OnLine Journal of Biological Sciences

Original Research Paper

Comparative Assessment of Meat Quality Characteristics of Cattle Depending on Breed, Age and Growing Conditions in the Republic of Kazakhstan

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Article history
Received: 02-03-2022
Revised: 20-04-2022
Accepted: 21-04-2022

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Abstract: The results of meat productivity of young cattle of beef breeds (Auliekol, Kazakh Whitehead, Galloway, Hereford) depending on the breed, sex, and age (young bulls, steers-calves, heifers, first-calf cows, adult cattle-cows, bulls, calves) grown in the Western Region of the Republic of Kazakhstan during winter, turning winter (pre-spring), early spring and spring periods are given. The animals were divided into three groups according to their breed and growing conditions. The highest slaughter yield among adult animals was found in the cow of the Auliekol breed-63,7% with a pre-slaughter weight of 532.8 kg; the lowest yield was in the cow of the Hereford breed -53,6% with a pre-slaughter weight of 410.0 kg. Studies of young animals showed that the highest and the lowest values were 61.3% in a bull of the Auliekol breed with a pre-slaughter weight of 460.1 kg and 50.8% in a bull of the Hereford breed with a pre-slaughter weight of 372.3 kg, respectively. The proportion of muscle, fat, connective, and bone tissue in the slaughter process is determined. The muscle tissue of the animals of higher fatness in the I and II groups consists of 56.6-57.3% of carcass weight, fat-15.7-16.1%, and connective, bone, and cartilage-26.9-27.2%. The muscle tissue of the animals of I and II groups of average fatness amounts to 59.7-60.2% of carcass weight, fat-9.8-10.3%, connective, bone and cartilage-29.8-30.1%, the muscle tissue of the animals of III group of average fatness amounts to 58.4% of carcass weight, fat-10.2%, connective, bone, and cartilage-31.4%. The amino acid content of cattle cuts of different breeds is almost identical in proline-0.68-0.7%, serine-0.76-0.79%, alanine-1.09-1.13%, tyrosine-0.63-0.66%; but there are also significant differences, such as arginine-from 0.65 to 1.27%, lysine-from 0.86 to 1.66% and leucine-from 0.87 to 1.56%. The highest total amino acid content is 13.59% and the lowest is 9.26%. As a result, the food and biological quality of beef depend on breed, age, living conditions, pre-slaughter housing, slaughtering, and production processes.

Keywords: Cattle, Kazakh Whitehead, Meat Quality, Breed, Carcass

Introduction

The meat industry is one of the most important branches of the national economy of Kazakhstan, which is connected with the national feature of nutrition-meat and meat products are a product of high demand. At present, the consumption of meat and meat products in Kazakhstan does not satisfy in sufficient quantity the physiological norms of humans. This is a consequence of the fact that the meat complex, combining cattle breeding and livestock processing, does not provide sufficient production of meat raw materials and products from them (Jia *et al*., 2022; Yessimbekov *et al*., 2021).

The government of the Republic of Kazakhstan continues to pay a lot of attention to the problems of meat industry development. Regulatory documents are being developed to support the industry and domestic producers. The State Program "Development of export potential of cattle meat of the Republic of Kazakhstan" is a part of the program of development of the agro-industrial complex. Studies on the technological chain of beef production are necessary for the development of meat exports (Nasambaev *et al.*, 2021; SPDACRK, 2017).

Cattle breeding is widely spread in many countries in Europe, Australia, the USA, and Canada. For example, in France, the specific weight of cattle of meat breeds is 55%, and in the U.S. -92%. The potential market for imported beef in Russia is at least 600 thousand tons annually, and Kazakhstan will be able to supply about 60 thousand tons of chilled cattle meat. Also domestic beef meat market will be about 500 thousand tons by 2020 (SPDACRK, 2017; Bowling *et al.*, 2008).

World practice shows that of the greatest interest to the consumer market is high-quality beef that meets the international and national standards of the countries exporting this type of meat. To assess the applicability of international standards, it was of scientific and practical interest to study the quality of beef obtained from breeds raised in the Republic of Kazakhstan following the UNECE international standard (Vaskin *et al.*, 2021; Zali, 2019).

Standards for meat in different countries are prepared based on many interrelated factors: Traceability of products, national tastes, and traditions, price policy, etc. Domestic and international experience reveals that standards for slaughtering livestock and post-slaughter products (beef and veal) should be interrelated to increase the interest of commodity producers.

The main economic tool for the development of international trade, increasing the competitiveness of food products, and expanding the list of market countries are harmonized international standards. The use of international quality standards provides broad opportunities for Kazakh enterprises to enter the international market (Kopteva *et al.*, 2020; Livestock and Poultry, 2021).

Harmonization of domestic standards with international standards, specification of product commodity qualities in standards in combination with the clauses of the Technical Regulations of the Customs Union 021/2011, which establish safety requirements, creates the basis for increasing the competitiveness of domestic products on the international market (RBMEEUMS, 2017; Bonny *et al.*, 2018).

The United Nations Economic Commission for Europe (UNECE) standards (international standards) most fully meet the requirements of international trade, which provide a unified principle of evaluation and sorting of carcasses, as well as a unified classification for the convenience of trade and are of great practical importance in the growing volume of the international meat trade. However, international standards, as in general, do not consider all regional and breed characteristics of slaughtered animals.

In 2020, the Eurasian Economic Union (EEU) countries exported meat and edible meat by-products to foreign markets for nearly a billion dollars, which is 1.5 times more than a year ago. The distribution of "meat" export shares among the EEU countries: 78.2% For Russia, 18.6% for Belarus, and 3.1% for Kazakhstan. In money terms, Kazakhstan's contribution to meat exports from the EAEU is only about $30 million (TMOEEUKSM, 2021).

The potential of Kazakhstan: The availability of pastures and croplands, water resources, and other factors will allow exporting meat and meat products in the long term with the development and implementation of an effective system of quality food production, based on the requirements of international standards.

The global cattle meat market is characterized by a relatively stable level of consumption, with an average annual growth rate of 0.4% over the period 2014-2020. China, Brazil, the USA, and the European Union remain the most capacious markets, but the growth of demand is provided mainly by China (Nassyrova *et al.*, 2020; Ibrayeva *et al.*, 2020).

