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# Improving the quality of animal meat by using blue iodine (Amyloiodine)

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**ABSTRACT**

**Background:** Low-quality meat negatively impacts human health and leads to diseases. The nutritional value of low-quality meat is relatively poor, emphasizing the need to provide the population with high-grade and safe products so that individuals can consume adequate energy and nutrients, such as proteins, amino acids, vitamins, and minerals. These dietary components work in conjunction to ensure health status.

**Objectives:** This study aimed to observe the increase in nutritional value of cattle meat through using amyloiodine (blue iodine or iodized starch), a functional food ingredient. The use of this compound will make it possible to solve the iodine deficiency issue in the animal's body, strengthen the cattle's immune system, and obtain a higher-quality beef yield. This research included the study of chemical and organoleptic parameters of meat, the content of minerals within the product, and indicators of thyroid hormones such as thyroxine (T4), triiodothyronine (T3), aspartate aminotransferase (AST), and alanine aminotransferase (ALT).

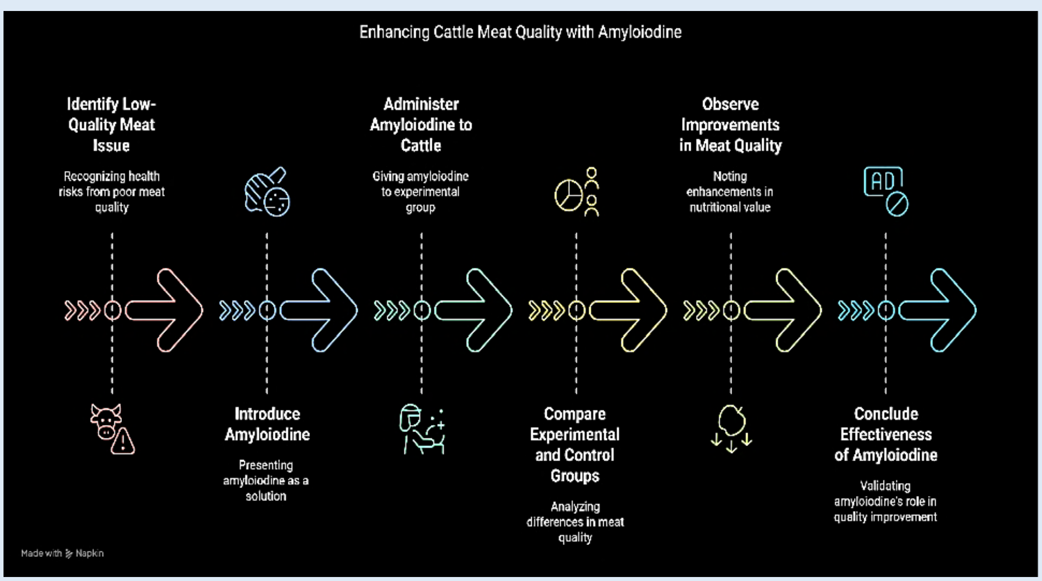
**Methods:** Scientific research was carried out using farms in the Ararat region, some of which were subsidiary. Observations were conducted in the laboratories of the Scientific Research Center for Veterinary Medicine and Veterinary and Sanitary Expertise of the National Agrarian University of Armenia. The objects of the study were cows of the Caucasian brown and Simmental breeds (n=30). The animal population was divided into 2 groups: the experimental (n=15) and the control group (n=15). The experimental group orally received amyloiodine in a dose of 200 mL diluted in 200 mL of water daily for 5 days, while the control group did not receive amyloiodine. However, the dietary pattern in both groups was the same. After 5 days of drinking the amyloidine, the experimental group paused, returning after 5 days to receive blue iodine for another 5 days. During the trial period, amyloiodine, which is sold in pharmacies in ready-made form, was obtained in the laboratory, as its preparation method is simple and accessible. Amyloiodine was used in this study as it is an iodized starch that is highly effective in reducing iodine deficiencies and the incidence of diseases caused by viruses, bacteria, fungi, protozoa, and helminths.

**Results:** In the studied cows, biological value and physico-chemical parameters were observed as deviations, given as a percentage, to indicate an increase in the nutritional value of meat. Positive deviations were observed in the experimental group, which received the amyloidine.

**Novelty:** This study uniquely investigates using orally administered amyloiodine (blue iodine) as a functional food ingredient to enhance cattle meat's nutritional value and quality in an iodine-deficient region. It demonstrates amyloiodine's effectiveness in improving meat's protein and mineral composition, reducing potential toxins, and enhancing overall meat safety and organoleptic properties.

