Bulgarian Journal of Agricultural Science, 19 (No 5) 2013, 1112-1119
Agricultural Academy

EFFECT OF CONCENTRATE SUPPLEMENT ON SLAUGHTER VALUE AND MEAT QUALITY OF LIMOUSIN SUCKLER BEEF REARED ON PASTURE UNTIL THE AGE OF 8 MONTHS

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Abstract

FLOREK, M., P. STANEK, Z. LITWIŃCZUK and P. ŻÒŁKIEWSKI, 2013. Effect of concentrate supplement on slaughter value and meat quality of Limousin suckler beef reared on pasture until the age of 8 months. *Bulg. J. Agric. Sci.,* 19: 1112-1119

The objective of the present study was to evaluate the effect of concentrate (ground grain) served to Limousine suckler beef in the period of rearing on pasture with mothers until the age of 8 months on slaughter value and quality of two skeletal muscles, i.e. *musculus longissimus lumborum* and *musculus semitendinosus*. The slaughter value parameters (e.g. dressing percentage, round dissection results, linear measurements) of calves' carcasses were determined and samples of *m. longissimus lumborum* – MLL and *m. semitendinosus* – MST for basic chemical composition and intrinsic properties determinations were collected. The supplement of concentrate in a dose of calves reared on pasture with their mothers effected on higher slaughter output (by 2 percentage points), significantly ($P<0.05$) higher weight of round (more than 4 kg) and significantly ($P<0.05$) larger share of meat in the round (by 2.35 percentage points) and the lower share of bones ($P<0.05$) and fat with regard to calves not receiving the concentrate. Simultaneously, concentrate supplement did not affect the deterioration of Limousin veal quality and in some cases, the quality was even improved in comparison with the control group. The results obtained in own study indicate that supplementing of nutritional dose of calves on pasture with a certain amount of concentrate is economically justified. The issue that needs a solution is elaborating of technique, quantity and quality of fodder according to a target slaughter weight (age) and nutritive value of the pasture without compromising the meat quality.

Key words: Limousin, suckler beef, slaughter value, meat quality

Abbreviations: MJ – megajoule; MLL – *musculus longissimus lumborum;* MST – *musculus semitendinosus;* EC – electrical conductivity; W/B – moisture:protein proportion; DFD – dark, firm, dry meat

Introduction

Individualistic meat sensory characteristics such as texture and flavour are important factors that consumers consider when deciding whether to purchase a product again, which is particularly important for expensive products such as certain cuts of fresh beef. Although a variety of *ante* and *post mortem* factors can affect the organoleptic attributes of meat, the animal feeding system can be particularly important (Scheeder et al., 1999; Priolo et al., 2001; Stelzleni and Johnson, 2008).

The most of beef is produced using extensive rearing systems consisting primarily of grazing pasture. However, a desire to increase productivity or a need to overcome periods of forage deficits has led to an increase in the use of diets that are supplemented with cereal grains (approximately 1% of live weight) (Resconi et al., 2010).

Grass-based beef production systems are low-input systems that are particularly suitable to meet the demand of meat retailers and consumers for naturally and animal friendly produced beef (Schor et al., 2008). In general, research in the United States of America (USA) has suggested that

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feedlot systems produce beef with superior sensory qualities (higher tenderness and lower intensity of off-flavours) to those produced under grazing feeding systems (Priolo et al., 2001; Stelzleni and Johnson, 2008). However, if the grazing is made under high quality pastures, which allow good animal performance, the meat quality produced not necessarily is poorer than a concentrate-based diet (French et al., 2001; Latimori et al., 2008).

According to del Campo et al. (2008), feed costs are the most crucial factors in determining the commercial efficiency of any beef system. In certain regions, better grass utilization could be the cheapest source, especially considering fluctuations in grain prices. Key aspects that involve the use of concentrates and/or the extra time needed to a final pasture fattening of animals should be taken into consideration with a view to shareholders' interests. Alternative methods for cattle fattening may be viable as long as they are profitable for producers, plant processors and consumers accept them. To maximize profitability and attain different markets, potential animal growth could be achieved by an inclusion of concentrates in a forage-based diet, considering commercial issues and without any impairment of meat quality.

