

COMPARISON OF SLAUGHTER VALUE AND MUSCLE PROPERTIES OF SELECTED CATTLE BREEDS IN POLAND – REVUE

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Abstract. The aim of the paper was the comparison of slaughter value and muscle properties of dual-purpose cattle most common in Poland with that of beef type, from which high quality culinary meat is obtained. Four breeds were compared: two of them were dual-purpose type i.e. Holstein-Fresian of Black and White variety and Polish Red and the other two – of beef type i.e. Limousine and Hereford. There are discussed factors influencing cattle slaughter value and muscle properties, i.e. the impact of the utility type, gender, age, feeding systems, as well as maturation rate of animals. The slaughter value was presented using the dressing percentage and the content of main components in the carcass i.e. the muscle tissue, fat and bones. The tissue composition of analysed cattle breeds and the share of main cuts in their carcasses were presented. Higher daily gains of beef type or dual-purpose breeds are connected with a higher number of muscle fibers (hyperplasia) and also with a bigger size of their diameter (hypertrophy). These phenomena are accompanied by increased lightness of meat colour what is the result of changes in the muscle fibers metabolism and the proportion of myosin heavy chains (MHC) of the I, IIa and IIx type. Observed differences in the slaughter value existed not only between breeds, but also inside them indicating the need for further improvement of animal selection and deeper analysis of factors influencing it. It was stated that the amount of culinary meat obtained from carcasses may be increased not only through the selection of corresponding genotypes, but also through the modification of the system of carcass cutting. The performed analysis of the slaughter value emphasizes special significance of the domestic Polish Red cattle also as a breed for production of good quality meat similar to beef cattle breeds.

Key words: cattle, genotype, slaughter value, dressing percentage, carcass and muscle composition, muscle quality

The quality of domestic beef is low as confirmed by observations of many researchers [Grześkowiak et al. 2006, Wajda 2006, Pisula et al. 2007]. For a number of years now, attempts have been made aiming both at increasing the amount of beef on the market and improving its quality. In countries leading in beef culinary production, the above target is achieved by the utilisation in production of beef cattle breeds, their crosses or crossbreeds sired by bulls of beef breeds and dairy breed cows. Experience has proved that beef types of cattle are always characterised by higher slaughter value and meat quality in comparison with the cattle utilised for milk production [Rottger 1993, Jasiorowski et al. 1995, Papstein et al. 1995, Ender et al. 1997, Litwińczuk and Litwińczuk 1998, Wajda 2001, Wajda and Daszkiewicz 2001].

The most numerous cattle breed in Poland is Polish Holstein-Frisian of Black and White variety making up more than 90% of the entire population of this animal species and it can be utilised as a typical dairy cattle but also as a dual-purpose breed, although the former use is more common. Second, with regard to the size of cattle bred in Poland, is Polish Holstein-Frisian of Red and White variety. Polish Red Cattle constitutes the smallest proportion of cattle found in our country. It makes up a very small proportion of this group of farm animals (0.5%) but, according to Pogorzelska and Wroński [2005], meat products obtained from these animals are of good quality. Several researchers [Grodzki and Brzozowski 2005, Szulc and Houszka 2005, Wójcik and Trela 2005] maintain that Polish Red Cattle is the only native cattle breed in Poland. Wójcik and Trela [2005] and Oprządek et al. [2007] claim that the results obtained for many traits in Polish Red Cattle were much better than those recorded for Polish Holstein-Frisian of Red and White, as well as Black and White variety cattle.

The population of the beef type cattle is represented in Poland, primarily, by the Limousine breed which, in 2006, made up more than 50% of the population of this cattle type. Other breeds of the beef type cattle constitute smaller proportions of these animals, including: Hereford (21% – 2005), Charolaise (18% – 2005), as well as Angus, Simmental, Salers and Piemontese.

The selection of a specific breed for meat production depends on the farmer who, aiming to obtain greater quantities and better quality of this meat, should take into account environmental conditions, the rearing system, as well as the market requirements.

The goal of this article was to compare the literature data concerning slaughter value of the dual-purpose cattle with beef breeds bred in Poland from which meat of high culinary value is obtained.

