COMPARISON OF THE RESULTS OF FATTENING STEERS AND HEIFERS MEAT HYBRIDS HFXLM FED WITH RATIONS BASED ON GRASS SILAGE AND MIXTURE OF TRITICALE AND RAPESEED MEAL

Cezary Purwin[1], Iwona Wyżlic[1], Zenon Nogalski[2], Zofia Wielgosz-Groth[2], Monika Sobczuk-Szul[2], Antanas Sederevičius[3], Paulius Matusevičius[4]

[1]*Department of Animal Nutrition and Feed Management, University of Warmia and Mazury*
[2]*Department of Cattle Breeding and Milk Quality Evaluation, University of Warmia and Mazury*
Oczapowskiego 5,10-718 Olsztyn, Poland, E- mail:purwin@uwm.edu.pl
[3]*Department of Anatomy and Physiology, Veterinary Academy, Lithuanian University of Health Sciences*
Tilžės 18, LT47181, Kaunas, Lithuania
[4]*Department of Animal Nutrition, Veterinary Academy, Lithuanian University of Health Sciences*
Tilžės 18, LT-47181, Kaunas, Lithuania

Abstract. The research was conducted on growing steers and heifers, hybrids of HFxLM, the aim was to compare the results of fattening of steers and heifers, hybrids of limousine and hf breed fed with unlimited grass silage complemented with limited mixture of triticale and rapeseed meal as well as to analyze the impact of sex and age of animals on the structure of feed intake. The observation was conducted on 15 steers and heifers, hybrids of HFxLM, aged from 210 to 450 days, kept in a free-stall barn, fed individually with unlimited grass silage and limited ration of triticale and rapeseed meal (30-25g/kg $W^{0.75}$), which contained 170 g/kg of general protein (<300 kg of body weight) and 155 g/kg of general protein (>300 kg body weight) respectively. Preliminary and final body weight of steers was higher ($p<0.01$) as compared to heifers, however, mean daily gain and feed conversion did not differ. DMI and DMI of silage per 1 kg of metabolic body weight (g/kg $W^{0.75}$) were higher in heifers than steers, apart from age there was impact of sex of fattened animals ($p<0.01$) in particular periods as well as interaction ($p<0,01$) between sex and age. No impact of sex in analyzed periods of fattening on daily body weight gain, conversion of dry matter, general protein, PDI and net energy was observed. Yet, an impact of age of steers and heifers of LM hybrids on daily gains ($p<0.05$) and feed conversion ($p<0.01$) was noted. What is more, with respect to daily body weight gains there was interaction ($p<0.05$) between the sex and age of fattened animals. The pace of growth of heifers was faster in comparison to steers only in the first 60 days of fattening and maximum values were reached between 271–330 days of life. Steers grew faster than heifers after 270 days of life; the maximum pace of gains was reached between 331 and 390 days of fattening.

In reaction to similar rations of concentrates heifers had higher silage intake which lowered the content of concentrate in total intake. The age in particular periods of fattening influenced the effect of substitution, particularly in steers. On the basis of the results one may conclude that heifer hybrids of HFxLM may obtain pace of growth similar to steers if they are fed rations with smaller content of concentrate.

Keywords: limousine hybrids, steers, heifers, grass silage, triticale, rapeseed meal.

Introduction

Improvement of production results of fattening, the slaughter value of carcass and quality of meat are the main directions of research in the field of cattle fattening. The feeding system is mentioned as the most significant factor determining the effects of cattle fattening. Extensive and half-extensive, based on green forage and grass silage or maize silage, fattening plays the main role In Polish climatic and soil conditions (Nogalski and Kijak 2001, Bilik et al. 2009). Feeding based on silage is usually less intensive, animals are often older at the moment of slaughter so the meat can be less tender and darker (Belury 2002). Cattle fattening systems based on grass are thought of as low-cost and particularly adequate for a numerous groups of consumers expecting natural and animal-friendly production methods (Razminowicz et al. 2006). Feeding with grass is also in accordance with health-related and quality requirements of consumers, i.e. fat content in meat and composition of fatty acids contained in tissue fat (Fisher et al. 2000). Another advantage of cattle fattening with grass are more beneficial proportions of n-3 CLA acids in beef as compared to meat from animals fed with maize silage and concentrate (Dannnenberger et al. 2004, Nürberg et al. 2002). Energy concentration in feeding ration predetermines the pace of growth of fattened cattle and consequently the age of animals in slaughter which significantly influences slaughter value and meat quality. Concentration of energy in ration of fattened cattle is determined mainly by the level of concentrates the prices of which often determine the profitability of fattening. Concentrates which are recently in demand and relatively cheap include triticale and rapeseed meal. Triticale, so far underestimated as feed grain in Poland, is commonly used in numerous countries as a cheap source of energy in feeding fattening cattle. High protein content, the profile of amino acids of protein in triticale grain in comparison to other grain species (Hill and Utley 1989) and the content of digestible energy comparable with barley grain (ZoBell 1986, 1990) allow assuming that triticale can be an economically attractive alternative for wheat, maize, sorghum and barley (Jaśkiewicz and Cyfert 2005).

