POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

www.pan.olsztyn.pl/journal/
e-mail: joan@pan.olsztyn.pl

Pol. J. Food Nutr. Sci.
2007, Vol. 57, No. 4(A), pp. 31-35

EFFECT OF BULL FEEDING INTENSITY IN THE FINISHING PERIOD ON SLAUGHTER TRAITS AND LIPID COMPOSITIONS OF MEAT

Krzysztof Bilik[1], Zenon Choroszy[2], Magdalena Łopuszańska-Rusek[1]

[1]Department of Animal Nutrition and Feed Science, [2]Department of Animal Genetics and Breeding; National Research Institute of Animal Production, Balice

Key words: fattening bulls, feeding level, slaughter traits, fatty acid profile

A total of 12 Limousin bull calves were assigned to two feeding groups (6 animals per group) analogous in terms of body weight. Bulls were reared during calfhood with suckler cows and then fed indoors with farm-produced feeds (silages, hay, concentrates) to obtain a body weight gain of approximately 1000 g/day. The basic bulky feed was maize silage (fed *ad libitum*), supplemented with meadow hay (1 kg/day), and different amounts (according to group) of concentrate (kg/100 kg body weight): 1.0 (group KK-I) or 0.6 (KK-P). The study showed that compared to semi-intensive feeding, intensive feeding of Limousin bulls in the finishing period with diets containing maize silage, meadow hay and concentrate had a more favourable effect on fattening traits, slaughter traits, economic efficiency of feeding and fatty acid profile in the intramuscular fat, *n-6/n-3* PUFA ratio and total cholesterol content of the longissimus muscle.

INTRODUCTION

Current methods of feeding young slaughter cattle are aimed at modifying not only the fat to meat ratio [French *et al.*, 2000; Yang *et al.*, 2002], but also the proportion of, and relationships between, polyunsaturated fatty acids (n-6 and n-3 PUFA) and conjugated linoleic acid (CLA) isomers in cattle carcasses [Dannenberger *et al.*, 2005; Scollan *et al.*, 2006]. One of the nutritional methods of improving the dietetic value of beef is to reduce feeding intensity in the finishing period [Marino *et al.*, 2006]. Excessive reduction in the dietary energy density, however, may negatively affect fattening efficiency and the slaughter and quality traits of meat [Berthiaume *et al.*, 2006; Dannenberger *et al.*, 2006]. There are insufficient data on the possibility of improving the dietetic properties of meat of fattened bulls using diets differing in the amount of concentrates in the finishing period.

The aim of the study was to determine the degree to which varying feeding levels of finishing Limousin bull calves (diets containing maize silage, meadow hay and concentrates) will affect fattening and slaughter traits and fatty acid profile in the intramuscular fat of the longissimus muscle.

MATERIAL AND METHODS

Experimental design, feeding and management of animals. The experiment was carried out during a 70-day finishing period. A total of 12 Limousin bull calves at an initial body weight of approx. 440 kg were assigned to two feeding groups (6 animals per group) analogous in terms of body weight. Bulls were reared during calfhood with suckler cows for 6-7 months and then fed indoors farm-produced feeds (silages, hay, concentrates) to obtain body weight gains of approximately 1000 g/day. The experiment was preceded by a 2-week preliminary period in which the animals were accustomed to the new diet. The basic bulky feed was maize silage (fed *ad libitum*), supplemented with meadow hay (1 kg/day), and different amounts of concentrate, which contained ground barley (42%), ground wheat (20%), ground triticale (17%), rapeseed meal (15%), soybean meal (2%) and a mineral-vitamin mixture (4%). Depending on the feeding level, the daily amount of concentrate per animal (100 kg body weight) was 1.0 kg (group KK-I) or 0.6 kg (group KK-P).

Animals were fed individually and daily feed intake was recorded at 2-week intervals for 3 successive days. The energy and protein value of the feeds and the percentage composition of concentrate were determined using IZ-INRA feeding standards [Strzetelski *et al.*, 2001] to obtain weight gains of 1400 g/day in group KK-I and 1000 g/day in group KK-P. Silage and concentrate were given twice a day, and meadow hay was given once a day after evening feeding.

During the experiment, animals were kept in tethered stalls equipped with automatic drinkers and partitioned troughs, with separate bins for concentrates.