SLAUGHTER VALUE

Dressing percentage gives the best practical expression of the slaughter value of livestock making it possible, at the same time, to carry out various comparisons. This parameter is expressed in percentage and constitutes the ratio of the animal carcass weight after slaughter to its weight before slaughter. The dressing percentage variability is quite considerable and, according to numerous researchers [Ender 1985, Litwińczuk and Litwińczuk 1998, Pogorzelska and Wroński 2005, Prost 2006, Ender and Augustini 2007], it can range from 45% to over 65%. Usually, its lowest value is recorded in dairy cows, whereas the highest – in fattened heifers and bulls of fast-growing beef breeds [Ender 1985, Litwińczuk and Litwińczuk 1998, Wichłacz 1998, Pogorzelska and Wroń-

ski 2005, Prost 2006, Ender and Augustini 2007]. Moreover, dressing percentage is higher in the case of bulls in comparison with cows, beef cattle in comparison with dairy cattle, intensively reared livestock in comparison with extensive management on grasslands, heavy and old in comparison with light and young cattle [Ender and Augustini 2007]. In practical assessment, dressing percentage should be considered low when it ranges from 40 to 45%, moderate – when it ranges from 45 to 50% and high when it is over 60% [Prost 2006].

The dressing percentage depends on many factors both of genetic and environmental nature. The most important of these factors within one species include: production type, gender, age, nutrition and rearing conditions. They influence also the quantity of external and intermuscular fat, appearance and colour of meat, as well as its sensory properties after cooking.

UTILITY TYPE OF CATTLE

From among the most popular cattle production types, i.e. beef and dairy cattle, beef breeds of cattle deserve special attention. Investigations conducted by Ziemiński [2005] show that the dressing percentage of Limousine and Hereford breeds, i.e. most common beef type breeds in Poland, reached 65%. In the case of the Limousine type of cattle, both young and at older age, very good dressing percentage is usually obtained.

In investigations of Daszkiewicz and Wajda [2002 b] carried out on Limousine and Black and White breed bulls, they reported dressing percentages of 61.84% and 50.22%, respectively. A similar dressing percentage (61.40%) for the Limousine breed was reported by Monsón et al. [2005]. In experiments carried out more recently on 12-month old bulls [Oprządek et al. 2007] results similar to those reported by Daszkiewicz and Wajda [2002 b] and Monsón et al. [2005] were obtained. Limousine cattle revealed a bit lower dressing percentage, namely 59.25%, and Holstein-Frisian of Black and White variety cattle, a little higher – 50.94%. Hereford cattle obtained dressing percentage at the level of 54.92%. Dressing percentages of Hereford at the level of 55.3% and of the Limousine breed at 63.86% were reported by Miciński et al. [2005].

While relatively many papers are concerned with beef cattle breeds (Limousine, Hereford), as well as domestic Black and White cattle more and more often referred to as Holstein-Frisian, much less attention is paid to the Polish Red Cattle. Experiments carried out by Łapa et al. [1975] showed that the dressing percentage of bulls of this breed fattened to the age of 12 months reached 56.77%, and when bulls were slaughtered at the age of 15 months, this index reached 57.8%. Recent studies of Oprządek et al. [2007] confirmed earlier research results. Dressing percentage of 12-month old of Polish Red Cattle amounted to 54.45%.

It is worth emphasising that we usually observe higher dressing percentage when animals' daily weight gains are greater (Table 1), when the fattening process is more intensive and the body weight of animals is higher [Plesník et al. 1972, Ender 1985] (Table 2). Breed of cattle and the age at which it is slaughtered, may modify this relationship [Oprządek et al. 2007]. Dressing percentage is also correlated with the size of the abdominal cavity and its increase is associated with the decrease of the percentage proportion of the stomach and intestines (Table 3).