In the world, a veal meat is obtained from immature bovine animals and that includes calves from several different management systems. Therefore, the meat and fat content is different. In complying with Council Regulation (EC) No 700/2007 of the 11th of June 2007 the veal category origins only from cattle up to 8 months of age before slaughter, while the beef category is derived from cattle from 8 to 12 months of age (category V). In Poland the young bulls of dairy breeds are allowed for a veal production and in a lesser extent the calves with a dual-purpose type of use. Purebred calves have a marginal prominence. Among the meat breeds used in Poland a limited extent of the veal production in Poland involves French Limousin suckler beef, i.e. calves reared by their dams on the pasture. Usually, these animals are slaughtered at weight ranging from 250 to 350 kg, shortly after weaning (Florek et al., 2012).

Significant popularity of this breed is due to an excellent carcass and meat values, especially for the production of "baby beef" calves and in France a few local categories, i.e. de Saint Etienne calves (age – 7-9 months and body weight – 250-350 kg), d'Aveyron calves (8-10 months and 350-450 kg, respectively) or older and heavier ones – Lyon type (12-16 months and 400-600 kg, respectively). The main advantage of this breed is a very high proportion of muscles and low fat content in carcass. This allows to intensive feeding of fattening animals to a high final weight without fear of carcass quality deterioration and its excessive fatness. Therefore, Limousin cattle are especially appreciated by the meat industry.

According to experiments of Golze (2001), a good slaughter performance and carcass value of pasture fattening calves raised on cattle out of the mother cows with beef cattle can be reach already with a slaughter age of seven-eight month.

The objective of the present study was to evaluate the effect of concentrate (ground grain) served to Limousine suckler beef in the period of rearing on pasture with mothers until the age of 8 months on slaughter value and quality of two skeletal muscles, i.e. *musculus longissimus lumborum* and *musculus semitendinosus*.

Materials and Methods

The study was conducted on experimental herd of beef cattle reared in the Lublin region and included 18 Limousine calves, which were maintained with their mothers (suckler cows) on the pasture until the slaughter. The feeding basis consisted of mother's milk and grass. The average milk composition of Limousine cows maintained in the region of presented research given by Litwińczuk and Król (2001) amounted respectively, fat 2.62%, protein 3.54%, lactose 4.95%, and total solids 11.76%. Period of grazing on feedlots lasted from early May to late October (150 days). The value of pasture was evaluated using the analytical method developed by Różycki (Borowiec, 2001). Feedlot evaluation was conducted twice a season. The first evaluation was performed on May before putting animals out to pasture and the other on October before grazing the last feedlots. The pasture value on May (valued in food units) was very good (averagely 49.7 thous. MJ of net energy), while on October weak (averagely 22.3 thous. MJ of net energy). According to the botanical evaluation share of grass in the pasture sward was 70%, legumes – 23%, herbs and weeds – 7%.

During the rearing on pasture with mothers (150 days) the rate of calves was divided into two groups: experimental – E and control – C. Animals from group E received additionally (except pasture and milk) concentrate (ground grain) *ad libitum*. Concentrate was a mixture of middlings (grain of triticale, barley and oat, constituting 33%) with the addition of mineral mixture for calves staying on pasture (0.5% of dose, i.e. 40-60 g/head/day). Calves also had a constant access to the salt licks enriched in magnesium. Suckler cows and calves of the control group C did not have the access to concentrate.

With the age, the calves imbibed more concentrate to recompense a reduced milk yield of mothers and lower pasture value (due to weather conditions). Throughout the pasture period calves ate 0.5 kg of ground grain per day averagely, however, they imbibed most of concentrate (about 1.5 kg/day) in the last two months of grazing.

Due to a schedule of slaughter and subsequent analyses, the rate of animals was divided into two rounds. In the first order, calves from the control group (C) were directed to slaughter and in the next week calves from the experimental group (E). Prior to the slaughter, animals were individually weighed, and then stunned mechanically and bled out. The average age of calves from group C was 230 days (from 214 to 267) and the mean weight was 293.9 kg ± 22.8 kg while for the calves from experimental group (E), respectively: 238 days (222 to 254) and 307.5 kg ± 34.2 kg. The slaughter operations were performed in compliance with the technology applicable in the meat industry and under the constant supervision of veterinary inspection. The carcass weight was measured before and after the chilling and dressing (hot and cold) percentages were calculated. After cooling of carcasses (at 2°C for 24 h) linear measurements (cm) were performed by measuring the length of carcass, depth of chest and length and girth of round. During the technological cutting the right half-carcass was dissected into meat, fat and bones as well as two samples of skeletal muscles ie. *longissimus lumborum* – MLL *semitendinosus* – MST were collected for chemical analyses and intrinsic properties determinations.