Rapeseed meal is the most important source of protein used in feeds for cattle. Currently, many producers of beef use protein supplementation of rations based on grass silage even though the price of rapeseed meal is high in comparison to grains (Klopfenstein and Erickson 2002, Huuskonen 2009).

The effects of feeding in the majority of researches are varied depending on age, breed and sex. Since 1990s in Poland there has been a systematic growth of headage of beef cattle in the structure of which the French breed limousine dominates. Slaughter cattle of this breed have very good yield of meat, their carcass have good quality and high adaptability (Bilik et al. 2006). As a result, limousine bulls are used for crossbreeding with dairy breeds. In fattening young slaughter cattle bulls and heifers dominate.

Fattening of heifers is connected with quite fast carcass meatiness due to reaching faster sexual maturity. Fattening of bulls guarantees obtaining higher weight gains with lower use of nutritive components per kg of body weight gain. Bulls, due to their temperament, are onerous in fattening and they provide DFD meat more frequently than heifers. In many countries bulls are castrated into steers for fattening (Nogalski i Kijak 2001).

The majority of researches concerning cattle fattening undertakes the issue of the results from the final period of fattening and post-slaughter effects so the aim of the present research was to compare the results of fattening steers and heifers, hybrids of limousine and hf breed fed with unlimited grass silage complemented with triticale and rapeseed meal and to analyze the impact of sex and age on the structure of feed intake.

Materials and methods

Animals and feeding. The present fattening research was conducted in the Animal Laboratory in Lipowo, part of the Production and Experimental Station in Bałcyny near Ostróda. Observation included 15 steers and 15 heifers, hybrids of LM x HF, aged from 210 to 450 days. Calves for fattening were purchased. After the purchase, bulls were castrated bloodlessly by putting on a rubber band. In the period of grow-out till 6 months they were kept in a group in a calf pad bed down with straw. Calves were fed with milk substitute dosed by automatic calf feeder. From the second week, calves received concentrate and hay and from week 4 grass silage. Feeding was over when the calves reached the following body weight: heifers 120 kg, steers 130 kg. In the period of feeding with concentrates (4 to 6 months of life), calves were kept in the same place. They were fed the same grass silage without limits and a concentrate; the ration was 2.5 kg/animal daily. All animals were dehorned by cauterization.

After 6 months, the animals were moved to fattening laboratory. The experiment was started after 30 days of preparation period. During fattening, the animals were kept in a free-stall system and fed individually in the system of feed intake control (RIC System Instentec Control; Holland). Grass silage was the only bulky feed not limited to the animals and its intake was strictly controlled in feed hoppers (1 RIC station was for 5 animals). The silage was administered to feed hoppers with a feed transporter SEKO twice a day (8.00 and 16.00).