China is a promising market for Kazakh beef. The export of meat to China from Kazakhstan began in 2019. To increase beef exports to China, it is necessary to introduce quality management systems in the meat processing enterprises of Kazakhstan (Enahoro *et al.*, 2021; Wang *et al.*, 2019). Kazakhstan is well-positioned to provide its population with high-quality meat and meat products and to increase its exports. For increasing the competitiveness of produced meat products the research directed on the improvement of quality and safety of production is required (Uzakov *et al.*, 2020).

Carcass yield is determined by age-related changes in the ratio between the weight of individual pieces of animal carcass. The study of the properties and quality of cattle carcasses during their rearing is of practical importance for meat cattle breeding in the Republic of Kazakhstan.

The purpose of this study is to study and compare the evaluation of meat quality indicators of cattle depending on the breed, age, and growing conditions in the Republic of Kazakhstan. These studies will help to develop the production of high-quality beef, including increasing the export potential of the country. Equally important is the problem of scientific substantiation of the optimal age and live weight of animals to be slaughtered, considering their breed characteristics, growing conditions, and the quality of meat.

Materials and Methods

The Objects of the Study

The objects of the study were: young cattle of beef breeds (Auliekol, Kazakh Whitehead, Galloway, Hereford) of different ages and sex (young bulls, steers-casters, heifers, first-calf cows, adult cattle-cows, bulls, calves) (Fig. 1); fresh and chilled carcasses; cuts; growing groups of 3 to 5 heads. The studies were conducted at a specialized industrial complex for the production of beef LLP "Baiserke-Agro".

At the first stage of the research, the animals were divided into groups of 25 animals according to age and breed, as follows.

"Group I" -group of stall growing, in farm conditions, for cows of local breed Kazakh white head.

"Group II" -a system of stall growing, in conditions of farms, for cows of local breed Auliekol (breed created by the three-breed crossing of Kazakh white-head, Charolais, Angus).

"Group III" -a group of stall growing, in the conditions of private farms, for cows of the local breed of Kazakh white head.

Regardless of the breeding system, cows were slaughtered in slaughterhouses using electro stunning, followed by processing according to traditional technology.

Slaughtering was carried out according to generally accepted technological schemes. After slaughtering and primary processing the fresh carcasses were cooled at the temperature of 0 ... +4 C.

Carcasses were cut according to the UNECE international standard "Beef-Carcasses and Cuts".

Meat Productivity of Cattle

Meat productivity of cattle was determined following standard (GOST R 57784, 2017). The summary of the test method is to determine the live weight of animals at birth and at a different age, periods to assess their productivity in absolute terms and determine their index or rank in a peer group (in relative terms), as well as to determine their breeding value. The live weight of calves at birth is a good indicator of calving difficulties: Light calves are usually born easier, and heavier ones are more difficult. The weight of calves at birth is influenced by the gender of the calf (bulls are larger than heifers) and the age of the mother (in young cows calves are smaller, in cows aged 5-9 years-the largest, in cows older than 9 years, the weight of calves decreases). The live weight of calves at birth is determined by weighing no more than three days after birth.

Animal productivity indicators are determined by the relative value of each trait in % of its average value in the peer group, i.e., the index or rank of the animal in the peer group (Formula 1):

$$\textit{Relative live weight of a calf at birth} = \frac{\textit{individual (own) adjusted live weight at birth, kg}}{\textit{the average adjusted live weight at birth for the peer group}} x100 \quad (1)$$

Determination of Moisture, Protein, and Fat

Mass fraction of moisture was determined according to standard (GOST 9793, 2016). The method is based on drying the sample with sand at a temperature of (150±2)°C for 1 h. Place 8-10 g of purified sand, and a glass rod into a bottle (cup) and dry it for 30 min in an oven at a temperature of (150±2)°C. Then the bottle is closed with a lid, cooled in a desiccator to room temperature, and weighed. Weighing results are recorded to the third decimal place. 2-3 g of the prepared sample is placed in a weighed bottle, re-weighed, thoroughly mixed with sand with a glass rod, and dried in an oven in an open bottle at a temperature of (150±2)°C for 1 h. Then the bottle is closed with a lid, cooled in a desiccator to room temperature, and weighed.

Mass fraction of moisture X, %, is calculated by the Formula (2):

$$X = \frac{m_1 - m_2}{m_1 - m}.100 \quad (2)$$

where:

m_1 = The mass of the bottle with the sample, stick, and sand, g
m_2 = Weight of the bottle with sample, stick, and sand after drying, g
m = The mass of the bottle with a stick and sand, g
100 = Conversion factor to percent

Mass fraction of protein was determined according to standard (GOST 25011, 2017). The method is based on the mineralization of the organic substances of the sample, followed by the determination of nitrogen by the amount of ammonia formed.

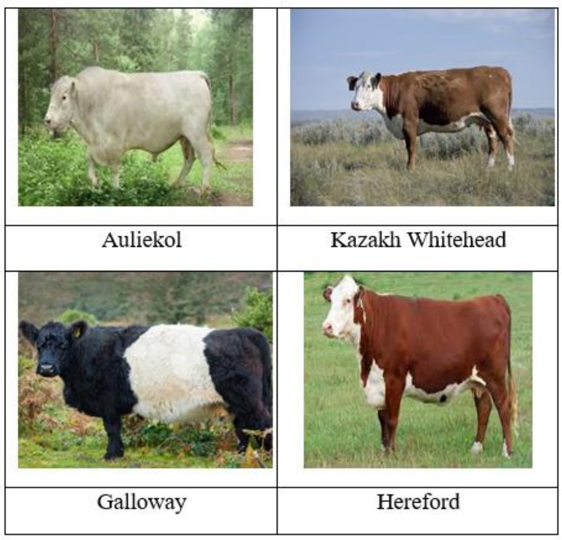

Fig. 1: Cattle breed

The mass fraction of protein, %, is calculated by the Formula (3):

$$X = \frac{0,0014.\left(V_1 - V_2\right).K.100}{m} = 6,25 \tag{3}$$

where,

0.0014 = The amount of nitrogen equivalent to 1 cm 0.1 moL/dm of a hydrochloric acid solution or 0.05 moL/dm of the sulfuric acid solution, g
V_1 = The volume of 0.1 moL/dm of a hydrochloric acid solution or the volume of 0.05 moL/dm spent on titration of the test sample, cm
V_2 = The volume of 0.1 moL/dm of a hydrochloric acid solution or the volume of 0.05 moL/dm spent on titration of the control sample, cm
K = The coefficient of correction to the nominal concentration of the hydrochloric acid solution
100 = The conversion factor to a percentage
m = The mass of the sample, g
6.25 = The conversion factor for protein

Mass fraction of fat was determined according to standard (GOST 23042, 2015). The method is based on repeated extraction of fat with a solvent from a dried analyzed sample in a Soxhlet extraction apparatus, followed by removal of the solvent and drying of the isolated fat to constant weight.