Directly in muscle tissue pH value and specific electrical conductivity – EC (mS/cm) were measured 45 min (pH_1, EC_1), 24 h (pH_{24}, EC_{24}) and 48 h (pH_{48}, EC_{48}) after slaughter using the PQM I-KOMBI device (INTEK GmbH, Aichach, Germany).

Meat color was determined in a fresh cross-sectional area after 30-minutes exposure (blooming), 24 and 48 h after slaughter by CR-310 Minolta (Minolta Camera Co., Ltd., Osaka, Japan) portable chroma meter. Absolute results were given as CIE L*a*b* values (CIE 1976), where L* − lightness, a* − red-green color, b* – yellow-blue color and h° – hue.

Evaluation of water holding capacity and texture of meat were performed after 48 h. Drip and cooking loss were assayed according to Honikel's method (1998). Quantity of loose water (mg) (Grau and Hamm, 1953) and proportion of M/T×100 (Hofmann et al., 1982) were calculated based on the filter paper method. MultiScan Base ver. 14th computer image analysis programme was used to measure a total area of leakage (T, cm^2) and meat sample area (M, cm^2).

A single column testing Zwick/Roell ProLine Z0.5 machine (Ulm, Germany), using the Warner-Bratzler's V-blade determined shear force (N) instrumentally. Muscle stripes (from samples after cooking loss treatment) with the length of 5 cm and cutting area section of 1 cm^2 were cut. The mean value for sample was calculated basing on five replicates. The results of shear force measurements were devised using TestXpert® II programme.

The basic chemical composition was assayed by conventional methods, i.e.: water content by the drying method (103ºC), according to PN-ISO 1442:2000; ash content by the combustion method in a muffle furnace (550ºC), according to PN-ISO 936:2000; crude protein content by Kjeldahl's method using a Büchi B-324 apparatus (Flawil, Switzerland), according to PN-75/A-04018 and intramuscular fat content by Soxhlet's method using a Büchi B-811 apparatus (Flawil, Switzerland), according to PN-ISO 1444:2000. Net caloric value of 100 g of meat was calculated based on the content of protein and intramuscular fat using physiological energy equivalents (Atwater's equivalents), i.e. for protein – 4.0 kcal = 16.76 kJ and fat – 9.0 kcal = 37.66 kJ. Total content of haem pigments by Hornsey's method (1956) was determined using Varian Cary 300 Bio spectrophotometer (Mulgrave, Varian Austraila Pty Ltd) at 640 nm wavelength.

The obtained results were analyzed statistically using the Statistica programme ver. 6, (StatSoft Inc., 2003) on the grounds of one-way analysis of variances. The mean value and standard deviation were given in the tables. The significance of differences between mean values was verified using Tukey's test.

Results and Discussion

Slaughter value

The results pertaining to parameters of slaughter value were shown in Table 1. Calves' carcasses of group E (both before and after chilling) were heavier but not significantly (P>0.05). Moreover, their slaughter output was higher. Older age and higher body weight, resulting from the schedule of slaughter (experience layout) could have been the reason. Significantly (P<0.05) longer and heavier rounds appeared to be obtained from calves of group E, compared to group C. Moreover, they characterized by a larger girth and share in carcass (but not significantly). Comparing the results of round dissection, it has been shown that in the case of the element of calves' group E the round contained significantly more meat (P<0.05) and less bones (P<0.05) and fat.

