail lyophilizate.
- To conduct laboratory tests of lyophilizate for compliance with quality characteristics.
- To test and implement the method in production.

The material, given in this publication, is the result of research work started in 2021 according to the roadmap and carried out in this direction to the present time on the basis of All-Russian Research Institute of Sheep and Goat Breeding – branch of the Federal State Budgetary Scientific Institution 'North-Caucasus Federal Scientific Agrarian Center' and the production part of research was carried out in Sole Trader Agricultural Enterprise A. K. Khramov of the Stavropol Territory.

The object of the study was a species of terrestrial gastropod Helix pomatia (grapevine snail), which is the largest snail in Europe and has a wide range of natural distribution.

Standard snail individuals of one population were selected under the conditions of industrial production technology. The selection of the grapevine snail was carried out at the physiological stage of the active vital activity of individuals. The conditions of keeping and feeding the gastropod were the same and corresponded to the farm's standard technology. The research scheme includes several stages (Figure 1).

Zootechnical analysis, including determination of the crude protein, fat and ash content, three samples of grapevine snails processed in different ways, was carried out in an accredited laboratory.

The quantitative amino acid composition of the three processed Helix pomatia samples was established using an amino acid analyzer, the operation principle of which is presented as a highly specialized computer-controlled automated liquid chromatography machine.

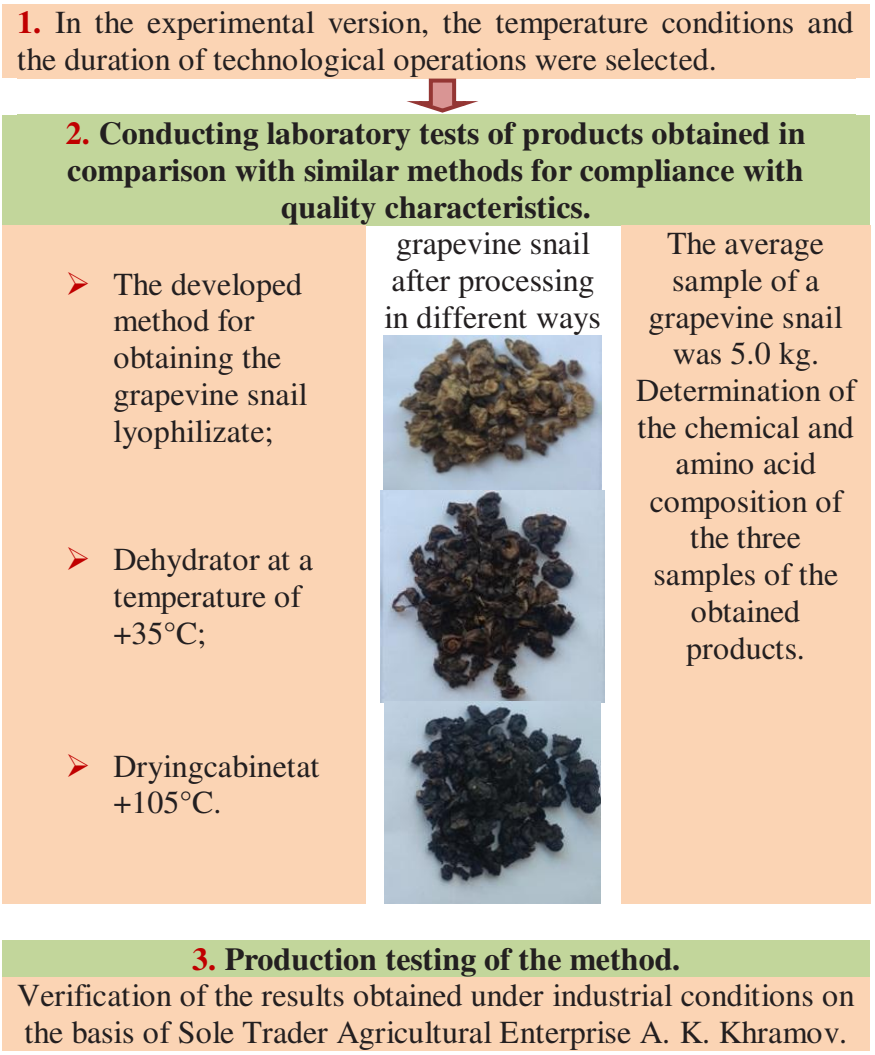

Fig. 1. Stages of research work.