Table 1. Slaughter value of bulls of different genotypes, as well as chemical composition and selected quality traits of their meat [Čepin et al. 1998]

Assessed traits	Genotype				
	S	B	B × BB	HF	HF × BB
Weight of live animal, kg	595 ^a	590 ^a	601 ^a	538 ^b	607 ^a
Carcass weight, kg	327 ^c	325 ^c	355 ^a	293 ^b	353 ^a
Dressing percentage, %	54.96 ^b	55.20 ^b	59.10 ^a	54.45 ^b	58.22 ^a
Meat content, %	70.09 ^{cd}	69.05 ^d	73.16 ^a	65.47 ^b	72.10 ^{ac}
Fat content, %	11.76 ^{bc}	12.48 ^b	8.92 ^a	13.61 ^b	9.79 ^{ac}
Bone content, %	16.37 ^a	16.63 ^a	16.27 ^a	19.08 ^b	16.67 ^a
Tendon content, %	1.63 ^{bc}	1.68 ^b	1.55 ^c	1.72 ^b	1.31 ^a
Evaluation of muscle tissue					
Water content, %	74.99 ^{ab}	74.75 ^a	75.61 ^b	74.63 ^a	75.66 ^b
Fat content, %	3.23 ^b	3.03 ^b	1.66 ^a	3.12 ^b	1.71 ^a
Protein content, %	20.73 ^b	21.18 ^{ab}	21.67 ^a	21.18 ^{ab}	21.58 ^a
Ash content, %	1.04 ^a	1.02 ^a	1.03 ^a	1.06 ^a	1.03 ^a
Shearing force, N/cm ²	117 ^b	102 ^{ab}	89 ^{ab}	105 ^{ab}	87 ^a
Tenderness, scores	3.7 ^b	4.64 ^{ab}	5.43 ^a	4.85 ^{ab}	5.43 ^a
Juiciness, scores	5.91 ^a	5.86 ^a	6.00 ^a	5.93 ^a	5.93 ^a
Aroma, scores	5.71 ^a	5.57 ^a	5.58 ^a	5.72 ^a	5.49 ^a

S – Simmental, B – Brown Swiss, HF – Holstein-Friesian, BB – Belgium Blue.
Means designated with different indices differ significantly ($P \leq 0.05$).

Table 2. Relationship between dressing percentage, body weight and fattening intensity of Black and White cattle [Ender 1985, after modification]

Body weight of animal kg	Fattening intensity, %	
	intensive	extensive
385	55.9	49.6
425	56.5	50.5
460	57.3	53.0
500	57.8	53.9

Table 3. Relationship between dressing percentage and body weight of cattle and the size of stomach and intestines [Ender 1985, after modification]

Dressing percentage %	Weight of live animal kg	Stomach and intestinal chyme in relation to the weight of live animal %
≥ 60	580	7
56-60	535	9
52-56	448	12
48-52	304	17
≤ 48	250	20

GENDER AND PRE-SLAUGHTER WEIGHT

Although there are considerable differences among researchers as to the impact of gender on cattle dressing percentage, it does find its expression in the after-slaughter classification of carcasses into categories. Many researchers [Čepin and Čepon 2001, Wajda and Daszkiewicz 2001, Jurczak 2004, Pogorzelska and Wroński 2005, Prost 2006, Pisula et al. 2007] indicate that gender exerts influence on meat quality and that it is especially connected with differences in the content of meat and fat in the carcasses of steers and heifers as corroborated by the data presented in Table 4. In female carcasses, there is usually higher proportion of fat in relation to meat [Sack and Scholz 1987, Wichłacz 1998, Strzelecki et al. 2006]. A more detailed analysis of data from Table 4 reveals significant differences between percentage proportions within a given gender which, most probably, is the result of individual variability. Similar variability is observed when comparing slaughter value within breeds [Daszkiewicz and Wajda 2002 b, Miciński et al. 2005, Artyszuk and Wróbel 2007].

