ANIMAL SCIENCE AND FOOD TECHNOLOGY

Journal homepage: https://animalscience.com.ua/en
Animal Science and Food Technology, 15(2), 93-106
Received 05.02.2024 Revised 17.04.2024 Accepted 29.05.2024

UDC 636.27.082.31:612.73/.74:591.175:637.5
DOI: 10.31548/animal.2.2024.93

The area of loin eye in bulls of the Ukrainian Black-and-White dairy breed and its relationship with beef characteristics

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Abstract. The relevance of the work was to determine whether the loin eye area of *m. longissimus dorsi* as a criterion for evaluating the yield of high-value cuts from beef carcasses, is associated with beef characteristics from bulls of the Ukrainian Black-and-White dairy breed. The purpose of the study was to establish correlations between the loin eye area and the slaughter characteristics by the chemical composition, sensory, physical and technological properties of beef. The correlation between the cross-sectional area of the oblong muscle and slaughter indicators, the quality of carcasses, the chemical composition, sensory, physical and technological properties of beef was studied in the bulls of Ukrainian Black-and-White dairy breed (UBWDB) aged from 18 to 24 months. A linear correlation was established between the loin eye area and the slaughter weight ($r = 0.404$; $P > 0.95$), the amount of muscle tissue ($r = 0.355$; $P > 0.95$), including the highest ($r = 0.680$; $P > 0.999$) and the first ($r = 0.501$; $P > 0.99$) grades, the content of fat tissue in the carcass ($r = 0.477$; $P > 0.99$). The loin eye area correlated inversely ($r = -0.607$; $P > 0.95$) with t he amount lost in boiling beef, the amount of second-class muscle tissue ($r = -0.377$; $P > 0.95$), the development of subcutaneous fat ($r = -0.395$; $P > 0.95$), the total ash mass ($r = -0.560$; $P > 0.95$), the juiciness of boiled meat ($r = -0.522$; $P > 0.95$), taste and aroma of broth ($r = -0.587$; $P > 0.95$). There was a tendency for an inverse correlation between the loin eye area and the total fat content of beef ($r = -0.119$), protein

Suggested Citation:
Kruk, O., & Ugnivenko, A. (2024). The area of loin eye in bulls of the Ukrainian Black-and-White dairy breed and its relationship with beef characteristics. *Animal Science and Food Technology*, 15(2), 93-106. doi: 10.31548/animal.2.2024.93.

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(r = -0.401), dry matter (r = -0.403), acidity (r = -0.458), muscle tissue colour (r = -0.126), conformation (r = -0.127), penetration (r = -0.477), taste (r = -0.214) and aroma (r = -0.363) of boiled meat, tenderness (r = -0.256), residue after chewing (r = -0.442), the thickness of broth (r = -0.207), and to a linear correlation – with the amount of tendons and ligaments (r = 0.331), marbling (r = 0.162), the colour of fat tissue on the carcass (r = 0.276), transparency of the broth (r = 0.180). The practical significance of the data is to obtain knowledge that allows formulating marketing strategies for predicting food quality, quantity of premium and first-grade beef, its technological properties and intended use based on the correlation between the loin eye area of *m. longissimus dorsi*

Keywords: meat productivity; conformation; marbling; carcass quality traits; sensory characteristics of meat

Introduction

To improve food quality and consumer safety, it is important that the quantitative and qualitative characteristics of meat from Ukrainian cattle meet international standards. Beef of different cuts has different nutritional quality, since it varies under the influence of many factors, and affects the cost of products. It is technologically difficult to determine their number during the life of an animal. Therefore, it is relevant to establish methods for predicting the slaughter characteristics, chemical composition, physical, technological and sensory properties of beef from animals of common Ukrainian breeds by the area of the loin eye of *m. longissimus dorsi*.

