

## ***ABSTRACT***

**Keywords:** *beef production, rearing systems, quality meat, Aberdeen Angus, body indices, physico-chemical analyses, Angus pastrami.*

Beef production plays an essential role in the global economy, having a significant impact on production, consumption, trade, and the environment. Here is an overview of the importance of beef on a global scale. In 2023, global beef production amounted to approximately 62.57 million tons. In 2024, Australia exported 1.34 million tons of beef, an increase of 24% compared to 2023, generating revenues of 14 billion dollars.

In Romania, currently, there are more than 40,000 Aberdeen Angus cattle registered across all regions of the country, according to data provided by the Aberdeen Angus Romania Association. Given these aspects, it is inherently necessary to discuss how cattle rearing methods influence the quality of beef, especially when aiming to obtain high-quality final products from the Aberdeen Angus breed.

This research thesis was carried out over the course of 3 years, during which we observed, measured, analyzed, and compiled various specific aspects related to quality rearing of Aberdeen Angus cattle, all with the aim of highlighting the productive aspects in terms of beef quality. The purpose of our research and the present work was to know the quality of meat obtained from the Aberdeen Angus cattle breed, and to see how extensive and semi-intensive farming systems can influence both the quality of the meat and the finished product. Naturally, the final product was made under the same conditions in the meat processing laboratories of the University of Life Sciences in Iași, using a simple recipe, without the addition of food additives, colorants, or various spices, so as not to alter the composition, appearance, or taste of the resulting products.

In the processing of the studied beef, we used simple, classic recipes in the technological process in order to observe whether the rearing system, as well as the specifics and characteristics of the beef studied, would influence the final product. The thesis is structured in two parts, consisting of seven chapters. The first part includes the first two chapters, while the second part — dedicated to research and original contributions — comprises the remaining five chapters, from which we were able to draw valid conclusions regarding the influence of rearing systems on the quality of beef from the Aberdeen Angus breed.

In the first chapter, we highlighted bibliographic aspects regarding the current situation and future outlook of beef production. It can be stated that cattle farming occupies a priority position in our country's animal production economy. The importance of cattle raising lies in the variety of products it provides, namely primary products (milk, meat) and secondary products (hides, manure, and unconventional energy such as slaughter by-products: blood, horns, hooves, etc.).

Globally, beef breeds are continuously developing, with the Aberdeen Angus breed accounting for 70% of the total, making it the most widespread and appreciated beef breed in the world. According to statistical data, in March 2019, 5,904 tons of beef were obtained from cattle, with the production expected to decrease to 5,800 tons in the pandemic year of 2020, and then to be on an upward trend with a maximum of 6,160 tons of beef from cattle in 2024.

The second chapter also presents bibliographic information from the specialized literature, focusing on the management of factors influencing beef production in cattle.

Large quantities of high-quality meat with better feed efficiency are obtained from specialized beef breeds. These breeds are characterized by early maturity, the ability to grow faster, and to reach higher weights at a younger age, providing fully qualified meat products with high organoleptic quality. The slaughter yield for specialized beef breeds reaches 68–70%, and sometimes even more; whereas for dairy breeds, the yield is between 45–50%. Cattle meat is highly utilized because it is rich in nutrients, has notable dietary properties, and is increasingly demanded by consumers. In recent years, consumers have shown a growing preference for lean, tender, flavorful, and protein-rich meat—characteristics specific to beef. Its typical composition includes 61.6% water, 19.2% protein, 18.3% fat, and 0.9% minerals. In conclusion, beef remains an essential component of the global economy, playing a significant role in agriculture, international trade, and sustainability strategies. In the context of environmental challenges and changing consumer behavior, the beef industry is adapting through innovation and the implementation of more responsible practices. In Romania, although beef consumption is relatively low compared to other countries, global market dynamics influence both the level of imports and domestic prices. The three main systems used in cattle farming for beef production allow the application of various fattening technologies and methods. Excluding the intensive system, where fattening is done exclusively in confinement, the semi-intensive and extensive systems involve a mixed fattening process that combines time spent in confinement with time spent grazing. The choice of the appropriate fattening method and system must consider both the bio-productive characteristics of the animals and the provision of optimal conditions for feeding and maintenance, in order to maximize growth performance and economic efficiency. Beef production in cattle is strongly influenced by several nutritional factors, including the type of feed, the quality of the forage, and how it is administered. The rations provided to the animals must meet their basic physiological needs and support an optimal growth rate. The type of feeding directly influences the morpho-physiological development of the digestive tract and is classified, depending on the predominance of certain types of feed, into: dairy-based, concentrate-based, and forage-based. Feeds with high energy content and low fiber contribute to accelerated weight gain and can be administered two to three times per day or provided *ad libitum*, depending on the maintenance system.