Aldai et al. (2012) evaluated the Limousine calves kept with their mothers on pasture in the mountains. Animals were slaughtered at the age of 7 months with the average weight of 318 kg after finishing, during which they received up to 3 kg/day of complete mixture. Carcasses, measuring 105 cm in length on average, weighed averagely 192.5 kg and their killing out was 60.51%. Cerdeńo et al. (2006) showed that even when comparing animals of similar weight, but otherwise fed, their carcasses will vary considerably in size and composition of tissue. These differences are mainly due to dissimilar dietary energy density and, consequently, because of the total energy consumed. Results given by Golze (2001) for dressing percentage (58.2%) of Limousin calves slaughtered at the younger age of about 7 months (214 life days) and lower weight of 225 kg was lesser in comparison with our result, however the share of round averaged 32.7%, was similarly like in present study.

Observations obtained in the present study (higher slaughter weight and carcass weight, higher dressing percentage and heavier round) are similar to those presented earlier by Vaz Martins et al. (2003). They found a higher weight of pistola (basic element consisting of round and rump cut) in carcasses of animals pastured and receiving additionally concentrate in the amount of 1.5% of live weight, in comparison with animals getting concentrate at the level of 0.7%.

Chemical composition

There were no significant differences between the content of basic chemical components and energy value in MLL between compared groups of calves (Table 2). However, significant differences in MST (except for ash content) were stated. Muscles of calves from group E contained significantly (P<0.05) more crude protein and less fat in comparison with group C. The similar tendencies (but not significant) were also observed in the case of MLL.

The chemical composition of *musculus longissimus dorsi* of Limousin calves at the age of 214 days determined by Golze (2001) contained more water (76%) and less protein and fat (22.1 and 0.5%, respectively) compared to our results. Aldai et al. (2012), evaluating the Limousin calves kept with their mothers on pasture in the mountains until the age of 7 months, analyzed the basic chemical composition of *musculus longissimus thoracis et lumborum*. The muscle contained 75.86% of water, 1.44% of fat, 22.19% of crude protein and 1.29% of ash. It should be noticed that the authors obtained higher content of water and fat and lower of protein compared to own results.

Intrinsic properties

Feeding of animals did not influence significantly on pH value and electrical conductivity of skeletal muscles of calves compared (Table 3). However, higher pH values were determined in muscles of calves from group E. Electrical conductivity, measured in both skeletal muscles of compared groups of calves, characterized by increasing tendency to 48 h *post mortem*.

Other authors who found no differences in a final pH value in the muscles of cattle fed cereal grains or pastured (Morris et al., 1997; French et al., 2000) obtained similar results. Contrarily, Muir et al. (1998) reported that meat of steers kept on pasture had a higher pH value than animals fed a concen-

Table 1
Slaughter value of Limousin suckler beef in relation to feeding

Specification	Feeding group	
	C – pasture	E – pasture + ground grain
Age, days	230 ± 14.9	238 ± 14.3
Slaughter weight, kg	293.9 ± 22.77	307.5 ± 34.15
Weight of carcasses		
before chilling, kg	181.62 ± 16.41	195.95 ± 24.43
after chilling, kg	178.53 ± 15.97	193.65 ± 24.98
Slaughter value of carcasses		
before chilling, kg	61.75 ± 1.71	63.68 ± 2.86
after chilling, kg	60.70 ± 1.61	62.91 ± 2.99
Length of carcasses, cm	112.2 ± 4.3	113.1 ± 3.1
Depth of chest, cm	51.1 ± 3.0	50.6 ± 2.3
Round		
Weight, kg	28.26[a] ± 2.45	32.39[b] ± 4.45
Share in carcass, %	32.12 ± 1.59	33.47 ± 1.88
Length, cm	61.7[a] ± 1.9	64.1[b] ± 2.2
Girth, cm	103.2 ± 4.9	106.5 ± 5.1
Share in round, %		
meat	82.33[a] ± 1.90	84.68[b] ± 1.93
fat	4.27 ± 1.77	3.30 ± 1.33
bones	13.47[b] ± 0.74	12.22[a] ± 0.98

Means marked with different letters differ significantly: a,b – p<0.05

trate. Similarly, French et al. (2001) noticed higher pH value of *musculus longissimus dorsi* of animals kept on pasture 4, 5, 6, 7 and 8 h after slaughter in comparison with animals receiving the concentrate. These contrary results can be partly explained by the influence of following factors: breed, temperament of animals, conditions of management or learned response of animals to human contact.

It is worth mentioning that despite the differences of initial and final pH value in own study, all values were within the desired range and no signs of DFD defects were observed.