The loin eye area is the cross-section of the oblong muscle between the 12th and 13th ribs, which is determined by dividing the carcass into quarters. As noted by A. Ugnivenko *et al.* (2022), the loin eye area of *m. longissimus dorsi* in cattle depends on the breed of animals. Thus, bulls of the Korean Hanvoo breed at the age of 30 months have an average loin eye area of 87.4 cm^2 (Bhuiyan *et al*., 2017), and Ukrainian meat cattle aged 22 months – 133.5 cm^2 (Ugnivenko *et al.,* 2022). Data on the loin eye area of *m. longissimus dorsi* is used to determine the optimal growth parameters of dairy cattle during their rearing for meat, determine the age and live weight for slaughter, and predict the resulting beef and its belonging to a certain variety through a direct connection with valuable carcass cuts. A linear positive correlation between the loin eye area of *m. longissimus dorsi* and pre-slaughter live weight and carcass weight were established by M.S.A. Bhuiyan *et al.* (2017) in bulls of the Hanvoo meat breed.

According to A. Ugnivenko *et al.* (2022), in Ukrainian beef cattle, the loin eye area of *m. longissimus dorsi* has a linear significant correlation with slaughter weight (r = 0.614; P > 0.95) and slaughter yield (r = 0.653; P > 0.95). This indicates a better effect on the development of muscle tissue in the carcass. Similar results were obtained (Naserkheil *et al.,* 2021; Piment-el-Concepción *et al.,* 2024) in studies of genetic correlations of the yield of primary cuts with qualitative features of the carcass and it was found that genetic correlations with the carcass weight and the loin eye area of *m. longissimus dorsi* were moderate to very strong; while low, moderate, and negative correlations were observed between primary cut characteristics with marbling and subcutaneous fat thickness. The relevance of these studies is also confirmed by G. Bittante (2023), since beef quality chartacteristics cannot be directly measured on live animals, unlike traits related to growth, productivity, and disease resistance, the study of

correlation of the loin eye area of *m. longissimus dorsi* with qualitative characteristics of beef would allow predicting its quality. Thus, with the same weight of carcasses and the content of fat tissue in them, an increase in the cross-sectional area of the oblong muscle indicates an increase in the yield of valuable cuts and a larger weight of steaks from them, which are the most profitable to sell. These are the features that manufacturers and processors are interested in.

According to I. Randhawa *et al.* (2021), consumers make their choices based on the nutritional value and sensory characteristics of beef. Therefore, A. Ugnivenko *et al.* (2022) determined of the relationship between the qualitative characteristics of beef and the loin eye area of *m. longissimus dorsi* in animals of the Ukrainian meat breed. It was found that there is a tendency to a weak inverse correlation (r = -0.193) between the cross-sectional area of the oblong muscle and the tenderness of meat, the content of dry matter in it (r = -0.345). The depth of the loin eye most correlates with the technological properties of beef. Data on the correlation between the loin eye area of *m. longissimus dorsi* with the qualitative characteristics of beef in animals of meat breeds is not enough to interpret dairy cattle. According to J. Soulat *et al.* (2022), the management approach that allowed for the best ratio between carcass and meat quality was intermediate rearing over a long fattening period, with the diet mainly based on hay and a high amount of concentrated feed. Such conditions allowed producing carcasses with a high conformation, smooth grain of meat, more uniform colour, darker and tastier meat, and low moisture content. The purpose of the study was to establish correlation relationships between the cross-sectional area of *m. longissimus dorsi* and slaughter characteristics, chemical composition, and qualitative characteristics of meat in bulls of the Ukrainian Black-and-White dairy breed, which is used in Ukraine both for the production of milk and beef.

Materials and Methods

The study was conducted on 34 bull carcasses at the "Zhuravushka" farming enterprise (FE) in the Brovary District, Kyiv Oblast. The animals were kept in groups of 25 units from birth to the age of 4 months. They were then reared and fattened to slaughter at the age of 18-24 months at the fattening facility based on their age. The farm's feed needs were met by its own fodder base. The bulls had free access to roughage, juicy, green, concentrated feed and mineral supplements, which were fed from the self-feeders in accordance with the developed rations. The cattle were slaughtered in the slaughterhouse in Kalynivka village following the Council Regulation (EC) No. 1099/2009 (2009). The animals were stunned with an electric current before exsanguination. Carcasses were suspended vertically on hooks by the fusion between the calcaneus bone and Achilles tendon. After evisceration, the carcasses were divided into halves and cleaned of excess fat and meat.