Water is an essential element for digestion and for the proper functioning of biochemical and metabolic processes. An insufficient water supply leads to reduced feed intake, negatively affecting growth rate and, consequently, meat production. Cattle can be

raised under three main systems: intensive, semi-intensive, and extensive. As for housing, it can be carried out either in a tied system or in a free (loose housing) system. Although the loose housing system may yield slightly lower technical performance compared to the tied system, it is increasingly being used due to the possibility of fully mechanizing technological processes. Moreover, the choice of housing system affects the comfort level of the animals, which directly impacts growth rate and fattening efficiency.

The second part of the doctoral thesis, accounting for approximately 78% of the total, begins with Chapter III, which introduces the research hypothesis and objectives and presents the methods used in the research, such as statistical analysis, physico-chemical analyses of Angus beef, meat pH, brightness, chemical composition, and histological analysis of the raw material. For evaluating the quality of certain types of final products, only sensory analyses were used. Various methods were applied to assess Aberdeen Angus meat products using specific sensory analysis questionnaires in a controlled environment.

Chapter IV includes information about the organizational and institutional framework in which the research was conducted regarding the influence of rearing systems on the quantity and later the quality of Aberdeen Angus beef. We studied two different rearing systems for Aberdeen Angus cattle: extensive and semi-intensive. First, we monitored the body development of Aberdeen Angus animals, and then the growth performance indicators achieved in each of the two rearing systems.

Finally, we closely monitored each type of farm involved in the study, tracing where the animals were delivered and slaughtered. Generally, in the semi-intensive rearing system, farmers had their own slaughtering facilities, which made it much easier to collect beef samples for quality analysis and subsequent processing into final products.

For the meat samples from the extensive rearing system, samples were collected from slaughterhouses where the cattle were processed shortly after delivery, without any interventions or enhancements afterward. The meat samples analyzed were beef round and beef muscle from Aberdeen Angus cattle raised on farms using the two studied rearing systems. The final products were processed using a very simple, identical technological recipe for both types of meat: Aberdeen Angus round pastrami and muscle pastrami. The cattle farms studied within the two systems—extensive and semi-intensive—are as follows: The extensive system included three livestock farms: one with about 90 cattle owned by Asoltanei Elena, and another with approximately 220 cattle operated by Agromixt Spineni. The semi-intensive system included four farms, with Aberdeen Angus cattle populations ranging from a minimum of 211 cattle at Ghergut's Ranch to a maximum of 650 cattle at CosmiVas Impex.

We were able to observe how the same cattle breed responds differently under different rearing systems. The extensive system influences the meat in a particular way, while the semi-intensive system modifies the characteristics of the meat both nutritionally and qualitatively. This is understandable, as the semi-intensive system is more controlled and designed to produce high-quality cattle carcasses, which are essential for technological processing into final products. The biological material studied consisted of young

Aberdeen Angus bulls with Pedigree certification, raised on the seven studied farms. Three of these implemented extensive rearing systems: Pașcu Marinela, Agromixt-Spineni, and Asoltanei Lica. Four additional livestock farms practiced semi-intensive rearing: Ghergut's Ranch, CosmiVas Impex, Carpatis Welt and Dincu Elena.

All the studied farms raise Aberdeen Angus cattle; some also operate their own slaughter lines and even manage the entire processing flow up to product distribution and sale of Angus beef.

Chapter V includes statistical analysis and interpretation of the data collected from the seven studied farms, focusing on the quantitative parameters of meat production in the Aberdeen Angus breed. This research involved a comparative analysis of the body development of cattle raised under two distinct production systems: extensive and semi-intensive, as well as a mixed batch from both systems based on geographical area, representing the overall herd average, without considering the specifics of each rearing system. The methods used included statistical processing, which is of great importance when analyzing growth parameters, helping to draw conclusions about the positive impact of the semi-intensive rearing system on meat yield. According to centralized statistical data, the average birth weight across systems was around 31 kg, but calves in the extensive system could reach up to 47 kg, while those in the semi-intensive system reached up to 44 kg. Cattle of this breed showed a body weight average of 837 kg, nearly 100 kg more than those raised in the extensive system, with individual weights ranging from 458 kg to 1,156 kg. This proves that the rearing system significantly influences performance: genetically valuable herds may fail to express their full potential if the conditions in Romania differ from those of the breed's origin. When proper welfare conditions are met, cattle increasingly express their genetic potential, which directly impacts productivity.

Chapter VI focuses on the qualitative parameters of meat production in the Aberdeen Angus breed through a series of physico-chemical analyses, including meat pH, brightness, chemical composition, as well as sensory analyses, which reconfirm the superior quality of Aberdeen Angus beef. According to quality standards, Aberdeen Angus beef contains 75% water and 25% dry matter, composed of 18% protein, 3% lipids, 1.5% nitrogenous extractive substances, 1.2% non-nitrogenous extractive substances, 1.2% minerals, and trace elements. Angus beef is rich in protein, aminoacids, minerals, omega-3 fatty acids, vitamins B12 and B6, zinc, and iron, with low cholesterol, all of which are essential to human health.