Mass fraction of fat X, %, is calculated by the formula (4):

$$X = \frac{\left(m_2 - m_1\right).100}{m} \tag{4}$$

where,

m_2 = The mass of the extraction flask with fat, g
m_1 = The mass of the extraction flask, g
100 = Coefficient of conversion to percent
m = The mass of the analyzed sample, g

Determination of pH

The pH value was measured using a portable pH meter directly in the muscle tissue according to standard GOST R 51478-99 (1999). The electrodes are inserted into the sample and the pH meter temperature controller is set to the sample temperature. In the absence of a temperature controller, the sample temperature should be (20±2)°C. pH measurements are carried out depending on the design of the pH meter. After the readings of the device take a steady value, the pH value is counted directly from the scale of the device with an accuracy of ±0.05 pH units. Three single measurements are carried out on one test sample. The essence of the method is the measurement of the electrical potential difference between a glass electrode and a reference electrode placed in a sample of meat or meat products.

Determination of Amino Acid Composition

The amino acid composition was determined according to standards (GOST 34132, 2017). The method is based on the acid hydrolysis of a protein until it is completely decomposed into its constituent amino acids, followed by chromatographic determination of the mixture on an automatic liquid amino acid analyzer to identify the composition and determine the mass fraction of individual amino acids.

Quantitative determination is carried out by the peak area of the identified compounds relative to the calibration dependence obtained by chromatography of amino acid calibration solutions under similar conditions.

Following the operating instructions for the amino acid analyzer, it is turned on, if necessary, setting the pressure of the inert gas on the inlet pressure gauge of the chromatograph to 5 MPa. Following the characteristics of the chromatograph, a programmable analysis method is set.

Following the data obtained from the analysis of the calibration solutions, a table of peaks is created using the software. Calculations of amino acid content and peak area are performed by the data processing system in automatic mode.

The mass fraction of individual amino acid X, mg/kg, is calculated by the Formula (5):

$$X = \frac{C_{CT}.S_X.V_p}{S_{CT}.m} \tag{5}$$

where,

C_{CT} = The mass concentration of an individual amino acid in the calibration solution, mcg/cm
S_X = The peak area of the individual amino acid in the analyzed sample, cont. units
V_P = The volume of the solution for dissolving the analyte after sample preparation, cm^3
S_{CT} = The peak area of the individual amino acid in the calibration solution, cont. units
m = The mass of the sample, g

Determination of the Water-Binding Capacity of Meat

The method is based on the separation of the test sample with its light pressing, sorption of the released water with filter paper, and determination of the amount of separated moisture by the size of the spot area left by it on the filtered paper (Okuskhanova *et al.*, 2017). The weight of minced meat (0.3 g) is weighed on torsion scales on a polyethylene mug with a diameter of 15-20 mm (the diameter of the mug should be equal to the diameter of the cup of the scales). After that, it is transferred to an ashless filter placed on a glass or plexiglass plate. From above, the suspension is covered with the same plate, and a load weighing 1 kg is placed on it and maintained for 10 min. After that, the filter with the attachment is released from the load and the upper plate. The content of bound moisture is calculated by the formulas (6, 7):

$$X_1 = (A - 8.4B) * 100 / m_0, \quad (6)$$

$$X_2 = (A - 8.4B) * 100 / A, \quad (7)$$

where,

X_1 = The bound moisture content, % of meat
X_2 = Bound moisture content, % of total moisture
B = The area of the wet spot, cm^2
m_0 = The weight of the meat sample, mg
A = The total moisture content in the suspension, mg

Statistics

In total, 26 samples from each group of meat were sampled for the analysis. All measurements were performed in triplicate and all results have been expressed as mean ± standard errors. Statistical processing of the data was performed using Windows Microsoft Office 2010 software, software package Statistical 7.0. Differences were considered to be statistically significant at $p \leq 0.05$. Data are presented as mean values ± Standard Deviation (SD).

Results

Based on the experimental data obtained, we analyzed the quality characteristics of meat from animals of different breeding groups and ages, from the position of sustainability of production. The control slaughter showed that the animals of the II breeding group had obvious advantages compared to the I and III group counterparts (Table 1).

It was found that the pre-slaughter live weight of cows of groups I and II are different, and the carcass weights of beef of groups I and II are also unequal. But as we can see, the weights of chilled carcasses differed significantly. The carcasses of cows of group I were less by an average of 5 kg in weight than the carcasses of cows of group II. The highest indicator of slaughter yield was in animals of group II-58.57%, while in group I-53.73%.

The data in Table 1 show that there are significant differences in carcass yield depending on the fatness and weight conditions. Thus, the carcass yield of Kazakh white-headed steers of medium fatness was 47.51%, Auliekol breed-53.33%, and Kazakh white-headed steers bred on private farms-46.8%.

The muscle tissue of the animals with higher fatness in the I and II groups consists of 56.6-57.3% of carcass weight, fat-15.7-16.1%, and connective, bone, and cartilage-26.9-27.2%. The muscle tissue of the animals of I and II groups of average fatness amounts to 59.7-60.2% of carcass weight, fat-9.8-10.3%, connective, bone and cartilage-29.8-30.1%, the muscle tissue of the animals of III group of average fatness amounts to 58.4% of carcass weight, fat-10.2%, connective, bone, and cartilage-31.4%. Thus, the ratio of tissues in the carcass of cattle depends on the breed, the fatness of the animal, and the system of growing (Table 2, 3).

The analysis of the physicochemical composition of the muscle tissue showed (Table 4) that the beef from the animals of the third group had significantly higher moisture content: 73.1±0.9%, while in the first group the same indicator was 71.64%. The highest fat content was observed in the meat from the first group of animals-higher by 35.0% than in the meat from the animals of the third breeding group.