Carcasses were weighed and visually evaluated for conformation and subcutaneous fat development in accordance with the Commission Regulation (EC) system (2009). The conformation of carcasses was classified on a scale of 5 classes: from E (very high muscle development) to P (very low muscle development). Subcutaneous fat development was evaluated on a scale of 5 classes: from 1 (lean) to 5 (very fat). Next, the carcasses were sawn in half, and the half-carcasses were cut at the level of the 12th rib. The colour of muscle and fat tissue was determined using a 7-point scale, the marbling of meat was determined on a 12-point scale, and the thickness of subcutaneous fat on the carcass was measured between the 12th and 13th ribs in accordance with the JMGA method (2000). The length and depth of the loin eye were measured between the 12th and 13th ribs with a ruler (Fig. 1) immediately after dividing the half-carcasses into quarters.

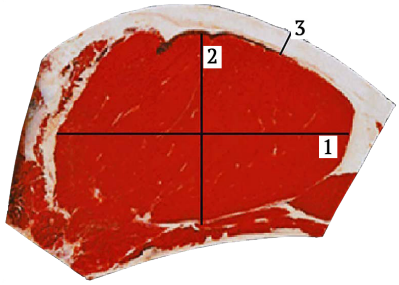

Figure 1. *Schematic division of bull carcasses into zones*
Notes: Length (1) and depth (2) of the loin eye, (3) subcutaneous fat thickness
Source: compiled by the authors

Its area was calculated in accordance with Order No. 290 "On Approval of the Instruction on Evaluation of Boars and Sows for the Quality of Offspring in Specialised Testing Stations" (2004) (equation 1):

$$S = a \times b \times 0{,}8; \quad (1)$$

where S – loin eye area, cm^2; a – loin eye length, cm; b – loin eye depth, cm; 0.8 – coefficient.

The penetration of raw meat was determined using an automatic penetrometer according to the method given in the paper (Guts & Koval, 2007). The content of bound moisture was studied by the "press method" by the amount of water that was released from the suspension of 0.3 g of crushed meat under the action of pressing and absorbed into the filter paper, forming a wet spot. The total area of the stain formed under the compressed meat and the released moisture absorbed by the filter paper was determined using a planimer. The difference between the total area of the spot and the occupied meat determined the area of the wet spot. The ability of meat to retain water was investigated by the content of bound water as a percentage of the weight of meat.

To determine the residual weight of beef after boiling down, rectangular pieces of meat weighing 150 g were cut out of *m. longissimus dorsi*. They were weighed on a THB-600 scale with an accuracy of 0.01 g. Next, they were placed in a 5-litre pot and 2-3 litres of cold distilled water were poured. The water was brought to a boil and cooked over low heat for 90 minutes. After cooking, the pieces were removed from the water, cooled to 20°C and weighed. The amount of meat lost in boiling was determined by equation (2) (Shkurin *et al.,* 2002).

$$Sm = \frac{Cm \times 100}{Rm}, \quad (2)$$

where Sm – amount lost in boiling of meat, %; Cm – weight of boiled down meat, g; Rm – weight of raw meat sample, g.

The chemical composition of beef was studied in the laboratory of the Department of Meat, Fish and Seafood Technology of the National University of Life and Environmental Sciences of Ukraine (NUBiP) in accordance with the methods described in Table 1.

Table 1. *Methods for determining the chemical composition of m. longissimus dorsi in bulls*

Studied indicators	Source
Total fat content	DSTU ISO 1443:2005 (2008)
Total ash weight	DSTU ISO 936:2008
Moisture content	DSTU ISO 1442:2005 (2008)
Protein	G.T. Shkurin *et al.* (2002)
Acidity (pH)	DSTU ISO 2917:2001 (2003)

Source: compiled by the authors

The characteristics of aroma, juiciness, tenderness, ease of chewing boiled beef, colour, taste, and strength of broth from it were determined by the tasting commission in the amount

of 8 people in the laboratory of "Meat quality" of the Department of Milk and Meat Production Technologies of the NUBiP of Ukraine.

The data were processed statistically using Microsoft Excel 2016 in combination with XLSTAT. They were evaluated using correlation coefficients calculated using appropriate methods (Osadcha, 2021). The correlation between the loin eye area and the above-mentioned quantitative and qualitative characteristics of all the studied carcasses and separately in the meat of 21-month-old bulls was calculated to compare the results obtained. The age difference in the group between them was up to 5%. Animal studies were conducted in accordance with the "General ethical principles for conducting animal experiments", approved by the First National Congress on Bioethics (Law of Ukraine No. 3447-IV "On the Protection of Animals from Cruelty", 2006), and the provisions of the "European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes" (1986).