Measurements, analyses and calculations. The initial and final body weights of animals, the chemical composition of feeds and samples of longissimus muscle (LM), and the fatty acid profile of the feed and meat samples were determined during the experiment. The basic chemical

Author's address for correspondence: Krzysztof Bilik, Department of Animal Nutrition and Feed Science, National Research Institute of Animal Production, 32 – 083 Balice, Poland; tel. (48 12) 258 83 01; e-mail: kbilik@izoo.krakow.pl

© Copyright by Institute of Animal Reproduction and Food Research of the Polish Academy of Sciences

composition of feeds was determined using standard procedures [AOAC, 1990]. NDF and ADF fibre fractions in the silage and hay were determined according to Goering & Van Soest [1970]. CLA in silage and the profile of higher fatty acids in feed samples were analysed by way of gas chromatography (Varian 3400, CP-WAX 58 column, 25 m, 0.53 mm, 1.0 micron, FID detection) using an 8200 CX autosampler. Lactic acid was determined using a Shimadzu chromatograph (Nucleosil 250/4 C 18 column, UV-Vis SPP-6 AV detector and SIL-10 AX autosampler), and silage pH using an Elwro N 5170 potentiometer. At the end of fattening, animals were transported to a slaughterhouse in which they were slaughtered following 24 h feed withdrawal. Post-slaughter evaluation of carcasses and dissection of 5 valuable cuts into meat, fat and bones were performed using a method developed at the National Research Institute of Animal Production [Choroszy *et al.*, 2004]. The samples of meat from the longissimus muscle were analysed for proximate chemical composition using the standard procedure [AOAC, 1990], total cholesterol content with the colorimetric method (using colour reaction with $FeCl_2$ solution) and fatty acid profile with gas chromatography, using the same chromatograph and procedures as for the determination of the fatty acid profile of feed samples. All the chemical analyses and determinations were carried out in accordance with current procedures at the Main Laboratory of the National Research Institute of Animal Production. The average cost of feeds per kg of body weight gain was calculated based on average daily feed intake in the two treatment groups, using cost of feeds from The Experimental Station Grodziec Śląski LTD for 2006.

Statistical calculations of the results obtained were performed by way of the ANOVA procedure of one-way analysis of variance, using SAS statistical package (1999/2001), and significance of differences between the groups was determined using the F test.

RESULTS AND DISCUSSION

The nutrient content and nutritive value of maize silage and meadow hay (Table 1) corresponded with the values of medium quality feeds, produced under the climatic conditions of southern Poland. The daily intake of dry matter, energy (UFV) and protein (PDI) by the bulls (Table 1) was similar to the requirement given by IZ-INRA feeding standards [Strzetelski *et al.,* 2001] for early-maturing beef bulls and weight gains of 1400 g/day (group KK-I) or 1000 g/day (KK-E).

No statistically significant differences were found between the groups in the initial body weight or meat, fat and bone percentage in five half-carcass cuts (Table 2). In animals from group KK-I, however, there was a tendency towards slightly higher meat and fat content and lower bone content of the half-carcasses compared to animals from group KK-P. For the other fattening and slaughter traits (daily weight gains, final body weight, hot carcass weight and dressing percentage), intensively fed animals (group KK-I) obtained significantly higher ($p \leq 0.05$ or $p \leq 0.01$) values than those fed at a lower level (KK-P). In bulls from group KK-I there was a significantly higher ($p \leq 0.05$ or $p \leq 0.01$) percentage of dry matter, crude protein and crude fat in the longissimus muscle (LM) and a lower percentage of total cholesterol in intramuscular

TABLE 1. Chemical composition (%) and nutritive value of feeds, daily intake of feeds and feed conversion.

Components	Maize silage	Meadow hay	Concentrate
Dry matter	29.20	85.24	87.70
Crude ash	1.31	7.87	6.93
Crude protein	2.51	7.76	15.30
Crude fat	1.16	1.52	2.41
Crude fiber	5.79	29.13	5.58
Non-protein N	18.33	38.96	57.46
ADF	8.73	29.34	-
NDF	12.15	47.50	-
Lactic acid	2.21	-	-
Acetic acid	0.41	-	-
Butyric acid	0.04	-	-
pH	3.67	-	-
Content in 1 kg feed:			
UFV	0.24	0.56	0.92
PDIN (g)	15.2	48.0	103.0
PDIE (g)	19.1	57.0	98.1
P(g)	0.49	2.62	4.60
Ca (g)	0.79	5.39	0.70