Table 4. Variation of tissue constituents of beef rumps [Wichłacz 1998, after modification]

Item	Heifers		Bulls	
	minimum	maximum	minimum	maximum
Live weight, kg	334	521	384	500
Rump, %				
proportion of meat	67.8	76.4	70.8	79.9
proportion of fat	6.0	15.0	3.4	9.6
proportion of bones	12.6	18.5	13.2	18.1

Results of studies published by Augustini et al. [1992] provide interesting complementation of these observations. They indicate that, in particular, the proportion of fat increases together with the higher weight of animals and this correlation is gender-related. In the weight range of 200-650 kg, its proportion doubles in the case of bulls

at only slight decrease in the meat content and, in the case of steers, three times at nearly 8% decrease in the meat content. The situation in heifers is similar to that in steers. Both in steers and in heifers, internal and intermuscular fat begins to accumulate at an earlier phase than in bulls.

Results of German experiments are confirmed by Polish observations [Brzozowski 2006]. Steers are rarely employed for fattening since they are characterised by worse musculature and usually attain worse weight gains than bulls, albeit better than heifers. During fattening, heifers should be fed using a semi-intensive feeding system because they grow more slowly, use approximately 15 to 20% more feed and a greater part of it is transformed into fat [Kaczmarek 1994]. The above factors cause that, in comparison with young bulls, the meat of steers and heifers reveals greater marbling, is more delicate and obtains higher grades during sensory property assessment. Tables 4 and 5 present example correlations indicating variations in proportions of meat, fat and bones in carcasses depending on gender.

Table 5. Carcass composition of bulls and heifers of Black and White breed [Litwińczuk et al. 1999, after modification]

Carcass composition	Bulls	Heifers
Meat content, %	70.53	66.94
Fat content, %	10.48	14.02
Bone content, %	18.86	18.78
Meat to bone ratio	3.74	3.56
Meat to fat ratio	6.73	4.77

Reaching the intended target weight depends not only on the production type but also on age and the method of fattening. According to Pogorzelska and Wroński [2005], the best fattening results were obtained by bulls, worse – by steers and the worst – by heifers (Table 6). In the first group of animals, the weight gains frequently exceed 1000 g/day, while in the case of heifers – usually below. Differences in the fattening results between bulls and steers find confirmation also in studies carried out by Wajda and Włodawiec [2002] who, in the case of the Black and White breed, found the dressing percentage of 55.04% in the case of steers and 56.6% – for bulls. Differences in the dressing percentage between bulls and heifers were also reported in the case of the Polish Red Cattle breed [Trela et al. 1992]. The above researchers determined dressing percentage at the level of 57.54% for bulls and 56.20% for heifers. Slaughtering animals at the age of 15 months yielded similar results, although differences between groups were slightly smaller.

Table 6. Impact of gender on fattening results and intermuscular fat content [Röhrmoser 1992, after Schwarz 1990]

Assessed traits	Bulls	Heifers	Steers
Body weight at slaughter, kg	660	500	580
Daily gain, g	1 170	960	1 030
Fat (in <i>m. longissimus dorsi</i> – %)	1.6	3.9	2.6

ANIMAL AGE AND FEEDING

Many researchers [Daszkiewicz and Wajda 2002 a, Brzozowski 2006] maintain that cattle fattening should be terminated as soon as the animals attain the so called slaughtering maturity, in other words, optimal sizes of culinary elements, best musculature and carcass tissue composition. At the same time, it is recommended to use high protein feeds during the period of development of muscle tissue and to limit its application during the phase of fat development. Slaughtering of too young animals, i.e. before they attain appropriate slaughter maturity, causes that such carcasses are usually characterised by poorly developed muscles and deprived of the subcutaneous fat cover, while their meat exhibits slight marbling.

Daszkiewicz and Wajda [2002 a] report that in countries with long traditions of production of culinary beef a trend can be observed for slaughtering heavier animals but at a younger age with the aim to obtain carcasses with a higher proportion of culinary meat characterised by better quality than the meat derived from carcasses of older animals.