Skeletal muscles of compared groups of calves showed the different properties of color instrumentally assessed 24 and 48 h *post mortem* (Table 4). Significant differences were solely found in the red color share. Higher a* value was determined in MLL of calves classified to group C, however, for MST of animals from group E, which simultaneously contained significantly (P<0.05) more haeme pigments. The adverse tendency (but not significant) was observed in the case of brightness (L*). Higher proportion of yellow color (b*) showed muscles evaluated of calves from group C. Anywise, the differences also were not statistically significant.

Feeding, age and activity of animals can affect meat color. High energy diet reduces concentration of haeme pigments and consequently a* value decrease is generally observed. However, such dependencies were not obtained in the present study.

Myoglobin is mainly responsible for the meat color. Darker area of veal (lower L* and higher a* value) is associated with a higher concentration of haem pigments (Florek et al., 2009). Aass (1996) and Priolo et al. (2001) suggested that the differences in meat color were related to the age and feeding strategy of animals. Darker color of meat occurred in animals pastured and brighter one in animals fed concentrate. Var-

Table 3
pH value and specific electrical conductivity (EC) of Limousin suckler beef muscles in relation to feeding

Specification	Feeding group	
	C – pasture	E – pasture + ground grain
MLL		
pH		
1 h pm	6.7 ± 0.28	6.8 ± 0.17
24 h pm	5.6 ± 0.20	5.7 ± 0.10
48 h pm	5.5 ± 0.15	5.7 ± 0.05
EC, mS cm^{-1}		
1 h pm	2.8 ± 1.55	3.5 ± 0.27
24 h pm	3.2 ± 1.20	3.5 ± 1.89
48 h pm	6.1 ± 2.01	5.6 ± 2.64
MST		
pH		
1 h pm	6.6 ± 0.26	6.7 ± 0.19
24 h pm	5.5 ± 0.14	5.5 ± 0.07
48 h pm	5.4 ± 0.07	5.6 ± 0.08
EC, mS cm^{-1}		
1 h pm	2.8 ± 0.99	3.5 ± 0.51
24 h pm	6.1 ± 4.41	6.0 ± 2.22
48 h pm	7.8 ± 3.12	9.4 ± 3.60

Table 2
Chemical composition and energy value of Limousin suckler beef muscles in relation to feeding

Specification	Feeding group	
	C – pasture	E – pasture + ground grain
MLL		
Moisture	74.44 ± 1.29	74.62 ± 0.50
Crude protein	22.84 ± 1.09	23.57 ± 0.39
Intramuscular fat	1.03 ± 0.30	0.72 ± 0.27
Ash	1.28 ± 0.12	1.24 ± 0.45
W/B	3.18 ± 0.21	3.17 ± 0.07
Net energy, kJ 100 g^{-1}	416.9 ± 19.9	416.7 ± 12.3
MST		
Moisture	75.15^{b} ± 1.18	74.05^{a} ± 0.52
Crude protein	22.47^{A} ± 0.92	24.01^{B} ± 0.51
Intramuscular fat	0.88^{b} ± 0.23	0.51^{a} ± 0.12
Ash	1.28 ± 0.14	1.24 ± 0.11
W/B	3.29^{B} ± 0.19	3.04^{A} ± 0.09
Net energy, kJ 100 g^{-1}	401.6^{a} ± 21.1	420.1^{b} ± 9.8

Means marked with different letters differ significantly: a,b – p<0.05; A,B – p<0.01

Table 4
Haeme pigments concentration and CIE L*a*b* color parameter of Limousin suckler beef muscles in relation to feeding

Specification	Feeding group	
	C – pasture	E – pasture + ground grain
<u>MLL</u>		
Haeme pigments, ppm	136.4 ± 30.5	133.2 ± 16.9
L*		
24 h pm	37.29 ± 2.65	38.34 ± 1.19
48 h pm	37.14 ± 1.91	37.27 ± 1.25
a*		
24 h pm	21.09^{b} ± 1.08	19.85^{a} ± 1.50
48 h pm	22 .07 ± 0.80	21.28 ± 0.65
b*		
24 h pm	3.19 ± 1.24	2.89 ± 0.69
48 h pm	3.63 ± 0.83	2.88 ± 0.82
<u>MST</u>		
Haeme pigments, ppm	119.4^{A} ± 14.3	158.3^{B} ± 10.1
L*		
24 h pm	39.69 ± 9.69	38.29 ± 2.60
48 h pm	42.44 ± 2.16	38.46 ± 3.36
a*		
24 h pm	21.77 ± 1.18	22.79 ± 1.76
48 h pm	22.06^{a} ± 0.80	23.21^{b} ± 0.52
b*		
24 h pm	5.60 ± 1.87	4.44 ± 1.72
48 h pm	5.40 ± 1.15	5.07 ± 1.15