The main ratios of amino acids are presented in Table 5. The result of studying the total amount of essential amino acids (lysine, tyrosine, phenylalanine, histidine, leucine + isoleucine, methionine, valine, and threonine) in cattle cuts of different breeding groups showed that the quantity of essential amino acids is high in animals raised in farms. By the number of substitutable amino acids (arginine, proline, serine, alanine, glycine) in 12 cuts of cattle of Kazakh whitehead breed of I and III rearing groups, the 1st rearing group differs favorably (Table 6).

To study meat productivity of young cattle of meat breeds (Auliekol, Kazakh Whitehead, Galloway, Hereford) depending on the breed, sex, and age (young bulls, steers-calves, heifers, first-calf cows, cattle-cows, bulls, calves) studies were conducted on cutting and deboning of cattle half-carcasses in the Western Region of the Republic of Kazakhstan in the period of winter (January-February), turning winter (pre-spring), early spring and spring periods (Table 7-10). After cutting and deboning of cattle during winter it was established that the highest slaughter yield among adult animals: The Kazakh white-headed bull breed-61.4% with a pre-slaughter weight of 478.6 kg; the lowest yield-the Hereford cow breed 56.9% with a pre-slaughter weight of 446.8 kg. In the same studies for young animals, the highest and the lowest values are 58.9% for a castrated bull with a pre-slaughter weight of 475.5 kg and 52.4% for a bull of the Auliekol breed with the pre-slaughter weight of 411.9 kg, respectively.

During cutting and deboning of cattle in the period of a turning winter (pre-spring) it was established that the highest slaughter yield among adults was in a cow of the Auliekol breed-59,2% with the pre-slaughter weight of 480,2 kg; and the lowest slaughter yield was in a bull of the Hereford breed-56,5%, with the pre-slaughter weight of 521,4 kg. Also, according to young animals: The highest and lowest slaughter yield values were 59.3% for the Galloway breed castrate bull with a pre-slaughter weight of 428.8 kg and 50.8% for the Hereford breed bull with a pre-slaughter weight of 372.3 kg, respectively.

After finishing cutting and deboning of cattle in the Western Region of the Republic of Kazakhstan in early spring it was established that the highest slaughter yield among the adult animals was in a bull of Hereford breed-59,0% with the preslaughter weight of 442,2 kg; the lowest yield was in a cow of Hereford breed-53,6% with the preslaughter weight of 410,0 kg. For the same studies of young cattle: The highest and lowest values are 60.2% for the Hereford breed steer with a pre-slaughter weight of 431.8 kg and 54.0% for the calf of the same breed with a pre-slaughter weight of 291.1 kg, respectively.

After completion of the processes of cutting and deboning of cattle in the spring period, it was established that the highest slaughter yield among the adult animals: The cow of the Auliekol breed-63,7% with a pre-slaughter weight of 532,8 kg; and the lowest yield-the cow of the Galloway breed 55,9% with the pre-slaughter weight of 471,0 kg. In similar studies of young animals, the highest and the lowest values were 61.3% in a bull of the Auliekol breed with a pre-slaughter weight of 460.1 kg and 51.9% in the first heifer of the Hereford breed with the pre-slaughter weight of 411.0 kg respectively.

We studied essential (arginine, praline, serine, alanine, glycine) and non-essential (lysine, tyrosine, phenylalanine, histidine, leucine + isoleucine, methionine, valine, threonine) amino acids in cuts of young cattle of Auliekol, Galloway and Hereford housed-farming breeds (Table 11, 12). The amino acid composition of the main 14 cuts of two different breeds of stall-fed cattle-Auliekol and Galloway. The quantity of non-essential amino acids (arginine, proline, serine, alanine, glycine) is higher in 10 cuts of meat of Auliekol breed: Neck cut-8.542%, rib-12.24%, shank-7.562%, brisket-10.312%, inside round-13.191%, flat rib-7.377%, chuck rib-6.02%, blade meat-7.812%, sirloin-6, 265%, hind shank-5.633% and in 4 cuts of meat of Galloway breed: Flank-13.421%, eye of round-10.334%, thick flank - 8.41%, outside around-8.01%.

The study of the total amount of essential amino acids (lysine, tyrosine, phenylalanine, histidine, leucine + isoleucine, methionine, valine, and threonine) in cattle cuts of two breeds showed that the highest amounts of essential amino acids were in 9 cuts of Auliekol breed (neck cut-7.614, rib-7.991, flank-14.716%, the eye of round-10.219%, inside round-10.32%, outside round-7.51%; chuck rib- 4.83%, sirloin-5, 32%; hind shank-4.883%) and 5 cuts of Galloway breed (shank-6.84%, brisket-9.602%, thick flank-6.82%, flat rib-7.15%, blade meat-7.13%).

The essential (arginine, praline, serine, alanine, glycine) and non-essential (lysine, tyrosine, phenylalanine, histidine, leucine + isoleucine, methionine, valine, threonine) amino acids in cuts of young cattle of Hereford breed were studied.

The study of non-essential amino acids in 14 cuts of stall-fed Hereford cattle breeds found that the following cuts favorably differ in the amount of the above amino acids: Eye of round-10.012±0.45%, brisket-10.07±0.46%, rib-11.72±0.49%, flank-11.977±0.51%, inside round-12.015±0.52%.

The results of determining the total amount of essential amino acids (lysine, tyrosine, phenylalanine, histidine, leucine + isoleucine, methionine, valine, threonine) in cattle cuts of different breeds revealed, that the number of essential amino acids the highest values in 3 cuts (inside round-10.05±0.46%, the eye of round-10.345±0.48%, flank-13.82±0.54%.