Feeds	Dietary group*	
	KK-I	KK-P
Maize silage (kg)	14.7	17.3
Meadow hay (kg)	1.0	1.0
Concentrate (kg)	4.97	2.85
Nutrient intake (kg/day):		
Dry matter (kg)	9.47	8.90
UFV	8.66	7.30
Crude protein (g)	1192.6	947
PDIN (g)	783.3	604.6
PDIE (g)	825.4	667.0
Nutrient conversion (kg/kg gain):		
Dry matter (kg)	6.92	9.29
UFV	6.33	7.63
Crude protein (g)	871.8	989.6
PDIN (g)	572.6	631.1
PDIE (g)	603.4	697.0
Bulky feed to concentrate ratio (%)	54:46	72:28
Energy density of diet**	0.98	0.81

Notes: * KK-I – intensive feeding; KK-P – semi-intensive feeding; ** according to Feeding standards for cattle, sheep and goats [IZ-INRA, 2001]

TABLE 2. Body weight and daily gains, average cost of feeds per kg of body weight gain, postslaughter carcass analysis and chemical composition and total cholesterol content of the longissimus muscle (n = 6; $\bar{x} \pm SE$).

Slaughter and fattening traits and chemical composition of meat	Groups				SEM
	KK-I		KK-P		
Initial body weight (kg)	440.5	3.31	440.2	2.46	9.88
Final body weight (kg)	536.3^{a}	5.29	507.2^{b}	2.83	18.71
Days of feeding	70	-	70	-	-
Daily weight gain (g)	1368.7^{A}	83.19	956.5^{B}	25.82	154.21
Carcass weight (kg)	341.50^{A}	7.82	315.9^{B}	1.91	12.35
Dressing percentage	63.67^{a}	0.53	62.30^{b}	0.27	1.25
Content of 5 half-carcass cuts (%):					
Meat	78.38	0.62	76.90	0.76	2.25
Fat	7.15	0.63	6.26	0.71	0.95
Bone	14.45	2.11	16.84	2.87	3.98
Chemical composition of meat (%):					
Dry matter	24.27^{a}	0.21	23.68^{b}	0.12	0.42
Crude ash	1.12^{a}	0.008	1.09^{b}	0.004	0.02
Crude protein	22.48^{A}	0.16	21.71^{B}	0.09	0.31
Crude fat	1.73^{a}	0.13	1.24^{b}	0.12	0.31
Total cholesterol (mg/100 g)	44.34^{A}	0.91	49.28^{B}	0.41	1.73
Cost of feeds per kg of body weight gain (PLN)*	3.99	-	4.31	-	-

Notes: a, b ≤ 0.05; A, B ≤ 0.01; *cost of feeds from The Experimental Station Grodziec Śląski LTD for 2006

fat compared to animals from group KK-P (Table 2). Furthermore, in animals fed with a higher level of concentrate (group KK-I) the cost of feeds per kg of weight gain was lower compared to animals from group KK-P.

Fattening value, post-slaughter carcass traits and dressing percentage in intensively fattened bulls (group KK-I) attained similar values, and in bulls from group KK-P lower values than those found for bulls of different meat breeds fed intensively with complete TMR diets [Oprządek *et al.*, 2002] or for Simmental bulls fed intensively with maize silage and concentrate [Sami *et al.*, 2004]. Studies by Dannenberger *et al.* [2006] with German Simmental bulls showed higher values for fattening and slaughter traits and intramuscular fat content of the longissimus muscle in animals fed intensively with maize silage and concentrate, compared to animals fed pasture forage in the initial fattening period, followed by haylage and concentrate supplemented with linseed. The values of fattening and slaughter traits and fat and crude protein content of the longissimus muscle as well as the cost of feeds per kg of body weight gain are also confirmed by the data of Berthiaume *et al.* [2006] and Juniper *et al.* [2005] that the excessive reduction of energy and protein concentration in the finishing diet may negatively affect carcass and beef quality traits and reduce fattening efficiency.

Comparison of the fatty acid profile of the feed samples (Table 3) showed that maize silage and concentrate, which had similar values to meadow hay for total unsaturated fatty acids (UFA) and polyunsaturated fatty acids (PUFA), were characterised by considerably higher levels of monounsaturated fatty acids (MUFA) and n-6 PUFA compared to hay. Meanwhile, meadow hay contained many times more n-3 PUFA than maize silage and concentrate, had a much lower n-6/n-3 PUFA ratio, and a higher concentration of saturated fatty acids (SFA). Compared to silage and meadow hay, the concentrate was characterised by a considerably higher sum of CLA isomers and, compared to maize silage, by a higher concentration of polyunsaturated n-3 fatty acids (n-3 PUFA).

