THE EFFECTS OF LINSEED CAKE SUPPLEMENTATION ON THE GROWTH AND QUALITY OF CARCASS AND MEAT OF FATTENING BULLS

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Abstract. In March–May, 2010, a trial with Lithuanian Black-and-White bulls was carried out at the LUHS Institute of Animal Science to determine the chemical composition of the compound feed containing the same amounts of rapeseed and linseed cakes, weight gains of fattening bulls, feed intake per kg gain and the quality of carcasses and meat. In the production of compound feed, replacement of rapeseed cake with linseed cake results in higher content of dry matter, crude fat, crude fibre and by 4 % higher energy value of the feed. The study indicated that bulls fed linseed cake consumed by 7.27 % less metabolizable energy, but by 9.10 % more crude protein than the bulls fed compound feed containing rapeseed cake. The growth rate of the treated bulls fed compound feed with linseed cake was by 9.8 % ($P < 0.05$) higher than that of the control bulls fed compound feed with rapeseed cake. However, different feeding had no influence on the carcass yield, muscle content and fatness grade, and the chemical composition of ground meat. All the differences between the groups were statistically insignificant. Feeding of bulls with compound feed containing linseed cake increased DM content in the *M. longissimus dorsi* by 1.39 % ($P < 0.05$) but had no effects on the other physicochemical indicators of *M. longissimus dorsi.* The differences between the groups were statistically insignificant.

Keywords: linseed cake, fattening bulls, carcass quality, meat quality.

Introduction

Rapeseed is a product important not only for oil industry, biodiesel production, but also for animal feeding. The by-products of rapeseed processing – cake and oil-meal – are used for poultry, pig, cattle and other animal feeding (Leikus R. et al., 2007; Schumann W., 2005). However, the use of rapeseed cake or oil-meal in animal nutrition is restricted by the contents of glucolinolates and erucic acid, harmful substances present in these feeds. The total amount of glucolinolates was 17–24 and 2–17 μmol/g dry matter in, respectively, rapeseed cake and oil-meal produced from rape varieties grown in Lithuania (Mikelionienė et al., 2006). According to W. Schumann (2005), the content of glucosinolates in rapeseed cake and oil-meal used for animal feeding should not exceed 20 μmol/g.

Feeding trials with fattening bulls indicated that compound feed supplementation with rapeseed cake or oil-meal had no negative influence on the growth and quality of carcasses and meat of bulls (Jatkauskas J., Vrotniakienė V., 1995). However, the growth of fattening cattle progeny, feed consumption, production quantity and quality are influenced not only by various protein supplements and feedstuff combinations, but also by the amount of feeding (energy value of the feed allowance), animal age and weight at slaughter and other factors (Schwarz F.J., 2005; Therkildsen M. et al 1998). The more intensive is the growth of fattening bulls, the lower is the feed intake per unit of production and the higher is the quality of the carcass (Bendikas P. et al., 2006).

In Morison's presentation on "Feeds and Feeding" (1946), it was pointed out that flax seeds are rich in oils (36 %) and, therefore, superior to other feeds by the nutritive value. Linseed, linseed cake and pellets are characterized by high energy and protein content (Lardy, Anderson, 2003). The studies carried out in Kansas University showed that the death rate among heifers was lower provided their rations contained linseed (Drouillard et al., 2004). Scholljegerdes and Kron-Berg (2010), also Kronberg (2011) observed that linseed supplementation of the bull diets resulted in their higher growth rate. However, linseed supplementation had no significant effect on feed consumption (Maddock et al., 2006) or it increased insignificantly (Drouillard et al., 2004).

Bartle et al. (1994) and Krehbiel et al. (1995) observed that linseed supplementation of cattle diets resulted in higher meat quality, but had no significant influence on the composition of carcasses.

The purpose of this study was to determine the chemical composition of compound feed containing the same amounts of rapeseed and linseed cakes, the growth of bulls, feed consumption per kg gain and the quality of carcass and meat.

Material and methods

The studies were carried out in compliance with the Lithuanian animal care, management and operation legislation (No 8-500, 28 November, 1997, in "Valstybės žinios").

Experimental design and feeding. The trial with Lithuanian Black-and-White bulls was conducted at the LHSU Institute of Animal Science. The experimental design is presented in Table 1.