Pogorzelska and Wroński [2005] maintain that intensive fattening of young cattle should lead to higher daily weight gains, lower consumption of nutrients per 1 kg body weight gain as well as better dressing percentage of animals. On the other hand, over intensive fattening results in excessive fat deposition, carcass quality deterioration and lowering of economic results. According to Kaczmarek [1994] in order to avoid this type of negative phenomena, young cattle nutrition should also take into account the rate of animal maturation. He maintains that beef cattle of early maturing breeds, such as for example Aberdeen Angus and Hereford, becomes fat earlier when fed intensively by concentrates and their carcasses are fatter. In the case of late-maturing breeds such as: Charolaise, Limousine, Chianina or Piemontese a higher capability to accumulate protein than fat can be observed [Litwińczuk and Litwińczuk 1998, Pogorzelska and Wroński 2005]. They are characterised by high daily weight gains and, consequently, are more suitable for intensive fattening [Pogorzelska and Wroński 2005].

CARCASS TISSUE COMPOSITION AND CHEMICAL COMPOSITION OF MEAT

Dressing percentage is usually burdened with the risk of making an error resulting from the fact that it refers to the weight of a live animal. This does not happen when the carcass value is assessed on the basis of the proportion in it of basic constituents affecting the suitability of the animal for meat production, i.e. the proportion of muscle tissue, fat and bones in the carcass. Additional valuable information can also be found in the amount and quality of culinary elements obtained from the carcass. It is worth mentioning here that both in Europe and the USA, carcasses characterised by a slight but noticeable muscle marbling as well as a thin, subcutaneous fat layer are preferred [Litwińczuk and Litwińczuk 1998]. Excessive fat cover is not desirable in carcasses because it decreases their value [Artyszuk and Wróbel 2007]. However, there may be differences in the distribution of intra- and intermuscular fat between cattle breeds. In dairy, as well as in dual-purpose breeds but also in early maturing beef cattle, fat begins to accumulate considerably earlier. That is why, in the case of dairy breeds, it is difficult to obtain culinary meat characterised by suitable quantities of intermuscular fat essential if meat is to be juicy and tender [Artyszuk and Wróbel 2007].

Bearing in mind the existing differences in the capability of cattle to accumulate fat, it is proposed to arrange the most common cattle breeds or utility types as follows: Angus > Hereford > dairy breeds > dual-purpose breeds > Limousine > Charolaise, Blond d'Aquitaine, Piemontese [Röhrmoser 1992 after Kögler 1980].

Nevertheless, a slightly greater carcass fattening, especially greater content of intermuscular fat, is welcomed because it makes meat more juicy and delicate and improves its aroma [Brzozowski 2006], particularly when the fat content increases from 3.5 to 5% [Mandell et al. 1997]. The above remarks may explain why in some countries, despite health contraindications, cattle meat with high fat content continues to be very popular or even assessed higher than meat that exhibits only slight marbling. A good example here is the meat of the Japanese cattle breed Wagyu [Okitani 1999]. However, it is not uncommon that lean meat can also be tender. This phenomenon can be attributed to variations in protein metabolism of bovine muscles. It is known that meat of Belgium Blue cattle is usually more tender than that of other breeds, although it contains less fat (Table 1). However, this meat usually contains more white fibres which undergo proteolysis easier. Proteolysis decreases losses during cooking and that exerts a positive influence on meat juiciness after thermal processing.

Litwińczuk [1996] carried out investigations on the slaughter value and meat quality of Black and White bulls and their crosses with different beef type cattle breeds and reported the mean proportion of 66.02% meat and 13.83% fat in carcasses of purebred Black and White bulls. In the case of crosses with the Limousine breed, the proportion of meat increased, on average, by nearly 6% and that of fat declined by 2-3%. The above indices were obtained for cattle slaughtered at the weight of about 490 kg. Pogorzelska and Wroński [2005] maintain that the meat of Limousine bulls contained low level of fat but it was tender and tasty. Experiments carried out by Papstein et al. [1995] showed that the tissue composition of the Black and White cattle slaughtered at the age of 12 and 24 months varied (Table 7). The proportion of meat in carcasses of the bulls slaughtered at the age of 12 months amounted to 61.4%, while that of older animals – 58.2%.