The study analyzed meat samples from 10 Aberdeen Angus cattle, with 5 samples from animals raised in the extensive system, and 5 samples from those in the semi-intensive system. All samples came from the four livestock and agri-livestock farms involved in the research. In the physico-chemical analyses, we evaluated the pH values of meat samples. In the round (hindquarter) meat, pH decreased with internal temperature, but over time, pH levels began to rise again—although not excessively—indicating that the meat is of high quality and suitable for processing into final products without any quality-enhancing additives. In the muscle samples from cattle raised

extensively, pH levels were initially optimal but tended to increase rapidly toward acidity, which can accelerate spoilage. Thus, extensively raised beef should be processed quickly after slaughter, as the optimal pH deteriorates rapidly, potentially affecting the processing of high-quality final products without additives. In muscle samples, brightness levels were higher in meat from the semi-intensive system, suggesting lower myoglobin content, which results in brighter meat. This implies that beef from semi-intensive systems may have better **visual appeal** due to higher brightness. The meat samples from cattle raised under the extensive system exhibited lower brightness, due to a darker color of the meat, which is relatively caused by a higher myoglobin and water content. Following the analysis of results obtained using FOOD CHECK, the meat samples from cattle raised in the extensive system showed lower protein and collagen content, mainly due to the feeding practices during the final stage before slaughter. In contrast, in the semi-intensive system, dietary corrections are made during this phase with the goal of improving meat quality and marbling. The presence of fat in the round cuts (hindquarter) from cattle raised under the semi-intensive system is attributed to the balanced and controlled pre-slaughter diet.

It can be concluded that the hindquarter meat from semi-intensively raised cattle is more marbled, richer in protein, and has normal water content, making it more suitable for producing high-quality finished products without requiring many additives or quality enhancers. The analyzed sample-muscle tissue, specifically round meat-from an Aberdeen Angus steer raised under the semi-intensive system, proved to be of very high quality, suitable for processing into a final product without the need for complex processing or additional additives. Histological analyses performed on these types of muscle samples (tenderloin and round) further confirmed the superior characteristics of the meat from the semi-intensive system. In the psoas muscle samples from the semi-intensive system, muscle fibers were 3.43% finer than those from the extensive system ( $p < 0.01$ ). This resulted in a higher proportion (+2.53%) of pure muscle tissue (78.06% vs. 76.13%) in the semi-intensive system, although this difference did not exceed the minimum statistical significance threshold. Therefore, for this type of specialty cut (tenderloin), the null hypothesis could not be rejected in 99% of the comparisons involving fiber thickness and cross-sectional areas of myocytes. However, there is a high probability that meat from semi-intensively fattened Aberdeen Angus cattle will have finer fibers by 3.43%, potentially leading to improved texture properties such as juiciness and tenderness, compared to the extensive system.

In the case of round muscle tissue, the differences between the two rearing systems led to statistically significant changes in terms of average muscle cell diameter (-4.97% in the semi-intensive system) and cross-sectional area of myocytes (-9.70% in the semi-intensive system) ( $P < 0.001$ ). This resulted in a significantly improved proportion (+4%) of pure muscle tissue versus connective tissue in animals raised under the semi-intensive system ( $p < 0.05$ ).

In Chapter VII, four samples of meat products obtained from beef raised under both semi-intensive and extensive systems were analyzed. The animals came from

Ghergut's Ranch and Asoltanei Lenuta's farm in the village of Slobozia, Iași, and the meat was processed at the meat processing facility of USV-Iași. The two types of pastrami—round pastrami (from the "nut" cut) and tenderloin pastrami—were obtained using a simple technological process, without the addition of food additives, using only salt and a small quantity of spices, specifically to avoid influencing the flavor characteristics of the final product. These four resulting samples were then subjected to various sensory analyses in the Sensory Analysis Laboratories of USV-Iași. From the centralized results of the sensory analysis questionnaires, it can be highlighted that pastrami-type products made from round cuts, especially those processed from meat of cattle raised under the semi-intensive system, are more appreciated by consumers. The same applies to beef pastrami from tenderloin—products from the semi-intensive system are preferred to a greater extent. Also, based on the centralized data from the sensory analysis sheets, Angus beef is appreciated for its low resistance to tearing, due to an optimal blend of fine muscle fibers and intramuscular fat. This results in meat that is tender, juicy, and easy to chew, making it ideal for dishes that require tenderness, such as steaks or roasts. After completing all the stages of the sensory analysis for products made from Aberdeen Angus beef, it can be concluded that meat from cattle raised under the semi-intensive system **is** more appreciated by consumers, according to the evaluations gathered from the applied test.

***This scientific endeavor resulted in several novel contributions:***

- 1. As a result of the research conducted, concrete results were obtained for the first time, which can help improve the technological process flow in the farms studied;*
- 2. For the first time, studies were conducted on the influence of rearing systems on the meat quality of Aberdeen Angus cattle raised under different technological and environmental conditions;*
- 3. For the first time in the Moldavia region, research was carried out on the impact of Angus beef quality on final processed products;*
- 4. The results obtained allowed for the formulation of viable solutions, which, when implemented, can lead to increased profitability of cattle farms and the production of high-quality meat products.*