Means marked with different letters differ significantly: a,b – p<0.05; A,B – p<0.01

nam and Sutherland (1995) hypothesized that higher content of myoglobin in muscles of animals grazed was due to their increased physical activity in comparison with other management systems. However, Muir et al. (1998) explained that a higher final pH value observed in the case of cattle kept on pasture in comparison to animals kept in pens. According to cited authors, animals pastured were more sensitive to stress and rapid utilization of glycogen reserves before slaughter associated with that, with regard to animals accustomed to human presence and kept in pens. However, in the research of French et al. (2000) and Razminowicz et al. (2006), such differences were not observed.

Similarly, French et al. (2000) found no effect of diet on color of *musculus longissimus dorsi* of cattle fed five different doses (green forage, silage and concentrate). L* value ranged from 35.8 to 37.0, a* – 16.8 to 17.9 and b* – 9.24 to 10.09. The latter authors also found no differences in the subcutaneous fat color discriminants with the exception of b* parameter which was higher in the case of feeding based only on pasture grass.

Contrarily, Realini et al. (2004) showed that *longissimus* muscle of Hereford steers pastured characterized by lower (P<0.05) L* value, i.e. it was darker compared to animals receiving concentrate. In addition, the meat of animals pastured was more red (P<0.05) and yellow (P<0.05) after five days of storage. Likewise, McCaughey and Cliplef (1996) found darker muscle color for cattle pastured than fed on cereal grains. However, no differences (P>0.05) between share of red (a* value) and yellow (b* value) color were showed.

Teira et al. (2004), assessing color of meat and fat of cattle pastured and fed total ratio fodders, showed slight differences between management systems. The b* parameter was solely different but in a small range (4.8-5.9). In the case of animals kept on pasture subcutaneous fat color had higher (P<0.05) b* value in comparison with fed fodder. Similar tendencies, but with regard to the color of MLL and MST, were proved in own study.

Skeletal muscles of calves compared showed similar tendencies in water holding capacity discriminants (Table 5). Significantly (P<0.05) lower amount of loose water and higher drip loss for the MLL (P<0.05) and MST was observed in the group of calves receiving concentrate supplementation (E). Moreover, significantly (P<0.05) lower cooking loss from MST in this group of calves was noticed. Contrarily, according to many authors (Cerdeńo et al., 2006; Kerth et al., 2007; del Campo et al., 2008), no effect of fattening system on cooking loss size was observed.

Results of shear force test indicate that both muscles of animals kept solely on pasture with mothers were tenderer as compared to the calves receiving additional concentrates. It is confirmed by both lower W-B shear force (P<0.05), and lower shear energy of equally MLL and MST.

Realini et al. (2004) showed that the initial value of W-B shear force was similar and did not differ significantly (P>0.05) between the *longissimus* muscle of animals grazed on pasture and fed concentrate. However, beef obtained from the cattle kept on pasture characterized significantly lower (P<0.05) W-B shear force value 7 and 14 days *post mortem*.

Studies of other authors also indicated that the texture of meat of cattle grazed might be tenderer than concentrate fattening cattle (Bruce et al., 2004). This could be due to not only the difference in final pH value but also the rate of decline in pH value and temperature of carcasses *post mortem*. In own study, the muscles of animals from group E, which had a higher final pH value (MLL – 5.7 and MST – 5.6), were tougher than the muscles of calves from group C (5.5 and 5.4, respectively) (Table 3). Moreover, higher weight of carcass of group E animals might contribute to slow a deterioration of internal temperature what resulted in deterioration of muscle tenderness, as earlier observations of May et al. (1992) indicated.