Healthy 12-month old bulls were allotted into groups analogous by origin, age and weight. The bulls were kept under equal conditions, tethered and automatically watered. During the trial, the bulls in both groups received the same amount of maize silage, clover-oat-pea mixture silage and compound feed with either rapeseed or linseed cake. Roughage feeds for bulls were weighed by a group method, whereas the compound feed was weighed individually per bull. The bulls were fed twice daily and received maize silage *ad libitum* and 2 kg compound feed at a.m. feeding and clover-oat-pea mixture silage *ad libitum* and 2 kg compound feed at p.m. feeding.

Table 1. **Experimental design**

Group	Bull weight, kg		Feeding pattern
	At the start	At the end	
Control (n=6)	370	420-440	Maize silage, clover-oat-pea mixture silage *ad libitum*, compound feed containing rapeseed cake, 4.0 kg/d
Experimental (n=6)	370	420-440	Maize silage, clover-oat-pea mixture silage *ad libitum*, compound feed containing linseed cake, 4.0 kg/d

In compliance with the nutrition standards (Jatkauskas J. et al., 2002), the daily allowance for fattening bulls was formulated to gain daily 900–1000 g of weight. Feed consumption was determined by weighing the amount of given feeds and their remains once a week. Weight gain was determined by weighing bulls at the start of the trial, every month subsequently and at the end of the trial. After completion of the trial, control slaughtering of bulls was carried out at JSC "Kekenavos agrofirma". Meat samples were collected from 3 bulls in each group. In order to determine the chemical composition of ground meat and physicochemical indicators of *M. longissimus dorsi*, the samples of ground meat and long dorsal muscle were taken from the left side of the carcass.

Feed analysis. During the trial, feed samples were analysed to determine their chemical composition and energy value. The analyses of the chemical composition and quality of the feeds and meat were carried out at the Analytical laboratory of the LVA Institute of Animal Science using standard methods. The feeds were analyzed for the dry matter content by oven-drying to a constant weight at 105^0C (AOAC-1990); crude protein by Kjeldhal method (AOAC, 1990); crude fat by extraction method using petrol ether and Soxtherm 416/HY 16/6 equipment (Gerhardt, Germany) (AOAC, 1990); crude fibre by FIBERCAP 2021 (Foss Electric, Sweden) (AOAC,1990); crude ash by ashing the samples in a furnace at 500–550ºC (AOAC, 1990); calcium by atomic absorption spectrometer Perkin Elmer 603 (USA) using caesium chloride and aluminium nitrate (AOAC-1990); phosphorus by the photometric method using "molibdovanate" reagent (AOAC-1990). The energy value of the feeds for cattle (AE, MJ/kg) was calculated by the formula:

$$AE = (17.46xVB+31.23xVR+13.65xVL+14.78xVNEM)/1000.$$

Meat analyses. Physical indicators of the meat from *M. Longissimus dorsi* were determined as follows: hydroxyproline content by Kolar et al. (1990), tryptophan by E. Miller's method, meat pH by pH-meter using glass electrode, colour intensity by the method of Horns, water binding capacity by the method of R. Grau and R. Hamm modified by V. Volovskaya and B. Kelman, cooking loss by the method of E. Schilling (Dubrovitsy, 1977).

The data were processed using STATISTIKA for Windows (version 7; Stat Soft. Inc. Tulsa, OK, USA) and presented as arithmetic mean (x) and its error (SE). The differences were significant at $P < 0.05$.

Results

The composition and energy value of the compound feed. The compound feed of the control group fattening cattle progeny was composed of crimpled barley, 33 %, crimpled triticale, 33 %, crimpled oats, 17 %, and rapeseed cake, 15 %, whereas for the treated group, rapeseed cake was replaced by 15 % linseed cake (Table 2).

Table 2. **Composition of compound feeds**

Feed	Group	
	Rapeseed cake	Linseed cake
Crimpled barley	33.0	33.0
Crimpled triticale	33.0	33.0
Crimpled oats	17.0	17.0
Rapeseed cake	15.0	-
Linseed cake	-	15.0
Mineral-vitamin premix Vita-Prem G-24	2.0	2.0
Analysis, per kg feed:		
Dry matter, kg	0.913	0.925
Metabolizable energy, MJ	10.01	10.41
Crude protein, g	149.8	148.0
Crude fat, g	37.6	64.2
Crude fibre, g	55.9	68.0
Calcium, g	5.04	4.86
Phosphorus, g	4.50	5.46

The mineral-vitamin premix Vita-Prem G-24 used for the manufacture of compound feeds was composed of vitamin A – 18.000 IU; vitamin D – 3.600 IU; vitamin E – 90.00 mg; manganese / Mn – 150.00 mg; zinc / Zn – 150.00 mg; cuprum / Cu – 36.00 mg; iodine / I – 4.20 mg; selenium chelatine / Se chelat – 0.75 mg; cobalt / Co – 1.50 mg.