Silage was produced in concrete horizontal silos, from the first windrow of grass mixture harvested in the final phase of heading. The green fodder was collected with straw cutter (John Deere 7050) after 24 hours of drying on windrow. Triticale grain came from own production whereas rapeseed meal (RSM) was purchased in the Oil Processing Plant (Kruszwica Polska). Concentrates were given in the form of two mixtures varied with respect to general protein, depending on the current body weight of animals. Steers with body weight under 300 kg received mixture I where the assumed content of general protein was 170 g/kg (25% content of RSM) , while steers over 300 kg of body weight received mixture II with general protein at the level of 155 g/kg (19 % content of RSM). Mineral-vitamin supplementation was a commercial mineral mixture for fattened cattle (Cargill Polska Sp zoo) containing in 1 kg: Ca – 235 g; Na – 79 g; P – 48 g; Mg – 28 g; Fe – 500 g; Mn – 2 000 mg; Cu – 375 mg; Zn 3 750 mg; J – 50 mg, Co – 12.5 mg; Se – 12.50 mg; vitamin A- 250 000 units.; D_3-50 000 units.; E – 1 000 mg; DL alpha-tokoferol – 909.10 mg. Daily rations of concentrate for steers and heifers were established on level 30 g per 1 kg of metabolic body weight ($W^{0.75}$). The ration of concentrate was provided in feed hoppers in four portions (6.00; 10.00; 14.00; 18.00).

Mean daily intake of dry matter was analyzed on the basis of individual daily intake of silage and concentrate. Feed intake was expressed in kg DM, g CP, g PDI, UFV /d and kg DM/kg metabolic weight ($W^{0,75}$). Body weight control was conducted every day with the use of automatic scales integrated with the stations for concentrate. The bases for analysis were the results of weighing performed at the moment of intake of the first ration of concentrate. The results of fattening were analyzed in four 60-day stages – 211–270, 271–330, 331–390, and 391–450 – and in the period of 240 days.

Feed conversion was expressed by dry matter conversion (kg/kg), net energy, general protein (g/kg), and concentrate (kg DM/kg) per 1 kg of body weight gain.

Sampling and chemical analysis

Silage samples were collected before and during fattening twice a day and kept at - 25° C. After defrosting, part of silage samples was dried at a temperature of 60 ºC in Binder air flow dryers, and ground with Retsch 200 mill (Retsch Co.) to 1mm particles. Along with bulky feeds, samples of triticale, rapeseed meal and concentrate were collected.

In all feed samples were determined: the content of basic nutritive ingredients – with standard methods (AOAC 2005), NDF, ADF, and ADL – with the method of Van Soesta et.al. (1991). Organic matter digestibility (DOMD) in silages, triticale meal and rapeseed meal was determined by Van Soesta method et.al. (1991), modified by Ankom with Daisy II. Additionally, in silages were determined: pH of silage with pehameter HI 8314, acid content (lactic, acetic, butyric) in water extract by the method of liquid chromatography (HPLC), apparatus Shimadzu using MetaCarb 67H column from VARIAN company, the content of water soluble carbohydrates by anthrone test (Thomas 1977), the content of protein nitrogen (N-protein) by TCA acid method and ammonia nitrogen (N-NH_3) by the Conway method (Licitra et.al. 1996). Amino acid nitrogen was calculated on the basis of the number of free amino acids which were determined with AAA 400 INGOS automatic amino acid analyzer (Czech Republic) with the use of lithium column after earlier deproteinization of TCA samples. Amino Acid Standard Solution AASS-18, L-metionin sulfone, L-cysteic acid, L-norleucine, Tryptophan produced by Sigma were used as amino acid standard.

The impact of sex on mean results of fattening of steers and heifers was established with one-way analysis of variance whereas the results of fattening in particular periods were analyzed with two-way analysis of variance for orthogonal designs in accordance with the model:

$$X_{ijk}= \mu + a_i + b_i + (ab)_{ij} + e_{ijk}$$

where:

μ – indicates mean;

a_i – sex effect (1,2);

b_i – age effect (1-4);

$(ab)_{ij}$ – interaction of factors in subgroup (i ,j);

e_{ijk} – effect of factors specific for k – that element of subgroup (i, j).

The significance of differences between the mean and interaction was verified using Duncan test.

Results

The grass silage used in the analyzed period of fattening experiment had a changeable chemical content (Table 1). Significant degree of drying reduced fermentation which is proved by a high content of organic matter, WSC and a relatively low level of fermentation acids. The content of net energy in the dry matter of the silage correlated with the amount of silage from the first windrow of permanent pastures collected in two phases in the preliminary period of heading (INRA Norms), whereas the values of PDIN and PDIE were slightly lower. The chemical composition and nutritive value of triticale grains and rapeseed meal were very similar throughout the research as they came from one batch and were stored in the same conditions (Table 2). As compared with the values provided in the norms (INRA, 2009), RSM had a higher content of ADF and ADL, while triticale grain NDF. The level of other components in concentrates did not vary from the data provided in the tables. The composition and nutritive value of the feeds during fattening fluctuated in comparison with assumed values.