Scheeder et al. (1999) revealed that meat of calves fattened on a maize silage and concentrate diet was either superior (shear force, intramuscular fat, sensory tenderness, juiciness and acceptance) or equivalent (cooking loss, flavor intensity) to meat of calves conventionally fattened on milk replacer only. Similarly, French et al. (2000) showed that pasture feeding supplementation in a small amount of concentrate allowed for obtaining more tender and acceptable meat the second day *post mortem*, however, a potential effect of feeding system was eliminated during the subsequent ripening process. In turn, Realini et al. (2004) indicated that meat of cattle pastured characterized a greater potential for tenderization during *post mortem* ageing and it became tenderer as compared to meat of animals fed concentrate after storage for 7 days.

Razminowicz et al. (2006), comparing the quality of beef produced in the traditional and pasture system, showed that the quality of veal from calves kept with their mothers until the age of about 10 months did not differ significantly in relation to meat of heifers and bulls conventionally held. In comparison with young cattle, meat of calves was slightly lighter (L^* = 39.8 vs. 38.1) and less red (a^* = 20.3 vs. 21.8), more tender (shear force = 40.3 N vs. 51.7 N) but with a slightly higher cooking loss (30.9% vs. 30.0%). Own results confirmed above mentioned findings with regard to the Limousin breed calves reared on pasture with their mothers until the age of 8 months and fed with concentrate supplement.

Conclusions

Utilization of concentrated feed during the pasturing in a limited period or for final fattening aims is becoming more common. However, this may be associated with a presence of numerous differences in the parameters of slaughter value and meat quality, which require research. The challenge for researchers and breeders is to create the best fattening strategy to improve a product – meat but without modifying its specific characteristics (prohealthy properties) produced during the extensive (low-cost) grazing conditions as well as without lowering a welfare status of animals and nor a charge of environment.

The most economically reasonable option of veal production therefore appears simultaneous use of milk by suckling calves, which together with their mothers (cows) are present on the local pastures and receive a small addition of concentrate. If in turn it leads to an improvement of production efficiency and meat quality, it can provide additional benefits for local beef producers and consumers.

The supplement of concentrate in a dose of calves reared on pasture with their mothers effected on higher slaughter output (by 2 percentage points), significantly ($P<0.05$) higher weight of round (more than 4 kg) and significantly ($P<0.05$) larger share of meat in the round (by 2.35 percentage points) and the lower share of bones ($P<0.05$) and fat with regard to calves not receiving the concentrate. Simultaneously, concentrate supplement did not affect the deterioration of Limousin veal quality and in some cases the quality was even improved in comparison with the control group. The results obtained in own study indicate that supplementing of nutritional dose of calves on pasture with a certain amount of concentrate is economically justified. The issue that needs a solution is elaborating of technique, quantity and quality of fodder according to a target slaughter weight (age) and nutritive value of the pasture without compromising the meat quality.

Table 5
Water holding capacity, W-B shear and energy force of Limousin suckler beef muscles in relation to feeding

Specification	Feeding group	
	C – pasture	E – pasture + ground grain
MLL		
Drip loss, %	$1.6^{A} \pm 0.51$	$2.8^{B} \pm 0.63$
Cooking loss, %	29.7 ± 5.22	29.5 ± 6.43
Loose water, mg	$52.3^{b} \pm 12.7$	$42.1^{a} \pm 4.0$
W-B shear force, N	93.5 ± 38.6	121.4 ± 37.1
W-B shear energy, J	0.43 ± 0.10	0.48 ± 0.14
MST		
Drip loss, %	3.3 ± 2.38	4.2 ± 0.71
Cooking loss, %	$32.8^{b} \pm 4.41$	$28.4^{a} \pm 3.13$
Loose water, mg	$56.6^{b} \pm 12.4$	$44.9^{a} \pm 7.10$
W-B shear force, N	$67.7^{a} \pm 27.8$	$100.3^{b} \pm 14.6$
W-B shear energy, J	0.31 ± 0.16	0.38 ± 0.06

Means marked with different letters differ significantly: a,b – $p<0.05$; A,B – $p<0.01$

Acknowledgements

The Authors would like to thank Dr. Aneta Brodziak for language support in the preparation process of the paper.

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Received March, 11, 2013; accepted for printing September, 2, 2013.