The analysis of the chemical composition indicated that the compound feed with linseed cake contained by 1.31 % more dry matter, 70.74 % crude fat, 21 % crude fibre and 21.3 % phosphorus, but the contents of crude protein and calcium were, respectively, by 1.22 and 3.70 % lower in comparison with the compound feed for the control group of animals.

Bull growth and feed consumption. Through the entire trial period, the bulls fed either rapeseed or linseed cake gained, respectively, 59.2 and 65.0 kg. The daily weight gain of the control group of bulls was by 857 g and that of the treated group 941 g or 9.8 % ($p < 0.05$) higher than of the control group bulls (Table 3).

Throughout the entire trial period, the consumption of maize silage in the linseed group was by 112 kg higher and that of clover-oat-pea mixture silage by 45 kg lower. The intake of metabolizable energy was by 131.1 MJ higher and there were no differences for the intake of crude protein in the linseed group of animals. The feed intake per kg gain indicated that the bulls in the linseed

group consumed 8.6 MJ or 7.27 % less metabolizable energy, but 160 g or 9.10 % more crude protein (Table 3).

Table 3. **The results of bull growth and feed consumption**

Item	Group	
	Rapeseed cake (n=6)	Linseed cake (n=6)
Bull weight, kg:		
at the start (12 months)	368.3±3.56	370.0±4.36
at the end (14.3 months)	427.5±6.76	435.0±4.69
Daily gain, g	857.0±60.51	941.0±70.57
Feed consumption in 69 days per bull, kg:		
Maize silage	6638	6750
	6900	6855
Compound feed with:		
Rapeseed cake	1656	-
Linseed cake	-	1656
Intake with feeds:		
Metabolizable energy, MJ	6996.6	7127.7
Crude protein, kg	104.5	104.2
Consumption per kg gain:		
Metabolizable energy, MJ	118.2	109.6
Crude protein, kg	1760	1600

Control slaughtering data. After the completion of the trial, three bulls from each group were selected for control slaughtering. Before slaughter, the weight of the bulls in the control group was 427.5 kg and that of the bulls in the treated group 435.0 kg or by 1.75 % ($P > 0.2$) higher. However, the carcass weight was higher in the control group of bulls, i.e. 213.2 kg vs. 212.2 kg, or by 0.5 % ($P > 0.5$) lower in the linseed group of bulls. Therefore, the dressing percentage in the linseed group of bulls was by 1.06 % lower. The differences between the groups were statistically insignificant.

According to SEUROP carcass classification, the bull carcasses of both groups met the requirements for lean meat content grade O and fatness grade 2. The fatness of carcasses was sufficient. Thus, it can be concluded that bull feeding with either rapeseed or linseed cake had no significant influence on the dressing percentage or lean meat content and fatness grades. The results are presented in Table 4.

Table 4. **Control slaughter data**

Item	Group	
	Rapeseed cake (n=3)	Linseed cake (n=3)
Finish weight, kg	427.5±6.76	435.0±4.69
Carcass weight, kg	213.2±4.66	212.2±3.06
Dressing percentage	49.87±0.62	48.81±0.64
Lean meat content	O	O
Fatness grade	2	2

Analysis of ground meat and M. longissimus dorsi. The ground meat of the bulls in the rapeseed and linseed groups contained, respectively, 22.87 and 22.58 % of dry matter. The dry matter content in the treated group was by 0.29 % lower as were the contents of protein (0.80 %) and fat (0.13 %) in comparison with the chemical composition of the ground meat in the control group. The ash content was the same in the ground meat of bulls in both groups (Table 5). The differences between the groups were statistically insignificant.

Table 5. **Chemical composition of ground meat, %**

Item	Group	
	Rapeseed cake (n=3)	Linseed cake (n=3)
Dry matter	22.87±0.28	22.58±0.17
Protein	20.97±0.31	20.17±0.20
Fat	1.24±0.13	1.11±0.07
Ash	0.99±0.01	0.99±0.02

The analysis of the chemical composition of ground meat indicated that neither rapeseed nor linseed feeding of bulls had any significant influence on the composition and quality of ground meat.