Table 1. **Chemical composition and nutritional value of feeds used in the research** (mean± SD)

Signification	Silage	Triticale	Rapseed meal	Concentrate I	Concentrate II
Triticale (g/kg)				710	770
Rapseed meal (g/kg)				250	190
N	9	1	1	7	7
Dry matter	397±109,3	881	887	883,9±7,1	885,5±8,2
In Dry matter [g/kg]					
Organic matter	920±30,6	981	927	932±13,1	925±18,3
Crude protein	141 ±11,4	133	388	189±15,1	163±7,1
NDF[1]	569± 52,3	193	310	160	184
ADF[2]	387± 59,2	44	228	72	31
ADL[3]	59± 21,0	13	108	37	31
DOMD[4]	741± 55,9	932± 26,5	848±4,4	-	-
Fermentation quality of silage, g/kg					
pH	4,8±0,3	-	-	-	-
Lactic acid	54±20,4	-	-	-	-
VFA[5]	27±5,3	-	-	-	-
WSC[6]	82±47,6	-	-	-	-
N-NH_3 [g/kg N]	103±67,4	-	-	-	-
N-protein [g/kg N]	518±45,6	-	-	-	-
NPN [g/kg N] [7]	482±45,6	-	-	-	-
NAA [g/kg N] [8]	144	-	-	-	-
UFC[9]	0,80±0,03	1,21	1,01	1,21	1,18
PDIN[10]	82,2±6,64	89	259	122,2	112,4
PDIE[11]	69,5±2,28	109	163	129,6	121,1
FUC [12]	1,0±0,28	-	-	-	-
Energy density UFV/FUC	0,8±0,26	-	-	-	-

[1]neutral detergent fiber, [2]acid detergent fiber, [3]acid detergent lignin, [4]dry organic matter digestibility [5]volatile fatty acids [6]water-soluble carbohydrates [7]non-protein nitrogen, [8]amino acid nitrogen, [9]feed unit energy for cattle, [10]protein digested in the small intestine depending on rumen degraded protein· [11]protein digested in the small intestine depending on rumen fermented organic matter

Table 2. **Body weight, mean intake and conversion of feed in steers and heifers in the period of 240 days of fattening**

Specification	Steers	Heifers	SEM	Sex
Initial live weight, kg	217	183	5,4	xx
Final live weight, kg	443	396	8,0	xx
Live weight gain, g/d	937	888	19	
DMI, kg/d				
Silage	5,2	5,3	0,1	
Concentrate	2,1	2,0	0,1	
Total	7,3	7,3	0,1	
DMI, g/kg $W^{0.75}$				
Silage	63,5	77,3	1,6	xx
Concentrate	26,6	26,5	0,5	
Total	90,1	103,8	1,8	xx
kg DM/ kg live weight gain				
Silage	5,9	6,3	0,2	
Concentrate	2,4	2,2	0,1	
Total	8,3	8,5	0,3	
Statistical significance: (x P ≤ 0,05), (xx P ≤ 0,01)				