The concentration of fatty acids in the intramuscular fat of the longissimus muscle is given in Table 3. The data show that compared to the medium intensity of feeding (group KK-P), the high intensity of feeding Limousin bulls in the finishing period did not result in significant differences in the sum of fatty acids UFA, PUFA, SFA, MUFA and CLA isomers in the intramuscular fat of the longissimus muscle. Compared to animals from group KK-P, the intramuscular fat of bulls from group KK-I had a significantly higher ($p \leq 0.05$) concentration of DHA (C22:6 n-3) and higher (but not significantly) concentration of EPA (C20:5 n-3), which shows particular benefits for human health. The longissimus muscle of animals from group KK-I had more beneficial, lower ($p \leq 0.01$) n-6/n-3 PUFA ratio and a tendency towards higher concentrations of C 18:3 n-3 and total n-3 PUFA compared to bulls from group KK-P. At the same time, animals from group KK-I compared to animals from group KK-P had a significantly lower ($p \leq 0.01$ or $p \leq 0.05$) concentration of SFA (C 12:0, C 14:0 and C 16:0).

Based on the present study, it is not clear whether the reduced intensity of feeding Limousin bulls with maize silage, hay and concentrate in the finishing period improves concentration of desirable fatty acids in the intramuscular fat of the longissimus muscle of beef. Because when the feeding level was lower, the level of undesirable SFA that increase the risk of cardiovascular diseases (C 12:0, C 14:0 and C 16:0) increased,

TABLE 3. Fatty acid profile in feed samples and intramuscular fat of the longissimus muscle of the fattened bulls (% of total acids).

Fatty acids	Feeds			Meat (LM)				SEM
				Groups				
	Maize silage	Meadow hay	Concentrate	KK-I (n=6)		KK-P (n=6)		
				$\bar{x}$	± SE	$\bar{x}$	± SE	
SFA (total)	12.46	27.70	11.39	40.50	1.15	44.11	1.28	2.98
C 12:0	0.138	0.278	0.000	0.025^{A}	0.09	0.079^{B}	0.014	0.02
C 14:0	0.17	0.69	0.21	1.06^{A}	0.10	1.92^{B}	0.16	0.33
C 16:0	8.38	19.87	9.89	20.01^{a}	0.90	23.31^{b}	0.59	1.87
C 18:0	1.56	2.68	1.12	19.05	0.68	18.76	0.80	1.82
UFA (total)	87.54	72.29	88.61	58.41	1.24	54.87	1.48	3.34
C 18:2 n-6	66.83	31.49	65.44	17.41	2.24	18.48	1.72	4.90
C 18: 3 n-6	0.035	0.121	0.014	0.155	0.011	0.143	0.003	0.02
C 18: 3 n-3	3.89	34.68	4.68	1.24	0.118	1.19	0.111	0.25
MUFA (total)	16.41	5.80	17.60	35.09	1.81	31.01	1.74	4.35
PUFA (total)	71.14	66.49	71.00	23.32	2.34	24.37	2.34	5.73
EPA	0.000	0.000	0.000	0.393	0.037	0.373	0.074	0.14
DHA	0.000	0.000	0.000	0.130^{a}	0.015	0.070^{b}	0.012	0.03
PUFA n-6	66.86	31.61	75.46	20.22	1.95	21.55	2.17	5.06
PUFA n-3	3.89	34.68	4.68	3.097	0.41	2.380	0.23	0.81
PUFA n-6/n-3	17.21	0.91	13.99	6.68^{A}	0.385	9.06^{B}	0.39	0.95
CLA*	0.388	0.208	0.870	0.598	0.048	0.562	0.032	0.099