Results and Discussion

In bulls aged 18 to 24 months and 21 months, a linear significant correlation was found between the loin eye area of *m. longissimus dorsi* and such traits as pre-slaughter live weight and carcass weight, the amount of muscle tissue, including the highest and first grades (Table 2), which mainly constitute the nutritional value of beef.

Table 2. *Correlation coefficients between the loin eye area of m. longissimus dorsi and slaughter characteristics and morphological composition of carcasses in bulls*

Indicator	Animal age at slaughter	
	from 18 to 24 months (n = 34)	including on the 21st month (n = 13)
Live weight after fasting	0.409*	0.650*
Carcass weight	0.404*	0.633*
Carcass yield	0.069	-0.285
Amount of muscle tissue	0.355*	0.524
including the highest grade	0.680***	0.811***
including first grade	0.501**	0.822***
including second grade	-0.377*	-0.367
Amount of fat tissue	0.477**	0.566*
Amount of tendons and ligaments	0.331	0.640*
Amount of bone tissue	0.049	0.160

Notes: *)P > 0.95; **)P > 0.99; ***)P > 0.99
Source: compiled by the authors

A positive insignificant correlation was established between the loin eye area and the amount of tendons and ligaments in the carcasses of 21-month-old bulls. As for the amount of bone tissue in the carcasses of experimental animals, there is no correlation.

There is also a tendency for a linear correlation between the cross-section of *m. longissimus dorsi* and the contents of tendons and ligaments in the carcass. There is practically no correlation between the number of bones in the carcasses of slaughtered animals and the loin eye area. This can be explained by the fact that the growth of muscle tissue (including *m. longissimus dorsi* an fat in the ontogenesis of cattle proceeds relatively faster, and the skeleton – slower, then the correlation between the area of the studied muscle and the content of bones is much lower. There is a reverse correlation (P > 0.95) between the cross-sectional area of *m. longissimus dorsi* and the amount of second-class beef, which has a significant amount of fat that

is not separated from the muscles during dressing. The obtained linear significant correlation coefficients between the loin eye area and quantitative characteristics of meat productivity on 21-month-old bulls better reflect the relationship between them than in the period from 18 to 24 months. Thus, the data obtained by the authors confirm the results of the study by V. Vinay-Vadillo *et al.* (2014), who reported that the loin eye area of *m. longissimus dorsi* can be used to predict the production of a certain amount of muscle tissue in the carcass, including by its belonging to the appropriate grade.

A similar relationship between the above-mentioned indicators was established in dairy breeds (Pogorzelska-Przybyłe *et al.,* 2014) and meat breeds (Ugnivenko *et al.,* 2022). So, according to R. Pogorzelska-Przybyłe *et al.* (2014), linear close correlation coefficients (r = 0.80) exist between the loin eye area of *m. longissimus dorsi* and the amount of muscle tissue in the carcasses of Holstein cattle, including the highest grade (r = 0.69). In animals of the Ukrainian meat breed, there is only a tendency to a positive relationship (r = 0.614) between the cross-sectional area of the oblong muscle, and the slaughter weight (carcass) and its output (r = 0.653).

The established linear significant correlation between the loin eye area and the slaughter weight (carcass), the amount of muscle tissue, including the highest and first grades, can be explained by the fact that the *m. longissimus dorsi* muscle is located mainly in the thoracic and lumbar regions, which are the most valuable cuts of carcass and its muscle tissue makes up a significant share. There is a linear significant correlation between the loin eye area and the total amount of fat tissue in the carcass. A similar correlation between the loin eye area of *m. longissimus dorsi* and the fat content in the carcass was also obtained by A. Oler *et al.* (2015).

Determining the correlation coefficients between the qualitative characteristics of beef carcasses evaluated in accordance with international standards, an inverse relationship was established between the loin eye area and the development of subcutaneous fat (Table 3).