Table 1: Main indicators of the slaughter of Kazakh white-headed and Auliekol breeds of castrated steers

	Body condition of the animal						
		I group		II group			III group
Indicator	Well Nourished cattle	Medium nourished cattle	P	Well nourished cattle	Medium nourished cattle	P	Medium nourished cattle
Weight, kg:							
- In housing	480,2±8,30	412,4±7,6	0.001	472,0±9,20	359,5±7,4	0.001	452,3±8,10
- After transportation	474,0±10,1	407,0±6,0	0.001	467,0±8,40	352,0±7,9	0.001	446,5±7,60
- Preslaughter	469,0±7,00	402,0±7,8	0.002	441,0±11,9	329,1±9,8	0.001	440,4±6,60
Hot carcass weight, kg	233,0±4,40	191,0±4,5	0.001	246,0±5,80	175,0±3,7	0.001	206,1±4,10
Carcass yield, %	49,68±0,00	47,51±00		55,78±0,00	53,33±0,0		46,8±0,00
Weight of internal fat, kg	19,0±0,30	9,7±0,3	0.001	12,3±0,20	6,8±0,1	0.001	6,4±0,10
Internal fat yield, %	4,05±0,00	2,41±0,0		2,79±0,00	2,07±0,0		3,6±0,00
Slaughter weight, kg	252,0±4,30	200,7±4,5	0.001	258,3±5,00	182,3±4,5	0.001	212,5±4,40
Slaughter yield, %	53,73±0,00	49,92±0,0		58,57±0,00	55,40±0,0		48,2±0,00

Table 2: Content of tissue types in Kazakh white-headed and Auliekol beef carcasses

	Body condition of the animal						
	I			II			III
Content of tissue, kg	Well-nourished cattle	Medium nourished cattle	P	Well nourished cattle	Medium nourished cattle	P	Medium nourished cattle
Muscle tissue	131,9±4,20	114,0±2,3	0.010	141,0±4,2	105,9±2,20	0.001	112,1±2,21
Fat tissue	37,5±0,74	20,1±0,4	0.001	41,3±0,8	19,6±0,41	0.001	21,0±0,42
Connective tissue	26,8±0,53	23,5±0,7	0.001	26,6±0,5	20,5±0,44	0.001	36,3±0,71
Bone and cartilage tissue	36,8±1,10	33,4±1,0	0.010	37,1±1,1	29,1±0,52	0.001	36,7±0,58

Table 3: Percentage content of tissue types in the carcasses of Kazakh white-headed and Auliekol breeds of beef

		Content of tissue, % to carcass weight			
Group	Body condition of the animal	Muscle tissue	Fat tissue	Connective tissue	Bone and cartilage tissue
I	Well-nourished cattle	56,6.00	16,1.000	11,5.00	15,8.00
	Medium nourished cattle	59,7.00	10,5.000	12,3.00	17,5.00
	P	0.05	0.001	0.05	0.01
II	Well-nourished cattle	57,3.00	16,8.000	10,8.00	15,1.00
	Medium nourished cattle	60,5.00	11,2.000	11,7.00	16,6.00
	P	0.05	0.001	0.02	0.01
III	Medium nourished cattle	54,4.00	10,2.000	17,6.00	17,8.00

Table 4: Physical and chemical characteristics of muscle tissue of beef carcasses

	Group		
Indicator	I	III	P
	pH (after slaughtering)		
Shoulder cut	6,02±0,26	6,31±0,22	n/s
m. longissimus dorsi	5,97±0,31	6,28±0,22	<0.05
pH (after 24 h)			
Shoulder cut	6.01±0,28	6,23±0,35	n/s
m. longissimus dorsi	5,58±0,29	6,18±0,45	<0.02
Quality indicators			
Mass fraction of moisture, %	73,1± 0,90	71,64±0,47	n/s
Mass fraction of protein, %	19,5±0,68	22,6±0,80	<0.002
Mass fraction of fat, %	6,37±1,19	4,14±0,77	<0.001
Water holding capacity, %	56,1±0,19	54,16±0,31	n/s
Digestibility, mg tyrosine/g protein	16,5±0,46	19,22±0,57	<0.002

Table 5: Content of essential amino acids (lysine, tyrosine, phenylalanine, histidine, leucine + isoleucine, methionine, valine, threonine) in beef cuts of Kazakh whitehead breed, %/100 g of protein

	Sum of amino acids		
Name of cuts	I	III	P
Neck cut	7,614±0,15	7,578±0,21	n/s
Rib	7,13±0,18	6,98±0,12	n/s
Shank	7,991±0,21	7,732±0,14	n/s
Brisket	14,712±0,36	14,205±0,28	n/s
Inside round	10,214±0,32	9,905±0,21	n/s
Eye of round	10,325±0,36	10,051±0,2	n/s
Outside round	7,51±0,20	7,23±0,14	n/s
Flat rib	6,82±0,11	6,36±0,12	<0.05
Chuck rib	4,83±0,12	4,48±0,09	<0.05
Blade meat	7,15±0,18	7,05±0,14	n/s
Flank	5,32±0,14	5,10±0,15	n/s
Hind shank	4,883±0,08	7,523±0,15	<0.001

Table 6: Content of non-essential amino acids (arginine, proline, serine, alanine, glycine) in beef cuts of Kazakh whitehead breed, %

Cut	I	III	P
Neck cut	8,542±1,60	8,330±0,21	n/s
Rib	12,24±0,25	11,98±0,28	n/s
Shank	7,562±0,16	7,451±0,17	n/s
Brisket	10,312±0,22	10,023±0,28	n/s
Inside round	13,191±0,31	12,988±,036	n/s
Eye of round	10,334±0,26	10,185±0,25	n/s
Outside round	8,01±0,17	7,86±0,23	n/s
Flat rib	7,377±0,14	7,053±0,18	n/s
Chuck rib	6,02±0,12	5,96±0,12	n/s
Blade meat	7,812±0,16	7,68±0,25	n/s
Flank	13,421±0,28	13,256±0,32	n/s
Hind shank	5,633±0,11	5,593±0,14	n/s

Table 7: Indicators of meat productivity of cattle in the western region of Kazakhstan during the wintertime