For notes, see Table 2; *Sum of CLA isomers: cis 9-trans 11, trans 10 – cis 12, cis 9- cis 11, trans 9- trans 11

and also unfavourably for health the n-6/n-3 PUFA ratio and the level of total cholesterol increased in intramuscular fat, while the level of n-3 PUFA (including C 18:3 n-3, EPA and DHA), which are desirable for human health as they regulate the cardiovascular system, decreased [Psota *et al.,* 2006]. These fatty acids inhibit the apoptosis of blood epithelial cells and reduce the risk of arteriosclerosis [Mozaffarian & Rimm, 2006]. This could result from the higher intake of concentrates (characterised by a higher level of n-3 PUFA and CLA and a lower n-6/n-3 PUFA ratio compared to maize silage) by intensively fed animals (group KK-I) than by animals fed less intensively (group KK-P), Studies by Lee *et al.* [2006] showed that the rumen environment of beef cattle is well adjusted to buffering large amounts of concentrates. The present results concerning the profile of UFA and SFA in the muscle tissue of fattened bulls did not confirm the results of other studies [Marino *et al.*, 2006], which showed that a higher rather than a lower ratio of bulky feds to concentrates in the finishing diet increases the UFA/SFA ratio. It must be stressed, however, that the above authors used other types of bulky feeds, including forages or silages from the same plants and meadow hay. These feeds are characterised by more desirable fatty acid profile than maize silage or concentrate [Bilik *et al.*, 2006; O'Sullivan *et al.,* 2002], resulting in beneficial differences in the composition of fatty acids in the muscle tissues of fattened animals [Bilik *et al.*, 2006; Scollan & Wood, 2006]. Studies by Gatellier *et al.* [2005] and Sami *et al.* [2006] also show that animals receiving pasture forage or bulky feed and concentrate diets containing linseed, are characterized by a greater concentration of desirable n-3 PUFA in muscle tissues at the cost of n-6 PUFA, compared to those fed high-starch diets based on maize silage and concentrate.

SUMMARY

It is concluded that, compared to semi-intensive feeding, the intensive feeding of finishing Limousin bulls with diets containing maize silage, hay and concentrate has a more beneficial effect on fattening and slaughter traits, economic efficiency of feeding and on the profile of fatty acids with health-promoting properties to humans, the n-6/n-3 PUFA ratio and the total cholesterol concentration of the longissimus muscle.

REFERENCES

1. AOAC, Association of Official Analytical Chemists. Official Methods of Analysis. Food Composition, Additives, Natural Contaminants. Arlington VA., 1990, 1, 684.
2. Berthiaume R., Mandell J., Faucitano L., Lafreniere C. Comparison of alternative beef production systems based on forage finishing or grain-forage diets with or without growth promotants: 1. Feedlot performance, carcass quality, and production costs. J. Anim. Sci., 2006, 84, 2168-2177.
3. Bilik K., Choroszy Z., Łopuszańska-Rusek M., Effect of silage type on the composition and health properties of beef. Anim. Sci., 2006, Suppl. 1, 72-73.
4. Choroszy B., Choroszy Z., Trela J., Methodology of breeding value evaluation in extent meat traits of bulls. 2004, IZ, Kraków, pp. 1-12 (Poland).