Table 3. *Correlation coefficients between the loin eye area of m. longissimus dorsi and other qualitative features of bull carcasses*

Animal age at slaughter	Indicator					
	conformation	Subcutaneous fat development	Subcutaneous fat thickness	marbling	colour of muscle tissue	colour of fat tissue on the carcass
from 18 to 24 months (n = 34)	-0.127	-0.395*	-0.030	0.162	-0.126	0.276
including on the 21st month (n = 13)	0.301	-0.495	0.271	0.149	0.341	0.810***

Notes: *)P > 0.95; ***)P > 0.999

Source: compiled by the authors

There was only a tendency for a linear correlation between the cross-sectional area of *m. longissimus dorsi* and the colour of fat tissue in bulls from 18-24 months of age and a high correlation (P > 0.999) at 21 months. This can be explained by the significant content of feed rich in carotene – green (28.3%), silage (9.6), hay (8.6), haylage (4.7), and relatively small (18.5%) – concentrated. According to A. Clinquart *et al.* (2022), in cattle that were fattened

on concentrated feed without greens, subcutaneous fat had a more yellow colour. There is a tendency for both a weak inverse correlation in bulls aged 18 to 24 months and a linear correlation (in 21-month-old animals) between the loin eye area of *m. longissimus dorsi* and the thickness of subcutaneous fat, conformation, and muscle tissue colour. From 18 to 24 months, the growth rate of the longest muscle passes regardless of the fleshiness of carcasses, the thickness of subcutaneous fat, and the colour of beef.

This indicates that *m. longissimus dorsi* develops better with the worse fatness of carcasses. A. Oler *et al.* (2015) also proved that in the presence of a significant amount of subcutaneous fat, the slaughter yield (carcasses) and some of the edible parts in muscle tissue are reduced. That is, a greater development of subcutaneous fat on the carcass (its fatness) inhibits the development of the loin eye area of *m. longissimus dorsi*, and therefore, simultaneously reduces the number of valuable edible parts in it. In addition, (Kruk *et al.,* 2023) found that the best development of fat tissue under the skin does not correlate with the sensory characteristics of boiled beef and broth from it and water retention, penetration, and marbling. According to the obtained data, there is a linear weak correlation between the loin eye area of *m. longissimus dorsi* and marbling of meat, which does not guarantee its good sensory characteristics. The marbling of beef is the main factor determining its sensory quality (Sakowski *et al.,* 2022). According to T. O'Quinn *et al.* (2024), no factor has a more beneficial effect on the taste of beef than its marbling content.

In the study, there is no correlation between a certain loin eye area and the rate of water loss (Table 4). The water-binding capacity is influenced by glycolysis metabolism. It is closely related to the juiciness of beef. The lack of correlation between the loin eye area and the water-binding ability of beef affects its further technological processing, and the yield of the product made from it, which is important in cattle breeding, since the preservation of more meat during its preparation (boiling down) is an important feature. So, the technological feature of beef – boiling down – inversely correlates with the loin eye area, which indicates an increase in waste during cooking.

Table 4. *Correlation coefficients between the loin eye area of m. longissimus dorsi and technological features of beef in bulls*

Animal age at slaughter	Indicator		
	water binding capacity	boiling down	penetration
from 18 to 24 months (n = 15)	0.096	-0.607*	-0.477
including on the 21st month (n = 13)	0.015	-0.612*	-0.446

Notes: *)P > 0.95
Source: compiled by the authors

Therefore, the cross-sectional area of *m. longissimus dorsi* can be used as an indicator of boiling down of beef from bulls of the Ukrainian Black-and-White dairy breed, since it correlates with it inversely and significantly. The correlation coefficients between the cross-sectional area of *m. longissimus dorsi* and its penetration stress were average and inverse. With an increase in the loin eye area of *m. longissimus dorsi* in beef, the content of the main elements of its chemical composition decreased (Table 5). That is, evaluating carcasses for this trait does not imply an increase in important nutrients for human health.

Table 5. *Correlation coefficients between the loin eye area of m. longissimus dorsi and the chemical composition of beef*

Animal age at slaughter	Indicator					
	Acidity (pH)	moisture content	dry matter	protein	total fat content	total ash weight
from 18 to 24 months (n = 15)	-0.458	-0.086	-0.403	-0.401	-0.119	-0.389
including on the 21st month (n = 13)	-0.420	0.518	-0.519	-0.527	-0.245	-0.534

Notes: *)P > 0.95

Source: compiled by the authors

The correlation between the loin eye area and acidity, the amount of dry matter, protein content, and total ash weight is inverse and average, and between the loin eye area and the total fat content – weak. A trend towards an inverse correlation between the loin eye area of *m. longissimus dorsi* and the acidity of beef indicates that in meat with a larger cross-section of the loin eye, the pH decreases faster to normal (<5.8) and receives microbial stability earlier. Sensory evaluation of the juiciness, tenderness, taste, and aroma of boiled meat determined its acceptability for the consumer. By analysing the sensory properties, a detailed description of how boiled beef and its broth are perceived by the human senses was provided.