Table 7. Carcass tissue composition of Black and White bulls slaughtered at different age [Papstein 1995]

Trait %	12 months		24 months	
	x	s	x	s
Muscle tissue	61.4	1.4	58.2	1.5
Fat – deposits	3.5	0.8	6.2	0.9
Intermuscular fat	12.2	1.2	16.7	2.0
Bones	18.2	1.1	15.6	1.0
Tendons	4.7	0.4	3.2	0.5

Łapa et al. [1975] investigated fattening and slaughter performance of Polish Red Cattle breed bulls. They found that carcasses of animals slaughtered at the age of 12 months contained 68.12% meat and 13.25% fat, while carcasses of those slaughtered at the age of 15 months – 66.61% and 15.12%, respectively. Nahlik [1973] conducted

investigations on the crossing of the Polish Red Cattle with bulls of the Simmental breed and reported that when bulls of Polish Red Cattle were slaughtered at the age of 15 months, the content of meat in their carcasses reached 71.01% and that of fat – 12.24%. Similar results, but more recently, were also obtained by Oprządek et al. [2007]. Evaluating the tissue composition of the carcasses from 12-months Polish Red bulls, they reported 71.91% of meat and 9.76% of fat in the primary cuts. The above data are presented in Table 8.

Table 8. Proportion of meat and fat in the analysed cattle breeds

Author	Proportion of meat %	Proportion of fat %	Remarks
Black and White			
Oprządek et al. [2007]	68.99	10.78	12-month old
Litwińczuk [1996]	66.02	13.83	slaughter weight – 490 kg
Papstein [1995]	61.4	12.2	12-month old
Limousine			
Oprządek et al. [2007]	78.45	6.29	12-month old
Monsón et al. [2005]	68.47	8.94	560 kg
Hereford			
Oprządek et al. [2007]	69.01	10.78	12-month old
Cole et al. [1965]	54.5	31.3	
Polish Red			
Oprządek et al. [2007]	71.91	9.76	12-month old
Łapa et al. [1975]	68.12	13.25	12-month old
Nahlik [1973]	71.01	12.24	15-month old

According to several researchers [Jurczak 2004, Węglarz and Makulska 2006], the Limousine breed is characterised by a high proportion of muscles in the carcass and a low share of fat and bones. A similar conclusion can be drawn from investigations carried out by Monsón et al. [2005]. They reported 68.47% meat, 8.94% fat and 16.96% bones in the carcasses of these animals. Furthermore, Plesnik et al. [1972] claim that Limousine cattle is not only characterised by low content of fat in carcasses but, equally importantly, this fat is uniformly accumulated.

Hereford breed cattle is characterised by considerable carcass fattening [Jurczak 2004]. Cole et al. [1965] reported 54.5% meat and 31.3% fat contents in carcasses of this breed.

The performed comparative analysis of the slaughter value of domestic beef cattle with Holstein-Frisian breed of Black and White variety and Polish Red Cattle indicates interesting properties of the latter. Its carcass and meat composition is similar to that of Limousine and exceeds significantly that of Hereford breed. In relation to Hereford, Polish Red Cattle reaches similar dressing percentage which is, however, lower in com-

parison with Limousine. It would be reasonable to intensify breeding work of this cattle breed in order to improve meat percentage in carcass.

SHARE OF PRIMARY CUTS IN THE CARCASS

According to many researchers [Kaczmarek 1994, Artyszuk and Wróbel 2007, Wajda 2007] carcass value depends on the development of the most valuable muscles of the rump-thigh and loin parts, which rarely happens in dairy cattle breeds. The most valuable elements obtained from cattle carcass cutting comprise sirloin and short loin. Other valuable carcass cuts also include rump muscles, i.e.: bottom round (*m. semimembranosus*), top round (*m. biceps femoris*), eye of round (*m. semitendinosus*), thick flank (thigh *quadriceps muscle*) and rump (complex of gluteal muscles). Wajda and Włodawiec [2002] reported that, in the case of bulls and steers of the Black and White breed, they obtained a slightly higher percentage proportion of the cuts of the highest commercial value such as sirloin and short loin in carcasses of steers than in those of bulls. On the other hand, the percentage proportion of culinary elements obtained from the cutting of the rump (bottom round, thick flank, rump, eye of round) was higher for the bull calf carcasses than for steers carcasses.