5. Dannenberger D., Nuernberg K., Nuernberg G., Scollan N., Steinhart H., Ender K., Effect of pasture vs. concentrate diet on CLA isomer distribution in different tissue lipids of beef cattle. Lipids, 2005, 40, 589-598.
6. Dannenberger D., Nuernberg K., Nuernberg G., Ender K., Carcass- and meat quality of pasture vs. concentrate fed German Simmental and German Holstein bulls. Arch. Tierz. Dummerstorf, 2006, 49, 315-328.
7. French P., O'Riordan E.G., Monahan F.J., Caffrey P.J., Vidal M., Mooney M.T., Troy D.J., Moloney A.P., Meat quality of steers finished on autumn grass, grass silage or concentrate-based diets. Meat Sci., 2000, 56, 173-180.
8. Gatellier P., Mercier Y., Juin H., Renerre M., Effect of finishing mode (pasture- or mixed-diet) on lipid composition, colour stability and lipid oxidation in meat from Charolais cattle. Meat Sci., 2005, 69, 175-186
9. Goering H.K., Van Soest P.J., Forage Fiber Analyses. Agric. Handbook. 1970, Department of Agriculture, Washington D.C., p. 379.
10. Juniper D.T., Browne E.M., Fisher A.V., Bryant M.J., Nute G.R., Beever D.E., Intake, growth and meat quality of steers given diets based on varying proportions of maize silage and grass silage. Anim. Sci., 2005, 81, 159-170.
11. Lee M.R.F., Tweed J.K.S., Dewhurst R.J., Scollan N.D., Effect of forage:concentrate ratio on ruminal metabolism and duodenal flow of fatty acids in beef steers. Anim. Sci., 2006, 82, 31-40.
12. Marino R., Albenzio M., Girolami A., Muscio A., Sevi A., Braghieri A., Effect of forage to concentrate ratio on growth performance, and on carcass and meat quality of Podolian young bulls. Meat Sci., 2006, 72, 415-424.
13. Mozaffarian D., Rimm E.B., Fish intake, contaminants, and human health: evaluating the risks and the benefits. J. Amer. Med. Assoc. (JAMA), 2006, 296, 1885-1899.
14. Oprządek J., Dymnicki E., Oprządek A., Słoniewski K., Reklewski Z., Feed intake, feed efficiency, growth rate and carcass traits in selected beef bulls. Rocz. Nauk. Zoot., 2002, (Suppl.) 15, 219--224 (in Polish; English abstract).
15. O'Sullivan A., O'Sullivan K., Galvin K., Moloney A.P., Troy D.J., Kerry J.P., Grass silage versus maize silage effects on retail packaged beef quality. J. Anim. Sci., 2002, 80, 1556-1563.
16. Psota T.L., Gebauer S.K., Kris-Etherton P., Dietary omega-3 fatty acid intake and cardiovascular risk. Am. J. Cardiol., 2006, 98, 3-18.
17. Sami A.S., Koegel J., Eichinger H., Freudenreich P., Schwarz F.J., Effect of the dietary energy source on meat quality and eating quality attributes and fatty acid profile of Simmental bulls. Anim. Res., 2006, 55, 287-299.
18. Sami A.S., Augustini C., Schwarz F.J., Effect of feeding intensity and time on feed on performance, carcass characteristics and meat quality of Simmental bulls. Meat Sci., 2004, 67, 2, 195--201.
19. Scollan N.D., Wood J.D., Enhancing the nutritional value of beef and its relationships with meat quality. Anim. Sci., 2006, (Suppl.) 1, 83-85.
20. Strzetelski J., Chomyszyn M., Stasiniewicz T., Feeding Standards for Cattle according to INRA (1998). 2001, *in*: Feeding standards for cattle, sheep and goats. Nutrient Value of feeds for ruminants., IZ, Kraków, pp. 21-90 (in Polish)
21. Yang A., Lanari M.C., Brewster M., Tume R.K., Lipid stability and meat colour of beef from pasture- and grain-fed cattle with or without vitamin E supplement. Meat Sci., 2002, 60, 41-50.

WPŁYW POZIOMU ŻYWIENIA BUHAJKÓW W KOŃCOWYM OKRESIE OPASANIA NA CECHY RZEŹNE I SKŁADNIKI LIPIDOWE MIĘSA

Krzysztof Bilik[1], Zenon Choroszy [2], Magdalena Łopuszańska-Rusek[1]

[1] Dział Żywienia Zwierząt i Paszoznawstwa, [2] Dział Genetyki i Hodowli Zwierząt; Instytut Zootechniki – Państwowy Instytut Badawczy, Balice

Doświadczenie przeprowadzono na 12 buhajkach rasy Limousine, przydzielonych po 6 sztuk do analogicznych pod względem masy ciała grup żywieniowych. Buhajki odchowywano w okresie cielęcym przy krowach matkach, a następnie żywiono alkierzowo paszami gospodarskimi (kiszonki, siano, treściwe) dla uzyskania przyrostu masy ciała około 1000 g/dzień. Podstawową paszę objętościową stanowiła kiszonka z kukurydzy (skarmiana do woli), uzupełniona sianem łąkowym (1 kg/dzień) i zróżnicowaną (w zależności od grupy) ilością mieszanki treściwej (kg/ 100 kg masy ciała): 1,0 (grupa KK-I) lub 0,6 (KK-P). Badania wykazały, że intensywne żywienie buhajków rasy Limousine w końcowym okresie opasania dawkami zawierającymi kiszonkę z kukurydzy, siano łąkowe i paszę treściwą, wpływa korzystniej w porównaniu z żywieniem pół-intensywnym na cechy opasowe, rzeźne i efektywność ekonomiczną żywienia oraz profil kwasów tłuszczowych w tłuszczu śródmięśniowym o właściwościach prozdrowotnych, stosunek PUFA n-6/n-3 i zawartość cholesterolu całkowitego w mięśniu najdłuższym grzbietu.