**Conclusion**: Scientific research in this study has shown that the orally administered amyloiodine, a functional food ingredient, improves meat quality by increasing protein and mineral composition, reducing toxins, and improving meat safety in production. The use of amyloidine within the meat production industry in Armenia is widely accepted, as cows are in an endemic zone of the territory. In this territory, there is a complete absence of iodine in the earth's interior and the plant kingdom.

**Keywords:** amyloiodine, cattle, organoleptic parameters, nutritional value of meat, bioactive compound



## INTRODUCTION

Experts are increasingly fascinated with improving beef quality, as consumer demand is increasing for high-quality, healthy, safe, and tasty meat with a red color, pleasant smell, moderate marbling, and elastic texture [1-4]. Low-quality meat harms human health, and consumption of food containing this product could lead to various diseases and an overall poor health status. Individuals can consume adequate energy and nutrients for the body's daily needs by providing the population with high-quality products.

The increasing demand for functional foods, stemming from the growing health consciousness among consumers and their preference for products that provide more than just basic nutrition, presents both opportunities and challenges for regulatory agencies, notably the U.S. Food and Drug Administration (FDA). Functional foods containing bioactive compounds, such as vitamins, minerals, antioxidants, and other beneficial substances, are crucial in promoting health and preventing diseases. Functional food science involves isolating and combining bioactive compounds to create functional ingredients for targeted health benefits [5-6].

As the prevalence of chronic diseases has increased in the United States, there has also been an increase in the need for products that can help prevent, manage, or treat diseases. Functional food products can do this through components called bioactive compounds. These compounds can provide multiple health benefits that act on disease biomarkers [7].

The research results indicate that the chemical composition of meat from animals with fasciolosis is directly influenced by the degree of infection. Consuming fasciolosis-affected meat can cause irreversible changes in the human body, and it is recommended that such meat be used only after thorough industrial processing [8].

One of the numerous methods of improving beef's nutritional value is using functional ingredients [9-13]. Blue iodine (amyloiodine) can be used since the possibilities of this functional ingredient are vast. Amyloidine is one of the few drugs that is inert to the cells of higher mammals and humans. Therefore, it does not affect the beneficial microflora of the gastrointestinal tract. This has led to its recognition as "smart" iodine, which has a regenerative effect.

Therefore, blue iodine is used in large quantities in various situations. Amyloiodine is maximally biologically active and has high antiviral, bactericidal, fungicidal, and helminthicidal activity. Amyloiodine is obtained by incorporating iodine into a high polymer molecule. Often, these molecules are in the form of a starch. As a result, iodine loses its toxic and irritating properties. The development of strains resistant to these changes is impossible.

Blue iodine is used to overcome primary iodine deficiency in animals and humans, enhance immunity, increase the content of red blood cells in the blood, improve the ability of white blood cells to absorb pathogenic microbes, cleanse blood vessel, and have a positive effect on the hormonal system to prevent and capture radioactive iodine.

This serious medical and social issue in Armenia has resulted in an epidemic of goiter. The absence of iodine is not only a goiter. Still, it is also characterized by signs of biological expression, underdevelopment of the body, and possible hereditary deformities caused by DNA dysfunction due to iodine deficiency. Professor Mokhnach V.O. discovered amyloiodine and first applied the iodine starch complex to himself and later used it to treat patients with dysentery [14]. The results were promising; the patients recovered, and healthy contacts did not become infected.

In the 60s of the 19th century, the mass media constantly reminded people about the importance of proper nutrition, specifically the importance of consuming adequate amounts of iodine. In kindergarten, children received iodine tablets, such as Antistrumin, without choice. Many researchers have attempted to apply the food iodization method developed by Professor V.O. Mokhnach, which involved incorporating iodine into confectionery products such as marmalade, marshmallows, and yeast-based goods [15–17].

**Purpose:** This study aimed to study the effect of the functional food ingredient blue iodine, amyloiodine, on the change in the nutritional value of cattle meat. The nutritional value of beef in this study could contribute to the enrichment of animal meat with iodine, which solves the problem of iodine deficiency and animal immunity.