However, G.A. Ferreira *et al*. (2024) conducted a study in Brazil to assess the perception of beef with different pH values. It was found that beef consumers do not devalue steaks in terms of its freshness even at pH⩾6.0. The chemical composition of beef depends on the type of breed productivity, the age of animals at slaughter (Hoa *et al.,* 2022), type of muscle and fat tissue (Vázquez-Mosquera *et al.,* 2023). The results of evaluating the sensory characteristics of boiled meat conducted by a group of tasters from 8 people are shown in Table 6. In bulls aged from 18 to 24 months, an inverse significant correlation was established between the loin eye area of *m. longissimus dorsi* and the juiciness of beef. The correlation between the cross-sectional area of the muscle and the taste, aroma, tenderness, and residue after chewing cooked meat was reverse and weak.

Table 6. *Correlation coefficients between the loin eye area of m. longissimus dorsi and sensory properties of beef*

Animal age at slaughter	Sensory characteristics of cooked meat					
	juiciness	taste	aroma	tenderness	residue after chewing	average values for 5 tasting indicators
from 18 to 24 months (n = 15)	-0.522*	-0.214	-0.363	-0.256	-0.442	-0.371
including on the 21st month (n = 13)	-0.457	-0.072	-0.176	-0.092	-0.275	-0.210

Notes: *)P > 0.95

Source: compiled by the authors

An inverse significant correlation between the sensory properties of beef and muscle tissue growth was established by I. Albechaalany *et al.* (2024). A number of factors had a negative impact on the results of the tasters' evaluation of boiled beef from the loin eye area of

m. longissimus dorsi. The main reason for the inverse relationship between the development of the loin eye area of *m. longissimus dorsi* and the sensory properties of beef is the weak inverse correlation between this trait and the total fat content in muscle tissue, and the direct correlation with the marbling of meat. According to A. Listrat *et al.* (2020), juiciness, which has a positive effect on the quality of beef consumption and which in the mouth is characterised by the amount of juice during chewing, also closely correlates with the fat content inside muscles. Increasing the area of the loin eye of *m. longissimus dorsi* partially contributes to the reduction of a valuable technological property – the tenderness of meat. Optimal distribution of total fat content inside muscle tissue can improve the tenderness of beef. V. Bulgaru *et al.* (2022) found that tenderness is significantly affected by the content of soluble proteins, fats, and collagen. Increase in the diameter of muscle fibres, due to which the loin eye area of *m. longissimus dorsi* increases, can be one of the main reasons for the deterioration of beef tenderness.

Results of the studied correlation coefficients between the loin eye area of *m. longissimus dorsi* in bulls and the signs of tasting beef broth are presented in Table 7. The linear positive correlation ($r = 0.587$; $P > 0.95$) between the loin eye area and the taste and aroma of broth was affected by feeding the bulls a significant amount of green, coarse, and juicy feed.

Table 7. *Correlation coefficients between the loin eye area of m. longissimus dorsi and sensory characteristics of beef broth in bulls*

Animal age at slaughter	Broth tasting indicators			
	taste and aroma	strength	transparency	average values
from 18 to 24 months (n = 15)	0.587*	-0.207	0.180	-0.057
including on the 21st month (n = 13)	0.594*	-0.161	0.215	0.018

Notes: *P > 0.99

Source: compiled by the authors

There is a tendency for a relatively weak inverse correlation between the loin eye area of *m. longissimus dorsi* and the strength of the broth. The inverse relationship between the loin eye area and the strength of the broth was conditioned by the fact that with a decrease in the content of dry matter, protein, total fat, and total ash in the muscles, fat diffuses less from the endomysium and pericardium cells into the boiled water, and less proteins, extractives, and mineral salts are transferred to the broth.