3 Results

The developed method for obtaining the grapevine snail lyophilizate consists in the step-by-step implementation of the following technological operations, which are: the collection of standard snails followed by its starvation exposure in farm conditions for at least two days; further freezing at temperature -(1–25)°C; removal of the snail body from the shell; directly carrying out lyophilization of the removed gastropod body at temperature -(40–50)°C; removal of residual moisture in the raw material, which occurs by increasing the temperature of the installation shelves up to +45°C and, simultaneously, the temperature of the raw material up to +40°C while achieving residual humidity in the intervals of acceptability 1–4 % and external visual stability.

The lyophilization is carried out directly when the atmospheric pressure is reached at the lowest temperature of the refrigerated surface at the initial stage, and the vacuum pumping is further started with a pressure reduction of up to 15–14 Pa. While in operation,

the available vacuum chamber plates are cooled down to -40°C. Cassettes with a pre-packed frozen body of a grapevine snail are installed on the plates. The cassettes have temperature sensors installed in them. The total freezing period lasts 14–16 hours.

Then, at 5 hour intervals, the heating temperature of the plates increases by 5°C to a maximum value of +45°C – the removal of residual moisture takes place (the dry phase lasts up to 15 hours when the Helix pomatia body temperature reaches +(20–22)°C and up to its constant sample weight).

After the drying stage, the mass fraction of moisture in the final product of the grapevine snail lyophilizate is 1.3 %, which corresponds to the acceptance criterion. Both the absence of thawing and the presence of a yellowish shade reflect the stability of the lyophilizate. The grapevine snail lyophilizate is a complete product ready for further use, both in animal husbandry and in other areas of human economic activity with a long shelf life.

In our work, we compared the qualitative characteristics of lyophilizate obtained by the developed method with the indicators characterizing two other products from grapevine snails obtained by exposure in the second variant – a dehydrator at a temperature of +35°C, in the third variant – a drying cabinet at +105°C.

A study of average samples showed that the lyophilizate produced by a grapevine snail in a completely dry substance has the following chemical content: crude protein – 74.9 %; crude ash – 8.9 %; crude fat – 3.5 %, which exceeds the first two indicators in comparison with products for which a dehydrator and drying cabinet were used by 2.9 %, 2.1 % and 0.6 % absolute, respectively. The crude fat content of lyophilizate was 2.3 % and 2.8 % absolute, respectively. The chemical composition isillustrated in Figure 2.

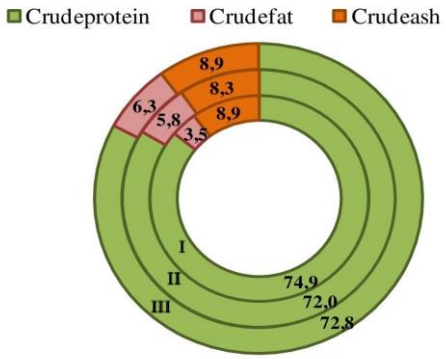

Fig. 2. The chemical composition of the Helix pomatia samples, %.

The analysis of the amino acid composition of three samples of the grapevine snail products showed the superiority of lyophilizate in the content of the amino acid complex, including those that were essential: leucine, phenylalanine, histidine and lysine within 0.1–0.4 % absolute in comparison with the other two samples exposed to a dehydrator and drying cabinet, respectively. The results obtained prove the full value of the grapevine snail lyophilizate protein.

4 Discussion

Thus, based on the analysis of the data obtained, it can be concluded that the use of the lyophilization method, which is characterized by a low-temperature regime, contributes to both the preservation of the structural integrity and the content of nutrients and biologically

active substances, as well as a long shelf life of the lowest weight product. The resulting grapevine snail lyophilization is therefore more nutritious and of better quality than the other two methods. These circumstances constitute and characterize the economic efficiency of using a new method for obtaining the grapevine snail lyophilizate.

In addition to the domestic works on the subject, which are few in number, there are foreign publications in which the authors consider the possibility of using Helix pomatia in cosmetology due to the high concentration of hyaluronic acid and antioxidants, and for therapeutic purposes due to its biological properties.