		Weight, kg							
Cattle breed	Sex	Age, month	Live	Preslaughter	Carcass	Internal Fat	Carcass yield, %	Feed consumption per 1 kg of growth, feed units.	Caloric value of meat per kg, kJ
Auliekol	Bull calf	18	424,0	411,9	205,2	10,9	52,4	8,0	6900
	Castrated bull calf	18	422,0	416,9	222,6	5,65	54,9	8,0	6822
	Heifer	18	411,0	406,4	217,0	5,45	54,8	8,6	6814
	First-calf heifer	24	417,0	409,2	223,8	5,43	56,3	9,2	6800
	Cow	40	455,2	443,7	248,0	15,1	59,3	11,0	8874
	Bull	40	493,7	480,0	260,0	17,8	57,9	10,5	9001
	Veal calf	2,5	80,4	78,0	36,8	1,0	48,5	-	-
	Calf	11	319,1	301,9	154,4	10,1	54,5	15,8	7819
Kazakh whitehead	Bull calf	18	427,3	418,8	229,5	13,0	57,9	12,7	8521
	Castrated bull calf	18	487,1	475,5	264,4	15,7	58,9	11,0	9648
	Heifer	18	445,6	432,0	239,3	15,1	58,89	7,4	7593
	First-calf heifer	24	476,6	467,7	264,4	9,6	58,6	8,0	8012
	Cow	40	499,4	471,1	258,0	19,3	58,8	8,4	9912
	Bull	40	498,2	478,6	286,4	7,4	61,4	8,5	8327
	Veal calf	2,5	78,8	76,1	35,6	0,9	48,0	-	-
	Calf	11	339,0	311,0	154,1	5,7	51,4	14,9	7081
Galloway	Bull calf	18	405,0	391,0	212,7	7,9	54,5	12,6	7145
	Castrated bull calf	18	433,3	424,2	217,4	11,2	53,9	9,0	7785
	Heifer	18	424,9	417,8	220,6	10,1	55,2	9,1	7774
	First-calf heifer	24	450,7	439,8	238,4	8,5	56,0	9,6	7681
	Cow	40	463,9	445,4	239,9	13,2	57,4	10,9	8894
	Bull	40	495,6	468,8	256,9	19,2	58,9	9,2	9387
	Veal calf	2,5	73,9	70,2	32,7	0,8	47,7	-	-
	Calf	11	333,1	318,0	167,9	7,0	55,0	16,1	6687
Hereford	Bull calf	18	412,7	406,0	210,1	11,0	54,44	11,5	7033
	Castrated bull calf	18	435,3	430,7	227,5	12,3	55,67	12,4	7891
	Heifer	18	441,8	433,3	235,6	13,4	56,06	12,3	7899
	First-calf heifer	24	462,5	442,1	236,1	12,8	56,2	12,6	7774
	Cow	40	464,5	446,8	241,3	13,4	56,9	13,3	7980
	Bull	40	525,3	502,3	276,3	10,0	57,0	11,1	7210
	Veal calf	2,5	80,0	77,2	36,2	0,9	48,1	-	-
	Calf	11	323,9	300,1	153,8	10,65	54,8	16,0	7699

Table 8: Indicators of meat productivity of cattle in the western region of Kazakhstan during the turning winter (pre-spring) time

		Weight, kg							
Cattle breed	Sex	Age, month	Live	Preslaughter	Carcass	Internal fat	Carcass yield, %	Feed consumption per 1 kg of growth, feed units.	Caloric value of meat per 1 kg, kJ
Auliekol	Bull calf	18	455,5	432,6	238,8	9,1	57,3	8,5	8164
	Castrated bull calf	18	411,8	389,8	215,8	5,5	56,8	10,0	7841
	Heifer	18	388,9	367,3	197,3	6,2	55,4	10,1	7604
	First-calf heifer	24	409,1	388,7	217,7	5,0	57,5	10,5	7710
	Cow	40	483,2	463,9	266,7	8,0	59,2	11,6	8045
	Bull	40	491,7	470,3	267,1	8,7	58,6	11,0	8111
	Veal calf	2,5	78,8	76,1	35,6	0,8	48,0	-	-
	Calf	11	336,2	327,4	173,4	7,4	55,3	15,2	7009
Kazakh whitehead	Bull calf	18	414,0	390,0	209,0	4,5	54,7	9,9	7015
	Castrated bull calf	18	451,4	413,0	229,7	4,4	56,5	8,4	7008
	Heifer	18	372,4	325,0	171,6	5,3	54,4	11,5	7814
	First-calf heifer	24	456,5	444,6	242,3	12,2	57,2	9,8	9046
	Cow	40	485,0	467,0	255,4	13,1	57,5	11,7	9154
	Bull	40	483,0	466,2	254,5	12,8	57,3	11,7	9141

Table 8: Continue

	Veal calf	2,5	69,8	64,1	30,1	0,8	48,2	-	-
	Calf	11	328,1	318,3	155,1	8,0	54,0	17,3	6155
Galloway	Bull calf	18	445,3	426,8	233,9	18,6	59,2	8,0	9987
	Castrated bull calf	18	431,8	413,0	228,4	16,4	59,3	8,4	9574
	Heifer	18	415,1	398,2	213,8	14,3	57,3	8,9	9021
	First-calf heifer	24	453,7	436,2	227,6	11,5	54,7	9,0	8742
	Cow	40	469,7	454,5	244,2	13,5	56,7	9,7	8944
	Bull	40	523,3	502,3	276,3	10,0	57,0	8,0	8399
	Veal calf	2,5	73,9	70,2	32,8	0,7	47,7	-	-
	Calf	11	348,0	328,0	165,8	4,78	52,0	15,5	7132
Hereford	Bull calf	18	375,3	361,1	182,5	0,9	50,8	11,5	6054
	Castrated bull calf	18	417,0	393,3	206,9	1,0	52,6	11,2	6260
	Heifer	18	407,2	372,0	202,5	3,1	55,2	11,4	6420
	First-calf heifer	24	408,7	372,3	197,8	5,3	53,1	10,8	7751
	Cow	40	513,4	506,1	280,2	12,9	57,9	9,0	8565
	Bull	40	530,3	521,4	283,1	11,8	56,5	8,2	8812
	Veal calf	2,5	78,8	76,1	35,6	0,9	48,0	-	-
	Calf	11	320,1	301,9	154,4	10,1	54,5	16,1	7701

Table 9: Indicators of meat productivity of cattle in the western region of Kazakhstan during the early springtime