Thus, the qualitative trait of carcasses – the loin eye area of *m. longissimus dorsi* in bulls of the Ukrainian Black-and-White dairy breed aged 18 to 24 months – is directly correlated with the slaughter characteristics, the weight of muscle tissue, including the highest and first grades, and the weight of fat tissue in the carcass. There is a tendency to worsen the chemical composition of muscle tissue with an increase in the size of the loin eye. The bone content in animal carcasses did not correlate with the cross-sectional area of the long back muscle. Assessing correlation coefficients between the lin eye area of *m. longissimus dorsi* with the qualitative characteristics of beef carcasses evaluated in accordance with international standards, there is a tendency for both weak inverse and linear relationships with their conformation, the development of subcutaneous fat and its thickness, colour and marbling of muscle tissue. Comparison of results with data from literature sources on correlations between the loin eye area of *m. longissimus dorsi* and the animal slaughter indicators, technological and sensory properties of meat from animals of

different breeds in most cases coincide. This indicates the possibility of using this method to predict the composition of carcasses and the sensory and technological properties of beef.

Among the characteristics of carcasses, an increase in the loin eye area of *m. longissimus dorsi* indicates only an increase in quantitative characteristics of muscle tissue yield in cuts, including those of the highest and first grades. It has no correlation with the moisture retention capacity of meat, which determines the technological quality of many meat products during thermal (boiling) processing.

Since the loin eye area of *m. longissimus dorsi* has a linear correlation with the quantitative characteristics of beef, rather than sensory characteristics that depend on the chemical composition, including the content of total fat in the middle of the muscle, in many countries of the world, the loin eye area is supplemented by the severity of meat marbling when assessing the quality of cattle carcasses. Thus, beef marbling is determined in the carcass quality assessment systems of the USDA (2001), JMGA (2000) and MSA (2015). In Ukraine, the demand for low-fat and biologically complete beef is growing. Such meat in the required amount is obtained from animals of the Ukrainian Black-and-White dairy breed. The biological feature of this cattle is that the beef from it is lean. At the age of 21 months, bulls of this breed have a mid-muscle fat content of only 2.6%. The curved relationships between meat tenderness, juiciness, taste, and muscle fat scores are aligned with its content of 15 to 17% (Thompson, 2004). Such cattle respond to satisfactory feeding with a significant growth of muscle tissue and late accumulation of fat. Since the quality characteristics of carcasses compared to beef quality are more sensitive to changes in animal husbandry management, J. Soulat *et al.* (2022) suggest that the same quality of carcasses or meat can be achieved under different conditions of keeping. According to R. Leighton *et al.* (2023), relying solely on their estimates by trained individuals may provide limited insight. Therefore, the findings of these researchers indicate that it is possible to manage the quality of carcass and beef using various methods of breeding, feeding, and housing. For Ukraine, it is currently important to develop ways to simultaneously improve the quantitative and qualitative characteristics of beef from animals of common breeds in the country.

Conclusions

Development of the loin eye area of *m. longissimus dorsi* in Ukrainian Black-and-White bulls aged from 18 to 24 months does not allow predicting the content of only quantitative characteristics in beef: slaughter weight (carcass), number of cuts of the highest and first grades, the content of fat tissue and tendons and ligaments in the carcass, but not qualitative characteristics, including sensory and physical characteristics, chemical composition of meat.

There is a direct correlation between the loin eye area and the pre-slaughter live weight of animals ($r = 0.409$; $P > 0.95$), the slaughter weight ($r = 0.404$; $P > 0.95$), the amount of muscle tissue ($r = 0.355$; $P > 0.95$), including the highest ($r = 0.680$; $P > 0.999$) and the first ($r = 0.501$; $P > 0.99$) grades, the content of fat tissue in the carcass ($r = 0.477$; $P > 0.99$); the data obtained confirm the possibility of using the cross-sectional area of the transverse muscle to predict the production of beef of a certain variety. The loin eye area of *m. longissimus dorsi* correlates inversely ($r = -0.607$; $P > 0.95$) with the amount lost when boiling beef, an important technological indicator, the amount of second-class muscle tissue ($r = -0.377$; $P > 0.95$), the development of subcutaneous fat ($r = -0.395$; $P > 0.95$), which protects the carcass from the penetration of pathogenic microflora, weathering and drying, affects the juiciness and tenderness of beef, the total weight of ash ($r = -0.560$; $P > 0.95$), juiciness of boiled meat ($r = -0.522$; $P > 0.95$), taste and aroma of broth ($r = -0.587$; $P > 0.95$). There is a tendency for an inverse correlation between