Table 3. **Feed intake in steers and heifers in further fattening periods**

Specification		Age – day				SEM[a]	Sex	Age	Sex*Age
		211-270	271-330	331-390	391-450				
DMI, kg/d									
Silage	S	4,1	6,1	5,1	5,9	0,3		xx	xx
	H	4,7	5,2	5,3	5,8	0,2			
Total	S	5,9	8,2	7,4	8,3	0,3		xx	xx
	H	6,4	7,1	7,4	8,0	0,2			
DMI, g/kg $W^{0.75}$									
Silage	S	67,4	81,3	58,8	61,3	3,4	xx	xx	xx
	H	86,5	83,6	66,3	72,9	2,8			
Total	S	96,5	109,3	85,3	85,5	3,6	xx	xx	xx
	H	114,8	110,3	92,5	97,6	3,0			
Crude protein intake, g/d									
Silage	S	566	917	745	833	35		xx	xx
	H	649	792	764	837	31			
Total	S	865	1243	1073	1167	40		xx	xx
	H	927	1078	1071	1156	34			
PDI g/d									
Silage	S	285	424	355	410			xx	x
	H	327	361	368	403				
Total	S	505	669	624	679			xx	x
	H	534	583	614	649				
Net energy UFV/d									
Silage	S	2,7	3,9	3,0	4,1	0,2		xx	xx
	H	3,2	3,3	3,2	4,2	0,2			
Total	S	4,9	6,5	5,7	6,9	0,2		xx	xx
	H	5,2	5,6	5,7	6,8	0,1			
[a] Standard error of mean Statistical significance: (x P ≤ 0,05), (xx P ≤0,01)									

The body weight of steer hybrids on the 210 day was 34 kilos higher (p<0.01) in comparison with heifers (Table 2). After 240 days of fattening, the difference between the body weight of steers and heifers amounted to 47 kg (p<0.01) even though mean daily gains did not vary significantly. In the whole period of fattening, the total dry matter intake (DMI) and the intake structure as well as feed conversion did not differ. On the other hand, there were differences (p<0.01) in the total DMI intake and silage DMI calculated per 1 kg of metabolic weight (g/kg $W^{0.75}$), which was higher in heifers than in steers.

Feed intake analysis at 60-day intervals of fattening in particular (Table 3) showed a significant impact of age (p<0.01) on the total daily intake and silage intake with respect to dry matter, general protein, PDI and net energy. For all mentioned parameters there were significant interactions (p<0.01) between the age and sex of animals. The analysis of dry matter per 1kg $W^{0.75}$ showed impact of animal sex (p<0.01); in particular periods there was also interaction (p<0.01) between the sex and age.

In the analyzed periods of fattening, no impact of sex on daily body weight gains, dry matter conversion, general protein, PDI and net energy was observed despite significant differences (p<0.01) in the body weight (Table 4). The effect of age of heifer and steer hybrids LM on daily gains (p<0.05) and feed conversion (p<0,01), except for PDI conversion was observed, With respect to daily body weight gains there was interaction (p<0.05) between the sex and age of fattened animals, which resulted from different pace of growth during fattening. Compared to steers, the pace of growth of heifers was faster only in the first 60 days of fattening and maximum values were reached on 271–330 days of life. Steers had a faster pace of growth after 270 days and they reached maximum pace of gains between 331 and 390 days of fattening.

Table 4. **Body weight, daily body weight gains and feed conversion in steers and heifers in further fattening periods**

Specification		Age – day				SEM	Sex	Age	Sex*Age
		211-270	271-330	331-390	391-450				
Initial live weight, kg	S	217	265	324	388	8	xx	xx	
	H	183	237	293	346	8			
Final live weight, kg	S	266	324	388	443	9	xx	xx	
	H	237	293	346	396	9			
Live weight gain, g/d	S	792	972	1075	909	48		x	x
	H	892	940	882	838	50			
kg DM/ kg live weight gain									
Silage	S	4,5	6,5	5,0	7,7	0,7		xx	
	H	5,4	5,7	6,3	7,7	0,4			
Total	S	6,8	8,7	7,2	10,7	0,9		xx	
	H	7,3	7,7	8,7	10,4	0,5			
g crude protein/ kg live weight gain									
Silage	S	623	982	720	1069	93		xx	
	H	743	858	895	1094	56			
Total	S	1009	1325	1036	1493	119		xx	
	H	1055	1162	1243	1475	71			
g PDI / kg live weight gain									
Silage	S	307	436	330	451				
	H	367	384	417	481				
Total	S	585	688	580	747				
	H	599	620	696	775				
Net energy UFV/ kg live weight gain									
Silage	S	3,1	4,2	2,9	5,3	0,5		xx	
	H	3,6	3,6	3,8	5,5	0,3			
Total	S	5,9	6,9	5,5	8,8	0,7		xx	
	H	5,8	6,0	6,6	8,6	0,4			

[a] Standard error of mean
Statistical significance: (x P ≤ 0,05), (xx P ≤0,01)