## MATERIALS AND METHODS

The research was conducted in farms and subsidiary farms of the Ararat region of the Republic of Armenia, in the laboratories of the Scientific Research Center for Veterinary Medicine and Veterinary and Sanitary Expertise of the National Agrarian University of Armenia, and the laboratory of the Center for Food Safety. The object of the study was cows of the Caucasian brown and Simmental breeds. The total number of experimental animals was 30, which were divided into 2 groups: the experimental (n=15) group, which received oral amyloiodine in a dose of 200 mL diluted in 200 mL of water daily for 5 days, and the control group (n=15), which did not receive amyloiodine. The diet in both groups was the same during this period. During the trial period, amyloiodine was obtained in the laboratory, since its preparation method is straightforward. It is prepared using 5 tablespoons of potato starch, 5 tablespoons of granulated sugar, and a teaspoon of citric acid added to 250 mL of warm water. The components were mixed in water until fully dissolved. In a glass or enameled dish, the resulting mixture was put on fire, and while stirring quickly, 750 mL of boiled water was added. This product was brought to a boil and removed from the heat. The final product was a jelly carefully cooled to 40-45 ° C. This temperature was chosen as iodine evaporates at 65 °C and above. After cooling the jelly, 1 tablespoon of a 5% alcoholic solution of pharmaceutical iodine, previously dissolved in 2-3 tablespoons of water, was poured into it. As a result, a blue jelly-like solution of amyloiodine was obtained. It was poured into a glass container and tightly sealed with a lid. The products were stored in a dark, cool place and consumed until amyloiodine began to lose its intense blue color, which could take months to achieve.

Meat was taken from the slaughterhouses of the Ararat region of the Republic of Armenia for evaluation.

Blood was taken from the jugular vein for biochemical analyses within cow subjects (T3, T4, total protein, ALT, and AST were examined).

The chemical analysis of meat indicated protein, fat, moisture, and ash content. Proteins were determined according to GOST 250011, fats according to GOST 23042, moisture according to GOST 9793, GOST 3338, and ash according to GOST 31727.

During the organoleptic evaluation of beef quality, the color, smell, consistency, taste of meat, and shelf life were considered. The ash content included macro and microelements: calcium, phosphorus, iron, zinc, and iodine.

In the Lastyr modification (1978), the Lowry method determined the protein content in meat [18]. The fat content was determined gravimetrically by burning the dry residue in a muffle furnace at 450 ± 25 °C, and the mass fraction of moisture was determined by drying at 103 ± 0.2 °C.

Biometric data processing was performed using the Microsoft Office Excel program on computer equipment.

## RESULTS AND DISCUSSION

The research revealed a substantial difference in quality indicators of animal beef between the control and experimental groups of cows. The experimental group received amyloiodine daily, while the control group did not.

Amyloiodine enters the body of animals orally with food or water. It moves to the stomach, then to the small intestine, where iodine is released from the starch complex and absorbed into the blood through the mucous membrane. In the bloodstream, iodine binds to plasma transport proteins and is delivered to various organs. The thyroid gland is involved in synthesizing hormones T4 and T3, which are regulators of metabolism.

Excess iodine is excreted through the kidneys, the intestines, the salivary glands, and the skin.

By studying the level of thyroid hormones in cattle blood, it is possible to determine the animal's metabolism and the condition of the liver and other organs.

Table 1 shows the levels of the hormones triiodothyronine (T3), thyroxine (T4), aspartate aminotransferase (AST), and alanine aminotransferase (ALT).

**Table 1.** Blood levels of T3, T4, ALT, and AST in cows of the experimental and control groups.

| Cow groups | Indicators | | | |
|---|---|---|---|---|
| | T3 (nmol/L) | T4 (nmol/L) | ALT (nmol/L) | AST (nmol/L) |
| Control (n=15) | 1,12 ± 0,18 | 36,4 ± 0,53 | 35,7 ± 2,17 | 132,8 ± 3,57 |
| Experienced (n=15) took amyloiodine | 2,57 ± 0,36 | 81,6 ± 0,49 | 38,7 ± 3,21 | 129,7 ± 2,47 |
| Hormone levels are | 1,2 - 2,5 | 40 – 80 | 6 - 40 | 60 – 130 |

Table 1. Shows that the resulting T3 and T4 hormones in the blood of the control group of animals display a hypofunction of the thyroid gland (T3 - 1.12 ± 0.18, T4 - 36.4 ± 0.53). However, after the use of amyloiodine in the experimental group of animals, this issue is addressed (T3 - 2.57 ± 0.36, T4 - 81.6 ± 0.49, ALT - 38.7 ± 3.21, AST - 129.7 ± 2.47).

After analyzing the results of the T3 and T4 levels in the blood, it is concluded that using amyloiodine contributes to an increase in these hormones. Therefore, the thyroid gland is regulated by this ingredient, and the metabolic rate in cows increases. In other words, it can be concluded that using amyloiodine by animals accelerates their metabolism, increases the amount of protein and ash content in meat products, and decreases the amount of fat and moisture.