The ground meat of bulls fed linseed cake contained lower amounts of dry matter, protein and fat, whereas the meat of *M. longissimus dorsi* contained by 1.39 % more dry matter ($P < 0.05$), 1.00 % more protein and 0.19 % more fat, yet the tryptophan and hydroxyproline ratio, which indicates the complete value of protein, was lower as well as lower were cooking losses (by 3.62 %) and colour intensity (by 4.82 %) in comparison with the rapeseed cake group of bulls (Table 6). The differences between the groups were statistically insignificant.

Table 6. **Physicochemical characteristics of *M. longissimus dorsi***

Item	Group	
	Rapeseed cake (n=3)	Linseed cake (n=3)
Dry matter, %	22.24±0.37	23.63±0.40*
Protein, %	20.17±0.32	21.17±0.29
Fat, %	1.06±0.23	1.25±0.11
Ash, %	0.97±0.01	1.05±0.02
Tryptophan, mg/100 g	305.73±3.44	317.04±7.20
Hydroxyproline, mg/100 g	63.74±3.73	75.94±2.96
Tryptophan : hydroxyproline ratio	4.83±0.24	4.20±0.25
Meat pH	6.52±0.12	5.92±0.23
Colour intensity (extinction unit)	180.00±5.00	188.67±4.04
Water binding capacity, %	58.34±1.72	57.79±1.56
Cooking losses, %	40.84±2.42	44.46±1.54

* $P < 0.05$

The analysis of the physicochemical traits of *M. longissimus dorsi* indicated that the dry matter content was by 1.39 % higher ($P < 0.05$) in the linseed cake group, but different feeding had no influence on the other

physicochemical indicators. The differences between the groups were insignificant.

Discussion

Rapeseed cake replacement with linseed cake in the production of compound feed results in higher content of dry matter, crude fat, crude fibre and, therefore, by 4 % higher energy value of the feed. Throughout the entire experimental period, due to higher intake of maize silage and higher energy value of the compound feed, the bulls in the linseed group received by 131.1 MJ more metabolizable energy and the same amount of crude protein if compared with the bulls of the rapeseed group. Equal intake of crude protein was a result of higher intake of clover-oat-pea mixture silage by the control group bulls and insignificant difference in the amount of crude protein in the compound feed. In the trials with Lithuanian Black-and-White bulls the daily weight gain was 857–941 g, whereas in the trials with Friesian bulls it was 1172–1359 g (Ben Salem et al., 2006). This is an indication that higher daily gains can be achieved with the bulls of beef breeds. The results from our study showed that the bulls in the linseed group used by 7.27 % less metabolizable energy and by 9.10 % more crude protein per kg gain and gained by 9.8 % more weight ($P < 0.05$) than the bulls in the rapeseed group. This is in agreement with the findings of Jukna Č., Jukna V. (2002), who indicated that more intensive growth of bulls increased daily gain and reduced feed consumption per production unit. Kim et al. also found that 0.10 and 15 % linseed supplementation of the diets resulted in significantly higher feed intake per production unit.

Different feeding of bulls used in our study had no significant influence on the dressing percentage, lean meat content and fatness grades, and the chemical composition and quality of ground meat. Preiβinger W. et al., (2004), Bendikas P. et al. (2008) reported that rapeseed cake and rapeseed oil-meal in the diets of fattening bulls had no influence on meat quality indicators. The results from our study showed that linseed cake supplementation of the compound feed for fattening bulls had increased the dry matter content in *M. longissimus dorsi* by 1.39 % ($P < 0.05$) but had no effects on the other physicochemical indicators of the long dorsal muscle. The differences between the groups were insignificant. However, Kim et al. (2004) have found that linseed had no influence on the carcass quality, and that linseed is a source of protein that improves the energy content in meat without any additional effect.

Conclusions

1. Compound feed supplementation with linseed cake instead of rapeseed cake resulted in higher contents of dry matter, crude protein, and crude fibre and by 4 % higher energy value of the feed.
2. Due to higher intake of feeds, the bulls in the treated group received 131.1 MJ more metabolizable energy than the bulls fed compound feed with rapeseed cake.
3. The bulls in the linseed group used by 7.27 % less metabolizable energy but by 9.10 % more crude protein and gained by 9.8 % ($P < 0.05$) more weight than the bulls in the rapeseed group.
4. Feeding linseed cake resulted in by 1.39 % ($P < 0.05$) higher dry matter content in *M. longissimus dorsi* and had no influence on the other physicochemical indicators of the long dorsal muscle.

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