Discussion

The differences observed in the chemical composition of grass silage resulted foremost from different length of storage and silo size. Consequently, the collected material was not homogeneous with respect to drying level which could also cause certain differences in the course of fermentation and composition of silage. Similar composition changeability was observed by Keane et al. (2006) and Huuskonen et al. (2007) during fattening experiments. The content of WSC, NDF, ADF, ADL and organic acids confirms a limited character of fermentation and points to appropriate date of grass harvest. The composition of fraction of structural carbohydrates and reduced fermentation influenced a high level of indicator of digestibility of rumen (DOMD), which was close to the values presented by other researchers (Steen and Robson 1995, Steen et al. 1998, Huuskonen et al. 2007). Fermentation quality of silage was lowered by too little acidification (pH 4.8) taking into account the fact that it was produced in a vertical silo from shredded material. Such acidification level may be indicative of low immunity of feed to aerobic processes during feeding

(Purwin et al. 2010). The content of protein nitrogen points to significant scope of protein hydrolysis during ensilage, yet the levels of amino acid nitrogen and ammonium nitrogen prove a high content of nitrogen in peptide form in the non-protein fraction. Fractions of protein and peptide nitrogen are the best nitrogen forms used in bacterial protein synthesis in rumen (Florek et al. 2004, Givens and Reulquin 2004).

The achieved body weight gains were similar to gains reported by other authors. In fattening of late-maturing steer hybrids with grass silage complemented with concentrate (37.5 % of ration DM) Keane et al. (2006) achieved gains on the level 900–929 g/d. Bailey et al. (2008) fattened steers and heifers with diets based on maize grain and achieved respectively 1020 and 910 g/d.

When feeding regular ration of concentrate, total intake and its structure were conditioned by the size of silage intake by steers and heifers. Despite the differences in the daily intake of steers and heifers, no statistical effect of sex on the intake in particular periods of fattening was confirmed. However, there was correlation between the sex and intake converted into metabolic weight. In all periods of fattening, the intake per 1 kg of metabolic weight was higher in heifers than steers and resulted from higher silage intake by heifers. The intake of concentrate converted into metabolic weight (g/kg $W^{0.75}$) was lower with age in both steers and heifers despite the differences in silage intake in particular periods of fattening. A similar effect was observed by Huuskonen et al. (2007). In that research the intake of dry matter of ration per 1 kg of metabolic weight was decreasing linearly with the increase of concentrate content in TMR rations.

The occurrence of interaction between the age and sex in relation to all analyzed parameters of intake may be explained by the differences in grass silage intake in steers in the first 120 days of fattening. In the first 60 days total dry matter intake in steers was on average about 0.5 kg DM/item/d lower than in heifers, while in the next period steers took in 1.1 kg DM/item/d more than heifers.

There was no impact of sex of hybrids on the mean feed conversion in the whole fattening period (Table 2), yet there was a tendency for higher conversion of concentrate and lower conversion of silage per 1kg of body weight gain in steers. In the research of Bailey et al. (2008), heifers had lower daily gains and feed intake than steers without any differences in feed conversion.

The intake of dry matter and nutritive ingredients by heifers was increasing with age whereas steers used feed better in the preliminary period (211–270) and between 331 and 390 days of life. Better feed conversion in the preliminary period of steer fattening, despite lower intake of nutritive ingredients, can be explained by a more beneficial intake structure (the highest share of concentrate in the total intake and its highest intake per 1kg of metabolic weight among analyzed periods) and beneficial tissue content of growth in this age. Moreover, with limited energy supply there might occur fat mobilization which supports protein synthesis particularly when the protein delivered has proper amino acid composition (Schroeder and Titgemeyer 2008). Better conversion of feed components in the time interval of 331–390 days resulted from the highest growth potential and protein synthesis efficiency connected with this physiological stage and higher share of concentrate in the total intake.

In the research of Huskonen (2009), the best conversion of rations containing grass silage, barley or oats and rapeseed meal occurred between 289 and 370 days of fattening. In the research of Huskonen et al. (2007), the period of maximum growth of bulls fattened with rations containing grass silage with varied complementation was from 279 to 363 days. It may be concluded that worse feed conversion in steers in two periods (271–330; 391–450) could result from higher energy intake. Steen et al. (1995) observed higher adiposity of carcass of animals which took in more bulky feed during fattening. Numerous researches concerning fattening (Huskonen et al. 2007, Steen and Robson 1995, Sobieraj et al. 2001, Nogalski and Kijak 2001) indicated that with growth of concentrate share in the ration the intake of dry matter and energy per 1 kg of body weight gain reduced.