**Table 2**. Indicators of the chemical composition of meat from experimental and control groups of animals

| Animal groups | Parameters | | | |
|---|---|---|---|---|
| | Caloric content (kcal) | Protein % | Fat % | Moisture % |
| Meat from animals of the control group (n=15) | 111,23 ± 5,42 | 19,8 ± 0,57 | 4,7 ± 0,21 | 73,8 ± 0,67 |
| Meat from animals of the experimental group (n=15) | 113,19 ± 6,31 | 21,7 ± 0,46 | 4,5 ± 0,47 | 73,1 ± 0,52 |
| Standards of indicators | 113 | 22 | 5 | 75 |

The data in Table 2 show that during chemical analysis, the meat of animals that received blue iodine contained increased protein (21.7 ± 0.46%). Fat and moisture were slightly reduced (4.5 ± 0.47, 73.1 ± 0.52, respectively). The increase in the protein and beef percentage and quality is explained by the iodine content in amyloiodine, which promotes the synthesis of hormones T3 and T4. These hormones regulate the animal body's metabolism of proteins, fats, and carbohydrates.

Amyloiodine improves the absorption of nutrients and the intestinal microbiome due to the bactericidal abilities of amyloiodine. This causes the growth of pathogenic microflora in the gastrointestinal tract to be suppressed, and the risk of inflammatory processes that cause edema to be reduced. This leads to a decrease in moisture in beef products. Humidity reduction may also be associated with accelerated metabolism, which causes fewer fat cells to retain water. With increased metabolism in the animal's body, more energy is used, thus reducing fat deposits [19-25].

The indicator of the mineral content in animal meat is the ash content, which reflects the level of calcium, phosphorus, iron, iodine, and other minerals within the body.

Table 3 shows the ash content of bovine beef in the experimental and control groups of cows.

**Table 3.** Indicators of the ash content of beef from experimental and control groups of cows

| Product | Indicators | | | | |
|---|---|---|---|---|---|
| | Ash content (mg/100g) | Calcium (Ca,mg/100g) | Phosphorus (P, mg/100g) | Iron (Fe, mg/100g) | Iodine (J, mcg/100g) |
| Meat from animals of the control group (n=15) | 1,3±0,36 | 8,4 ± 0,24 | 170 ± 54,7 | 2,9 ± 0,21 | 2,6 ± 0,5 |
| Meat from animals of the experimental group (n=15) | 1,8 ± 0,27 | 9,6 ± 0,46 | 210 ± 64,3 | 3,4 ± 0,36 | 4,1 ± 0,24 |
| The norm of mineral indicators | 1,05 - 2 | 5 - 12 | 140 - 220 | 2,3 – 3,5 | 2 – 4 |

Table 3 indicates the total mineral mass, which concludes that the ash content in the meat of experimental cows was increased (1.8 ± 0.27) due to an increase in minerals consumed.

The growth of iodine in the meat of animals treated with amyloiodine is especially prevalent (4.1 ± 0.24). If metabolic processes in the animal body are enhanced using amyloiodine, the indicators of the mineral composition (i.e., the ash content of beef) increase accordingly, which leads to a higher quality of meat being produced. We can conclude that after consuming blue iodine, cows began to absorb nutrients and minerals in the feed more actively. As a result, when properly processed, the beef had juicier and softer properties.

Table 4 shows the changes in the organoleptic parameters of beef after the animals received amyloiodine. These indicators were determined using the senses (vision, smell, touch) to assess the quality of the meat and its consumption.

**Table 4.** Organoleptic parameters of beef from experimental and control groups of animals

| Product | Indicators | | | | | |
|---|---|---|---|---|---|---|
| | Color | Odor | Consistency | Surface | Taste | Shelf life (days) |
| Beef without admixture of blue iodine (n=10) | Reddish, darker in places | Slightly acidic | Looser, when pressed, recovery is not fast. | Light moisture, small mucus | Weakened, weakly expressed | 6-7 |
| Beef with an admixture of blue iodine (n=15) | Red, pinkish, white, or creamy fat | Clean, meaty, slightly milky | Elastic, dense, when pressed, the fossa quickly recovers | Dry, drying crust without mucus | Rich, meaty, slightly sweet, less fatty | 7-12 |

Data in Table 4 show that iodized starch positively affects the organoleptic properties of bovine beef. Its antiseptic effect and enhanced metabolism in the animal's body contribute to the better preservation of meat's color, smell, consistency, and taste.