		Weight, kg						Feed consumption per 1 kg of growth, feed units.	Caloric value of meat per 1 kg, kJ
Cattle breed	Sex	Age, month	Live	Preslaughter	Carcass	Internal fat	Carcass yield, %		
Auliekol	Bull calf	18	397,3	382,3	209,3	2,2	55,4	14,4	6844
	Castrated bull calf	18	425,8	397,6	205,3	3,0	52,4	10,2	7145
	Heifer	18	420,9	388,5	198,2	2,9	51,8	11,73	7068
	First-calf heifer	24	413,6	401,2	216,4	12,7	57,1	12,3	7415
	Cow	40	451,7	426,4	245,1	3,1	58,2	13,7	7111
	Bull	40	449,1	426,2	242,9	2,9	57,7	13,8	6990
	Veal calf	2,5	69,1	64,2	30,3	0,6	48,1	-	-
	Calf	11	325,1	318,3	165,1	9,0	54,7	15,0	6200
Kazakh whitehead	Bull calf	18	413,6	401,2	216,4	12,7	57,1	10,8	7448
	Castrated bull calf	18	424,7	412,3	221,8	13,7	57,1	9,9	8447
	Heifer	18	408,0	395,4	222,1	12,1	59,23	10,6	7847
	First-calf heifer	24	388,5	367,4	196,2	9,5	56,0	17,7	7254
	Cow	40	449,5	426,2	242,9	3,0	57,7	15,1	7102
	Bull	40	446,3	420,0	236,7	2,1	56,8	15,2	7007
	Veal calf	2,5	69,8	64,1	30,1	0,8	48,2	-	-
	Calf	11	315,1	304,7	162,9	8,3	56,2	15,2	7112
Galloway	Bull calf	18	432,5	392,3	210,3	2,0	54,1	9,2	6957
	Castrated bull calf	18	443,3	405,7	217,7	3,0	54,4	9,6	7257
	Heifer	18	391,0	370,0	194,4	2,1	55,2	11,4	6847
	First-calf heifer	24	451,6	432,9	224,5	10,2	54,2	10,2	7584
	Cow	40	441,8	417,6	233,6	4,0	56,9	13,6	7014
	Bull	40	438,4	413,3	224,5	4,3	55,6	13,3	7248
	Veal calf	2,5	73,5	69,7	32,6	0,8	48,0	-	-
	Calf	11	305,5	339,6	160,0	8,0	55,0	15,5	7026
Hereford	Bull calf	18	427,8	416,8	234,2	13,3	59,38	9,3	7981
	Castrated bull calf	18	442,4	431,8	244,8	14,3	60,0	8,7	8017
	Heifer	18	438,0	426,3	239,7	13,6	59,42	8,7	7978
	First-calf heifer	24	438,2	428,8	235,0	12,9	57,8	10,7	7877
	Cow	40	434,6	410,0	215,5	4,2	53,6	12,1	7354
	Bull	40	459,5	442,2	246,3	14,8	59,0	10,5	8454
	Veal calf	2,5	66,0	63,2	29,4	0,7	47,7	-	-
	Calf	11	300,4	291,1	148,4	8,8	54,0	17,0	6196

Table 10: Indicators of meat productivity of cattle in the western region of Kazakhstan during the springtime

		Weight, kg						Feed consumption per 1 kg of growth, feed units.	Caloric value of meat per 1 kg, kJ
Cattle breed	Sex	Age, Month	Live	Preslaughter	Carcass	Internal fat	Carcass yield, %		
Auliekol	Bull calf	18	483,0	460,1	267,8	14,3	61,3	10,5	9713
	Castrated bull calf	18	522,3	488,0	280,5	14,2	60,4	7,6	7136
	Heifer	18	445,5	431,6	218,7	12,0	53,5	8,6	8459
	First-calf heifer	24	413,6	401,2	216,4	12,7	57,1	12,2	7402
	Cow	40	552,7	532,8	321,3	18,4	63,7	8,4	10116
	Bull	40	535,4	512,3	288,9	21,2	60,5	8,1	10039
	Veal calf	11	307,2	298,8	153,4	7,9	54,0	16,0	6900

Table 10: Continue

	Calf	18	418,8	411,7	210,3	8,8	53,22	7,5	8861
Kazakh whitehead	Bull calf	18	482,4	449,3	257,1	19,1	53,0	10,2	9729
	Castrated bull calf	18	475,2	442,4	244,7	13,2	58,3	8,3	9159
	Heifer	24	420,7	381,7	206,0	8,9	56,3	8,2	9398
	First-calf heifer	40	504,9	490,7	261,7	13,9	56,2	9,7	10005
	Cow	40	516,1	508,4	290,0	16,4	60,3	10,1	10107
	Bull	11	302,1	318,3	155,1	8,0	54,0	17,0	6155
	Veal calf	18	413,1	399,8	198,4	10,7	52,3	8,3	8271
	Calf	18	404,8	387,3	206,4	9,7	55,8	9,8	8568
Galloway	Bull calf	18	436,7	423,7	227,9	10,8	56,4	7,9	8577
	Castrated bull calf	24	435,6	431,5	236,3	5,43	56,2	10,9	8177
	Heifer	40	497,3	471,0	247,0	16,3	55,9	8,7	7541
	First-calf heifer	40	513,0	488,3	262,7	17,1	57,3	7,3	10143
	Cow	11	315,0	300,0	151,9	5,03	52,3	15,3	6698
	Bull	18	463,1	442,0	223,7	13,7	53,7	10,3	8892
	Veal calf	18	461,2	447,0	246,9	12,63	58,06	8,7	9213
	Calf	18	400,1	388,2	199,1	14,0	54,92	9,7	8093
Hereford	Bull calf	24	420,0	411,0	213,3	4,4	51,9	8,4	6600
	Castrated bull calf	40	509,2	485,0	271,7	17,7	59,7	10,4	7303
	Heifer	40	542,7	517,7	294,0	16,5	60,0	10,2	7134
	First-calf heifer	11	343,9	328,4	174,4	7,5	55,4	16,2	7049
	Cow	18	483,0	460,1	267,8	14,3	61,3	10,5	9713
	Bull	18	522,3	488,0	280,5	14,2	60,4	7,6	7136
	Veal calf	18	445,5	431,6	218,7	12,0	53,5	8,6	8459
	Calf	24	413,6	401,2	216,4	12,7	57,1	12,2	7402

Table 11: The content of non-essential amino acids in beef cuts of different breeds