Conclusions

The results of fattening steers and heifers, hybrids of LMxHF fed unlimited grass silage and mixture of triticale and rapeseed meal (RSM) served in the amount of 25–30g/kg $W^{0.75}$ between 211 and 450 days of life have only shown the influence on the total daily mean feed intake (DMI) and DMI of silage per 1 kg of metabolic body weight (g/kg $W^{0.75}$), which was higher in heifers than steers. Steers had bigger body weight from the beginning till the end of fattening while no impact of sex in the analyzed periods of fattening on daily body weight gains, dry matter conversion, general protein, PDI and net energy was observed, irrespectively of significant differences ($p<0.01$) in the body weight. In reaction to similar rations of concentrate, heifers had greater silage intake which lowered the content of concentrates in the total intake. Age in particular periods of fattening had an impact on the effect of substitution, especially in steers.

Concluding, one may state that heifer hybrids HFxLM may obtain the pace of growth similar to steers if they are fed rations with smaller content of concentrate.

Acknowledgements

The present research was implemented within the Project No WND-POIG.01.03.01-00-204/09 Optimizing Beef Production in Poland According to ”from Fork to Farm” Strategy co-financed by the European Regional Development Fund under the Innovative Economy Operational Programme 2007–2013

References

1. AOAC. Association of Official Analytical Chemists. Official Methods of Analysis. 18th Edition, Arlington. 2005.

2. Bailey C. R., Duff G. C., Sanders S. R., Treichel J. L., Baumgard L. H., Marchello J. A., Schafer D. W.,

McMurphy C. P. Effects of increasing crude protein concentrations on performance and carcass characteristics of growing and finishing steers and heifers. Anim. Feed Sci. Technol. 2008. 142. P. 111–120.

3. Belury M.A. Dietary conjugated linoleic acid in healt: physiological effects and mechanisms of action. Annu. Rev. Nutr. 2002. 22. P. 505–531.

4. Bilik K., Choroszy Z., Choroszy B., Łopuszańska–Rusek M. Effect of type of feed and breed of cattle on productive indicators and the chemical composition of beef. Ann. Anim. Sci. 2006. 6 (2). P. 301–312.

5. Bilik K., Węglarzy K., Borowiec F., Łopuszańska–Rusek M. Effect of feeding intensity and type of roughage fed to limousin bulls in the finishing period on slaughter traits and fatty acid profile of meat. Ann. Anim. Sci. 2009. 9. (2). P. 143–155.

6. Dannenberger D., Nürberg G., Scollann N., Schabbel W., Ender K. Effect of diet on the deposition of n-3 fatty acids, conjugated linoleic and 18:1 trans fatty acids isomers in muscle lipids of German Holstein bulls. J. Agric. Food Chem. 2004. 52. P. 6607–6615.

7. Fisher A. V., Enser M., Richardson R.I., Wood J.D., Nute G.R., Kurt E. Fatty acid composition and eating quality of lamb types derived from four diverse breed production systems. Meet Sci. 2000. 55. P. 141–147.

8. Florek S., Purwin C., Minakowski D., Stanek M., Trędowicz M. The influence of formic acid additives on silage quality obtained from different plants material. Vet. Ir Zoot. 2004. 26. (48). P. 23–28.

9. Givens D. I., Rulquin H. Utilisation by ruminants of nitrogen compounds in silage-based diets. Anim. Feed Sci. Technol. 2004. 114. P. 1–18.

10. Hill G. M., Uteley P. R. Digestibility, protein metabolism and ruminal degradation of beagle 82 triticale and kline barley fed in corn-based cattle diets. J. Anim. Sci. 1989. 67. P. 1793–1804.

11. Huuskonen A. The effect of cereal type (barley versus oats) and rapeseed meal supplementation on the performance of growing and finishing dairy bulls offered grass silage-based diets. Livest. Sci. 2009. 122. P. 53–62.