the loin eye area and the total fat content in beef (r = -0.119), protein (r = -0.401), dry matter (r = -0.403), acidity (r = -0.458), colour of muscle tissue (r = -0.126), conformation (fleshiness) of carcasses (r = -0.127), penetration (r = -0.477), taste of cooked meat (r = -0.214), its aroma (r = -0.363), tenderness (r = -0.256), the residue after chewing (r = -0.442), the strength of the broth (r = -0.207), and to a linear relationship – the amount of tendons and ligaments (r = 0.331), marbling (r = 0.162), colour of fat tissue on the carcass (r = 0.276), transparency of the broth (r = 0.180). In the future, a study should be conducted to determine the management factors for raising and fattening animals of other breeds of cattle common in Ukraine, the correlation between the loin eye area of *m. longissimus dorsi* and quantitative and qualitative characteristics of beef, and to substantiate the qualitative characteristics of carcasses that would be combined with sensory, physical and technological properties evaluated with the participation of consumers.

Acknowledgements

None.

Conflict of Interest

None.

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Площа «м'язового вічка» бугайців української чорно-рябої молочної породи та її взаємозв'язок з ознаками яловичини

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Анотація. Актуальність роботи полягала у необхідності визначення, чи площа «м'язового вічка» *m. longissimus dorsi*, як критерій оцінювання виходу високоцінних відрубів з яловичих туш пов'язаний із ознаками яловичини від бугайців української чорно-рябої молочної породи. Метою дослідження було встановити кореляції між площею «м'язового вічка» та ознаками забою хімічним складом, сенсорними і фізико-технологічними властивостями яловичини. У бугайців української чорно-рябої молочної породи (УЧМП) віком від 18 до 24 місяців дослідили кореляцію між площею поперечного перерізу продовгуватого м'яза та ознаками забою, якості туш, хімічним складом, сенсорними, фізичними та технологічними властивостями яловичини. Установлено прямолінійну кореляцію між площею «м'язового вічка» і забійною масою (r = 0,404; P > 0,95), кількістю м'язової тканини (r = 0,355; P > 0,95), у т. ч. вищого (r = 0,680; P > 0,999) та першого (r = 0,501; P > 0,99) сортів, вмістом жирової тканини у туші (r = 0,477; P > 0,99). Площа «м'язового вічка» корелювала зворотньо (r = -0,607; P > 0,95) з уварюванням яловичини, кількістю м'язової тканини другого сорту (r = -0,377; P > 0,95), розвитком жиру-поливу (r = -0,395; P > 0,95), загальною масою золи (r = -0,560; P > 0,95), соковитістю вареного м'яса (r = -0,522; P > 0,95), смаком і ароматом бульйону (r = -0,587; P > 0,95). Проявлялася тенденція до зворотньої кореляції між площею «м'язового вічка» та загальним вмістом жиру у яловичині (r = -0,119), протеїну (r = -0,401), сухої речовини (r = -0,403), кислотністю (r = -0,458), кольором м'язової тканини (r = -0,126), конформацією (r = -0,127), пенетрацією (r = -0,477), смаком (r = -0,214) і ароматом (r = -0,363) вареного м'яса, ніжністю (r = -0,256), залишком після розжовування (r= -0,442), міцністю бульйону (r = -0,207), та до прямолінійного зв'язку – із кількістю сухожилок і зв'язок (r = 0,331), мармуровістю (r = 0,162), кольором жирової тканини на туші (r = 0,276), прозорістю бульйону (r = 0,180). Практичне значення даних полягає в отриманні знань, які дозволяють формувати маркетингові стратегії прогнозування якості продуктів харчування, кількості яловичини вищого та першого сортів, її технологічні властивості і призначення для використання за урахування кореляційних зв'язків між площею «м'язового вічка» *m. longissimus dorsi*

Ключові слова: м'ясна продуктивність; конформація; мармуровість; якісні ознаки туш; сенсорні характеристики м'яса