	Amount of non-essential amino acids depending on cattle breed, %		
Beef cuts	Auliekol	Galloway	Hereford
Neck cut	8,542	8,54	7,5*
Rib	12,24	11,5	11,72
Shank	7,562	6.0*	8,2**
flank	13,191	13,421	11,977**
Eye of round	10,111	10,334	10,012
Brisket	10,312	10,288	10,07
thick flank	8,41	8,41	7,81**
inside round	13,191	12,65	12,015**
outside round	7,97	8,01	7,4**
Flat rib	7,377	7,11	8,5*
Chuck rib	6,02	5,55**	4,5*
blade meat	7,812	7,812	8,5**
sirloin	6,265	6,165	4,35*
hind shank	5,633	5,41	5,8

*P<0.001; **P<0.01

Table 12: The content of essential amino acids in beef cuts of different breeds

	Amount of essential amino acids depending on cattle breed, %		
Beef cuts	Auliekol	Galloway	Hereford
Neck cut	7,614	7,534	7,01**
Rib	7,991	7,819	8,56*
Shank	6,799	6,84	6,70
flank	14,716	14,553	13,82**
Eye of round	10,219	9,97	10,345
Brisket	9,478	9,602	8,3*
thick flank	6,775	6,82	7,81*
inside round	10,32	10,289	10,05
outside round	7,51	7,329	8,3**
Flat rib	7,01	7,15	7,6**
Chuck rib	4,83	4,642	4,5**
blade meat	6,98	7,13	8,5*
sirloin	5,32	5,03**	5,3
hind shank	4,883	4,43*	5,1

*P<0.001; **P<0.01

Discussion

Under the conditions of industrial complexes, the livelihood of animals is completely dependent on the housing system. Farms provide a high number of livestock in a limited area and intensive use, which affects the quality of beef (Smakuyev *et al*., 2021; Nugmanova *et al*., 2021).

The meat productivity of cattle is directly related to the growth and development of the animal. As a result of biological processes, the body weight growth and accumulation of nutrients in the animal body take place (Mironova *et al*., 2021).

The quality of beef is determined by the ratio of its constituent tissues-muscle, fat, connective, bone, and cartilage tissue and their chemical and physical properties (Yuldashbaev *et al*., 2022; Kaurivi *et al*., 2020).

The analysis of the above data shows that the quality of beef is largely determined by the ratio of its constituent tissues-muscle, fat, connective, bone, cartilage, and their chemical and physical properties, as well as their optimal ratio.

According to the UNECE International Standard, trimming the external fat is done by carefully separating along the contour of the surface of the muscles under the fat. When it is necessary to thoroughly remove fat from the surface of the meat, trimming the fat once is not sufficient. Fat thickness requirements may apply to surface fat (subcutaneous and/or exterior fat, depending on the product) and intermuscular fat (marbling) as specified by the customer (Razmaitė *et al*., 2020; Pećina and Ivanković, 2021).

It is noticed a decrease in the proportion of fatty tissue in the beef of medium fatness of the first and second groups, by 6% compared with the highest category of fatness. From the animals from private farms, the lowest yield of muscle tissue was also obtained-54.4%. The difference is due to both the principle of fattening and selection of beef feeding rations and the breed of cows.

When raising cattle, there are a large number of factors that lead to a deterioration in the quality of beef. The choice of breeding conditions must be accompanied by a careful evaluation of the quality indicators of slaughter products (Xie *et al*., 2012; Oraz *et al*., 2019). Summarizing the data obtained, it should be noted that in the fresh meat, the muscle tissue had pH values that are typical for the quality group according to the international standard. In general, the pH of beef from animals raised on private farms was higher in both the fresh and chilled state, regardless of the muscle type. Considering that shifting the pH of chilled meat closer to the value of 6.2 results in more red meat with a higher water holding capacity, we can state that meat from farm-raised animals would be more valuable for processing. By calculation, it is shown that with an increase in water holding capacity by 2% from 100 head of cattle the enterprise will get up to 112 kg of meat additionally.

The biological value of beef depends to a large extent on the qualitative composition of meat proteins and the degree of balance of the amino acid composition (Mwangi *et al*., 2019; Karwowska *et al*., 2021). Analysis of the amino acid composition showed that when growing cattle in the conditions of private farms, the meat obtained is less consistent with the recommended indicators, in contrast to the meat obtained from the animals raised on farms.

As a result of the studies, differences in the quality of meat obtained from different breeding groups were established.

Conclusion

Thus, it was established that the highest slaughter yield among adult animals was in the cow of the Auliekol breed-63.7% with the pre-slaughter weight of 532.8 kg; the lowest yield was in the cow of the Hereford breed-53.6% with the pre-slaughter weight of 410.0 kg. According to the results for young cattle, the highest and the lowest values were observed for a bull of the Auliekol breed with a pre-slaughter weight of 460.1 kg and 50.8% for a bull of the Hereford breed with a pre-slaughter weight of 372.3 kg, respectively. It was determined that the best and the worst indicators of fodder consumption per 1 kg of growth in the Kazakh white-headed breed - an adult bull at the age of 40 months (7.3 fodder units) and a calf (11 months) of the Kazakh white-headed breed - 17.3 fodder units. The highest indicator of meat caloric content is in a bull (40 months old) of the Galloway breed (10143 kJ). The quality indicators of meat obtained during the growing and feeding of young cattle of different breeds are established. Based on the data, we can determine that compared to the autumn period, there is a slight decrease in such parameters as pre-slaughter weight, caloric value, and slaughter yield. The studies showed that to produce export-oriented high-quality beef, producers need to consider the breed, sex, age, conditions of animal breeding, observe optimal conditions of transportation, pre-slaughter housing, slaughtering, production processes, and sales.

Acknowledgment

This research was funded by the Ministry of Agriculture of Kazakhstan, grant number IRN BR10764970.

Author’s Contributions

Gulzat Oraz: Wrote the first draft of the manuscript, and managed the analyses of the study and the literature search.

Asan Ospanov: Design the study wrote the protocol, and final manuscript reading, design the research plan, and organized the study.

Urishbay Chomanov: Supervision, project administration, design of the study, final manuscript proofreading, design of the research plan, and organized the study.

Anastasia Semenova: Performed the statistical analysis, and contribute to the writing of the manuscript.

Svetlana Islyakova: Managed the analyses of the study and the literature searches.

Ethics

The authors should address any ethical issues that may arise after the publication of this manuscript.

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