12. Huuskonen A., Khalili H., Joki-Tokola E. Effects of tree different concentrate proportion and rapeseed meal supplement to grass silage on animal performance of dairy breed bulls with TMR feeding. Livest. Sci. 2007. 110. P. 154–165.

13. INRA. Instytut Zootechniki PIB w Krakowie. Wydanie poprawione opracowane w oparciu o "Normy żywienia bydła, owiec i kóz" (2001). (Ed. Skrzetelski J). Kraków. 2009.

14. Jaśkiewicz B., Cyfert R. Charakterystyka i technologia uprawy odmian pszenżyta ozimego. IUNG-PIB-IHAR-COBORU, Puławy-Radzików-Słupia Wielka. 2005.

15. Keane M. G., Drennan M. J., Moloney A. P. Comparison of supplementary concentrate levels with grass silage, separate or total mixed ration feeding, and duration of finishing in beef steers. Livest. Sci. 2006. 103. P. 169–180.

16. Klopfenstein T. J., Erickson G. E. Effects of manipulating protein and phosphorus nutrition of feedlot cattle on nutrient management and the environment. J. Anim. Sci. 2002. 80 (E. Suppl. 2). P. E106–E114.

17. Licitra G., Hernandez T. M., Van Soest P. J. Standarization of procedures for nitrogen fractionation of ruminant feeds. Anim. Feed Sci. Technol. 1996. 57. P. 347–358.

18. Nogalski Z., Kijak Z. Fattening performance and slaughter value of the offspring of Black and White cows and Welsh Black bulls. Czech J. Anim. Sci. 2001. 46 (2). P. 68–75.

19. Nürnberg K., Nürnberg G., Ender K., Lorenz S., Winkler K., Rickert R. N-3 fatty acids and conjugated linoleic acids of *Longissimus* muscle in beef catle. Eur. J. Lipid Sci. Technol. 2002. 104. P. 463–471.

20. Purwin C., Pysera B., Sederevičius A., Makauskas S., Traidaraitė A., Lipiński K. Effect of silage made different plant raw materials with the addition of a fermentation inhibitor on the production results of dairy cows. Vet. Ir Zoot. 2010. 51(73). P. 44–54.

21. Razminowicz R. H., Kreuzer M., Scheder M. R. L. Quality of retail beef two grass-based production systems in comparison with conventional beef. Meat Sci. 2006. 73. P. 351–361.

22. Schroeder G. F., Titgemeyer E. C. Interaction between protein and energy supply on protein utilization in growing cattle: A review. Livest. Sci. 2008. 114. P. 1–10.

23. Sobieraj A., Purwin C., Florek S., Stanek M. Ocena przydatności żywieniowej kiszonek z traw w opasie młodego bydła. Zesz. Probl. Post. Nauk Rol. 2001. 479. P. 251–259.

24. Steen R. W. J. The effect of plane of nutrition and slaughter weight on growth and food efficiency in bulls, steers and heifers of three breed crosses. Livest. Prod. Sci. 1995. 42. P. 1–11.

25. Steen R. W. J., Gordon F. J., Dawson L. E. R., Park R. S., Mayne C. S., Agnew R. E., Kilpatrick D. J., Porter M. G. Factors affecting the intake of grass silage by cattle and prediction of silage intake. Anim. Sci. 1998. 66. P. 115–128.

26. Steen R. W. J., Robson A. E. Effect of forage to concentrate ratio in the diet and protein intake on the performance and carcass composition of beef heifers. J. Agric. Sci. 1995. 66. P. 125–135.

27. Thomas A. T. An automated procedure for the determination of soluble carbohydrates in herbage. J. Sci. Food Agric. 1977. 28. P. 639–642.

28. Van Soest P. J., Robertson J. B., Lewis B. A. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci. 1991. 74. P. 3583–3597.

29. ZoBell D. R. Growth performance and feed efficiency of yearling steers fed a barley or a triticale based ration at feedlot. Am. Soc. Anim. Sci. 1986. 37. P. 96–98.

30. ZoBell D. R. Potential of triticale as a feed for finishing heifers. Can. J. Anim. Sci. 1990. 70. P. 325–328.

Received 11 January 2013
Accepted 16 April 2014