In one of the papers, foreign colleagues studied the problem of extracting water-soluble protein, the source of which was the albumin gland as a significant anti-aging agent [1]. The mechanism of action is to reduce the synthesis of reactive oxygen intermediates (ROI). Studies have shown that the albumin gland is characterized by intense biosynthetic activity. Grapevine snails produce a complex of enzymes such as: glycosyltransferase, L-galactosyltransferase, D-galactosyltransferase, thioredoxin peroxidase. The result of the research work demonstrated the reliable possibility of using grapevine snails as a raw material with anti-aging properties necessary to fight against the aging process and its related diseases.

Numerous studies have proven the effectiveness of bee products in the livestock industry, including the use of larvae and pupae of drones in obtaining a sterile lyophilized feed additive to increase the sexual activity of sheep that have undergone anaplasmosis.

Many well-known pharmaceutical companies produce drugs and biologically active additives that are based on bee products and focus on drone broods and dead bees. Similarly, grapevine snails receive lyophilized brood. The brood is characterized by high nutritional and biostimulating properties, additionally it includes: antimicrobial, actoprotective, immunotropic, antioxidant, adaptogenic and anabolic action, which determines its areas of application in nutrition, cosmetology, therapy, in gerontology.

According to available data, lyophilized powder of drone larvae contains 41.6–51.2 % of protein and 4.8 % of fat, which is inferior to the Helix pomatialyophilizate in protein by 23.7 %.

A group of Polish scientists and others approached the study of gastropods as an alternative source of ascorbic acid (vitamin C) [2]. This vitamin is an integral component of the diet and cannot be synthesized in the human body. Because of this, the only way to obtain this vitamin is from outside sources. According to established data, mussels and oysters contain vitamin C within 8 mg/100 g of shellfish. The recommended intake of ascorbic acid is 75 mg per day for women and 90 mg per day for men. Studies involving three types of snails, Helix pomatia, Cornuaspersumaspersum and Cornuaspersum maxima, showed that the edible portion of Cornuaspersumaspersum has the highest concentration of ascorbic acid, which is 185.4 mg/kg, compared to 38.4 mg/kg (Helix pomatia). The outcome analysis shows that the genus Cornu contains more of this biologically active substance compared to other meat sources (pork, beef, nutria and reindeer). This fact opens up new prospects for the additional use of gastropods as a valuable source of vitamin C in human nutrition. Cornuaspersum Müller meat protein has also been found to be of high quality and to have the protein efficiency ratio (PER) close that of egg protein. In addition, snails are a source of calcium, potassium, magnesium, iron, zinc, copper and selenium.

According to Pissia et al., snails are a very popular food product in Europe [3, 4, 5].

Helix lucorum Linnaeus is attracting increasing attention from Czech scientists for the purpose of study [6].

Helix pomatia and Helix lucorum are periodically used as laboratory models in neurobiological research [7].

The ban on the use of antibiotics in animal husbandry has led to a new direction in the development of a variety of alternative additives to increase productivity, including the

study of chitosan oligosaccharides obtained from snail shells [8, 9, 10]. Studies of this feed additive have been carried out successfully and it has been proven to increase the productivity of quails when feeding.

The origin and composition of the Helix pomatia gland release is being studied as well [11].

Thus, the analysis of the collected data showed that information on processing, including lyophilization, homogenization, extraction with characteristics of individual nutrients and biologically active substances of snails is insufficient.

The proposed method for obtaining the grapevine snail lyophilizate contributes to solving this problem and has a number of advantages: availability of raw materials, simplicity of the method of production, weight reduction, and increased content of biologically active substances, high nutritional value and quality with extended shelf life.

5 Conclusion

In this publication, we have demonstrated the results of our research, which prove the possibility of using both the grapevine snail and its lyophilizate as a source of protein and biologically active substances in the form of food, feed, and biologically active additives in functional nutrition and cosmetology.

Due to the continuous growth in snail production and the lack of research on theoretical and applied aspects of using new biologically active, high-protein raw material from the grapevine snail to obtain high-protein components, semi-finished products, and products for functional and specialized applications, it is necessary to continue research at a deeper, fundamental level until we fully uncover how the compounds (components), included in the snail lyophilizate composition, interact with physiological processes occurring in the human and animal body, in different age and gender groups and physiological stages of the body.

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