**Iodine Deficiency:** Iodine deficiency remains one of the most widespread nutritional issues, affecting 35–45% of the global population [26]. Approximately 2.2 billion people worldwide are impacted, making iodine deficiency the leading cause of goiter, although not all goiters stem solely from iodine deficiency [26]. The prevalence of goiter correlates with deficiency severity: 5–20% in mild cases, 20–30% in moderate cases, and over 30% in severe iodine deficiency [26].

Vegan children are especially at risk of an insufficient supply and deficiency of critical nutrients such as iron, zinc, iodine, calcium, and vitamins. Deficiency of these nutrients could lead to various developmental and sometimes irreversible disorders [27]. When a sufficient amount of iodine is not present in our body, it can lead to various problems, including cretinism, mental retardation, and other risks, especially in pregnancy [28].

In the U.S., data from 2011–2012 revealed that 38% of the population had urinary iodine concentrations below 100 µg/L, classifying them as iodine deficient [29]. Between 1997 and 2015, clinical iodine deficiency notably increased among U.S. military males, though it remained more common in females and racial minorities overall [30]. Severe deficiency symptoms, such as hypothyroidism, affect about 5% of the U.S. population. The latest NHANES data (2011–2014) indicated that certain subgroups continue to face heightened deficiency risks [31].

The severity of iodine deficiency disorders determines clinical outcomes. Mild deficiency increases the risk for thyroid gland enlargement and benign nodular formation [32]. In contrast, severe deficiency can result in hypothyroidism, reduced fertility, intellectual disabilities, and developmental impairments such as deafness and cretinism in children [33].

It is essential to evaluate the nutritional value of meat by analyzing key parameters such as protein, fat, ash, iodine, and moisture content [8]. The inclusion of natural additives in animal diets plays a significant role in enhancing the nutritional quality of meat, thereby increasing consumer acceptance from health, nutritional, and economic perspectives [34].

Our study's findings demonstrate that oral administration of amyloiodine enhances the chemical composition of meat, increasing protein and mineral content and improving organoleptic properties. This is likely due to the positive impact of iodine on animal metabolism and thyroid function.

In future studies, evaluating amyloiodine as a functional food ingredient should follow the multi-step regulatory framework proposed by the Functional Food Center, which outlines specific criteria for establishing functional food products' biological efficacy and physical validity [35-38].

**Scientific Innovation and Practical Implications:** This research introduces a significant innovation by exploring the application of amyloiodine, a readily accessible iodized starch, as a functional food ingredient to directly improve the quality of animal meat. This approach is particularly novel in iodine-deficient regions, such as the Ararat region of Armenia, where it addresses animal health by supplementing iodine and meat quality for human consumption.

The practical implications of this research are considerable for the meat production industry, especially in iodine-endemic areas. The use of amyloiodine offers a cost-effective and straightforward method to improve beef's nutritional value and safety, potentially leading to higher-quality products with extended shelf life and enhanced consumer appeal. Furthermore, the observed positive effects on animal metabolism and overall health suggest a pathway for producing meat with a more favorable nutritional profile, contributing to public health initiatives focused on iodine deficiency. This study provides a scientific basis for the widespread adoption of amyloiodine as a functional feed supplement in cattle farming, offering a dual benefit of improved animal health and enhanced meat quality.

**Conclusion:** This study's findings demonstrate that amyloiodine is a valuable functional food ingredient for improving cattle meat's chemical composition and organoleptic properties, primarily due to its high iodine content. Oral administration of amyloiodine enhances animal metabolism, protein synthesis, and thyroid function, leading to higher-quality beef with improved taste, prolonged shelf life, and better color and aroma, attributed to its antimicrobial properties. Biochemical analyses revealed that iodine supplementation promotes a faster metabolism without negatively affecting cattle health.

Iodine plays a central role in regulating metabolism as a critical participant in synthesizing thyroid hormones (T3 and T4). Moreover, amyloiodine administration effectively replenishes iodine deficiency, enhances nutrient absorption, strengthens the intestinal microbiome, suppresses pathogenic microflora, and improves overall disease resistance in cattle. Based on these results, we recommend using amyloiodine to enhance cattle meat's quality and nutritional value.

**Authors' Contributions:** Zh. M. is the main author and conductor of the research. L. G., S. Y., V. G., and A. V. contributed to studying the composition of vitamins and minerals in the products and their comparative evaluation. G. P. and N. H. contributed to statistical processing. R. G. and V. A. contributed to the study of chemical parameters. S. W. edited and formatted the article and critically reviewed it. D. M. critically reviewed and edited the article and discussed novelty, scientific innovation, and practical implications.

**Competing interest:** The authors declared that there is no competing interest.

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