Artyszuk and Wróbel [2007] reported the highest commercial and culinary values of muscles derived from parts of the rump, back and shoulder. These parts of muscles are better developed only in the beef cattle breeds. Daszkiewicz and Wajda [2002 b] in investigations carried out on the Limousine and Black and White breeds, reported higher percentage proportions of sirloin, short loin, bottom and top round, eye of round, thick flank, rump and muscle triceps brachi in carcasses of the Limousine breed than those of Black and White bulls. On the other hand, the percentage proportion of principle cuts which can be used as culinary meat, i.e. fore ribs and best ribs (short loin), was similar for both of the examined breeds.

Relatively recent investigations carried out by Strzelecki et al. [2006] provide interesting information concerning the effectiveness of cattle carcass cutting. The above-mentioned researchers reported significantly higher quantities of culinary meat (by 12.4%) accompanied by smaller proportions of tallow (7.59%) and bones (3.46%) obtained from carcasses of bulls in comparison with those of heifers. By modifying the applied system of the Black and White cattle carcass cutting, the above authors showed that it was possible to obtain – from carcasses of dual-purpose cattle – significantly higher quantities of good quality culinary meat. They demonstrated that even meat obtained from front quarter-carcasses can provide 60% of culinary meat. However, this by no means contradicts the fact that beef breeds and their crosses constitute in the principle raw material for the production of high quality culinary meat as it is determined by processes associated with the development of muscles affecting their morphology and physico-chemical properties.

QUALITY AND AMOUNT OF MEAT. PROCESSES AFFECTING MUSCLE DEVELOPMENT

Differences in the carcass meat content between cattle even of the same production type but different with regard to breed can be attributed, primarily, to the mechanisms that control processes of muscle growth and development. This is achieved by way of diameter increment of muscle fibres which is the most common phenomenon [Młynek and Guliński 2007, Koochmaraie et al. 2002] described as hypertrophy. However, weight increments resulting from the increase in the number of muscle fibres – hyperplasia, leads to faster meat increases and higher meatiness. These phenomena are confirmed by investigations conducted by Wegner et al. [2000]. It is evident from these experiments that cattle of the Belgian Blue breed, characterised by faster increments, was also characterised by a higher number of fibres in comparison with the German cattle of Angus, Galloway and Black and White, despite the application of the same rearing system. At the same time, fattening resulted in significant changes in the fibre thickness in all breeds.

Frequently, cattle whose muscles exhibit particularly large dimensions most often associated with the increased number of muscle fibres is referred to as double-muscled cattle. Their muscles are often lighter and more tender.

Increased muscle lightness is probably caused by changes in fibres metabolism consisting in their transformation from aerobic-dominated processes into anaerobic. Such changes result in an accelerated process of glycolysis and meat tenderisation. As a rule, light fibres undergo faster proteolysis. The above-mentioned processes can be accompanied by changes in proportions of myosin heavy chains (MHC) of the IIa and IIx type corresponding to the rapidly contracting muscles in relation to the type I MHC which are typical for the slowly contracting red muscles characteristic for glycolytic aerobic processes [Hoof 1991, Wegner et al. 1997, Grześ et al. 2007]. In case of pork these processes can lead to pale colour of meat, its low pH value, which properties are typical for PSE meat [Strzyżewski et al. 2008, Pyrcz et al. 2009].

Another characteristic feature of muscles of double-muscled animals is smaller amount of collagen per bundle of muscle fibres. In addition, it also improves tenderness of these muscles [Nishimura et al. 2002, Ngapo et al. 2002].

Investigations carried out by Młynek and Guliński [2007] on Black and White cattle breed, as well as commercial crossbreds of this breed with beef breeds revealed that the greater growth intensity of commercial crosses in young age favoured the achievement by these animals of higher dressing percentage and resulted in lighter meat colour. Greater growth intensity of older animals was associated with increased mean fibre diameters in the *longissimus dorsi* muscle. However, some differences were found in the muscle structure between crossbreds and purebred cattle [Młynek and Guliński 2007]. The examined crossbreds were characterised by smaller fibre diameters in comparison with the purebred Black and White bulls. Larger muscles of smaller fibre diameter observed in crossbreds of the dual-purpose cattle with beef cattle in comparison with the purebred dual-purpose cattle appear to indicate that the phenomenon of heterosis is combined with the occurrence of hyperplasia. However, its size is smaller than in the double-muscled cattle.

CONCLUSIONS

Cattle improvement with the aim to obtain greater quantities of culinary meat of high quality is usually associated with impacts resulting from the effect of the utility type, breed, age, gender and feeding methods, animal maturation rate as well as by modifying carcass cutting system.

The analysis of the slaughter value of Polish Red Cattle indicates that, to some extent, it is similar to that of Limousine (quality and amount of meat) and exceeds significantly that of Hereford breed. In regard to the dressing percentage, this value is lower in comparison with Limousine. It seems reasonable to intensify breeding work on this cattle breed to improve its beef breed character.

Beef breeds and their crossbreds are characterised by higher dressing percentage in comparison with the dual-purpose cattle. Exceptionally large meat mass increments are associated with the occurrence of increased quantities of meat fibres (hyperplasia) as well as with their increased diameter (hypertrophy). The above-mentioned phenomena are accompanied by increased meat colour lightness resulting from changes in fibre metabolism.

Differences in the slaughter value are observed not only between breeds but also within them. This indicates the need for the improvement in the process of animal selection and more comprehensive analysis of factors determining it.

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WARTOŚĆ RZEŹNA I JAKOŚĆ MIĘSA KULINARNEGO BYDŁA TYPU MLECZNO-MIĘSNEGO ORAZ MIĘSNEGO UŻYTKOWANEGO W POLSCE

Streszczenie. Celem artykułu było porównanie wartości rzeźnej oraz właściwości mięsa bydła najczęściej użytkowanego w Polsce, w kierunku mleczno-mięsnym, z rzadziej spotykanymi rasami mięsnymi, z których uzyskuje się wysokiej jakości mięso kulinarne. Porównywano cztery rasy, tj. bydło holsztyno-fryzyjskie i polskie czerwone oraz limousine i hereford. Omówiono czynniki mające wpływ na wartość rzeźną i właściwości mięsa bydła, tj. oddziaływanie typu użytkowego, płci, wieku, sposobu żywienia, a także szybkości dojrzewania zwierząt. Charakterystykę wartości rzeźnej każdej z ras przedstawiono, opisując jej wydajność poubojową oraz wielkość udziałów podstawowych składników decydujących o przydatności zwierzęcia do produkcji mięsa, czyli udziału tkanki mięśniowej, tłuszczu i kości. Przedstawiono skład tkankowy analizowanych ras bydła i udział elementów zasadniczych w ich tuszach. Przeprowadzone porównania wykazały, że duże przyrosty masy mięsa wiążą się zwykle z występowaniem zwiększonej ilości włókien (hiperplazja), ale także ze zwiększeniem ich średnicy (hipertrofia). Zjawiskom tym towarzyszy zwiększenie jasności barwy mięsa, będące skutkiem zmian metabolizmu włókien. Obserwowane różnice w wartości rzeźnej pomiędzy rasami i wewnątrz nich wskazują na potrzebę głębszej analizy czynników je determinujących oraz doskonalenia selekcji zwie-

rząt. Stwierdzono, że ilość mięsa kulinarnego pozyskiwanego z tusz bydła może wzrastać nie tylko poprzez dobór odpowiednich genotypów zwierząt, ale również poprzez modyfikację rozbioru poubojowego tusz. Przeprowadzona analiza odnośnie wartości rzeźnej wskazuje na szczególne walory krajowego bydła polskiego czerwonego, które uzyskuje bardzo podobne parametry do bydła mięsnego. Skoro rasy mięsne limousine i hereford mają światowe uznanie, jest celowe zwiększenie wysiłku nad doskonaleniem i propagowaniem rodzimego bydła polskiego czerwonego w hodowli żywca i produkcji mięsa zarówno w kraju, jak i na świecie.

Słowa kluczowe: bydło, genotyp, wartość rzeźna, wydajność rzeźna, skład tuszy i mięśni, jakość mięśni

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