

OPPORTUNITIES TO PRODUCE HEALTHIER BEEF

POSSIBILITĂȚI DE A PRODUCE CARNE DE VITĂ MAI SĂNĂTOASĂ

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In this study the opportunities for enhancing the beneficial fatty acid in beef was examined. The effect of diet (extensive vs. intensive diet, forage to concentrate ratio, feeding concentrates rich in n-3 fatty acids) and the breed (old: Hungarian Grey, dual purpose: Hungarian Simmental, dairy: Hungarian Holstein-Friesian) was investigated on the fatty acid composition of beef. Findings reveal that the extensive diet with linseed supplemented concentrate influenced the n-6/n-3 ratio and the CLA content of longissimus muscle more advantageous concerning human nutrition. The meat from Hungarian Grey (HG) contained more CLA and less n-6 fatty acids than that of Holstein-Friesian bulls. The different forage to concentrate ratio with/without linseed supplementation did not significantly affect the performance and slaughter traits in Hungarian Simmental (HS) young bulls. The wider forage to linseed concentrate ratio caused slightly higher dressing percentage, meat and fat proportion and lower bone in carcass. The effect of muscle type on chemical composition of muscles is more significant than that of the diet. SFA and MUFA were affected by muscle type, n-3 fatty acids and n-6/n-3 fatty acid ratio of the diet. The level of cis-9 trans-11 CLA (mg/100 g) was influenced by muscle type, but not by diet.

Key words: beef, fatty acids, linseed

Introduction

Nowadays the production of high quality, healthy beef is an important tool to ensure consumer satisfaction. Besides the genetic type of animal the rearing systems including nutrition also influence beef quality. The fat with „healthy” fatty acid composition is the ratio of PUFA/SFA is higher than 0.45, the ratio of n-6/n-3 PUFA is lower than 4:1 and the fat contains a high amount of the conjugated linoleic acid (CLA). The manipulation of fatty acid composition in monogastrics is easier, than in ruminants. Rumen biohydrogenation in cattle limits the incorporation of the amount of long chain PUFA into the tissues as a results of this the ratio of PUFA/SFA in beef is typically low, The PUFA/SFA ratio is mainly influenced by genetics, in particular the overall fat level of the animal and less nutrition. At the same time the biohydrogenisation also results in the production of

conjugated linoleic acid (CLA) in the rumen. It is recognized that the CLA confers a health advantage (f.i. anticarcinogenic properties, antiatherogenic activities) to humans and beef is relatively rich in this fatty acid.

The ratio of *n*-6 and *n*-3 fatty acids of beef strongly depends on diet (grain-based-diet or forage fed). The reason of this is the high level of linoleic acid (C 18:2 *n*-6) in the grain but the forages are rich in the linolenic acid (C 18:3 *n*-3) the base of the long chain *n*-3 fatty acids. The widespread fattening system in Hungary is based on maize silage, hay and high concentrate diet. Beef produced from this feeding regime had undesirable fatty acid composition from human nutritional point of view (Holló *et al.*, 2001). One opportunity to modify the *n*-6/*n*-3 ratio is the inclusion in the concentrate of the high amount of *n*-3 fatty acids such as linseed.

Our aim was enhancing the content of beneficial fatty acids in intramuscular fat of beef and improving the meat quality for the consumer. In our experiments on the one hand the feeding strategy (extensive or intensive diet, different forage to concentrate ratio and feeding concentrates with/without *n*-3 fatty acids), on the other hand the effect of breed (old: Hungarian Grey (HG), dual purpose: Hungarian Simmental (HS), dairy: Hungarian Holstein-Friesian (HF)) were analyzed on the fatty acid composition of intramuscular fat of beef.

Materials and Methods

The experimental design in two fattening trials is shown in Table 1. In the first fattening trial HG and HF growing-finishing bulls were fed rations consisting of either grass, grass silage and concentrate or maize silage and concentrate with and without linseed supplementation according to a 2 x 2 factorial experimental design in four groups. In the extensive and intensive groups, days on feed lasted for 221 and 201, respectively. There were no significant differences among groups in the initial live weight. Average final weights were actually identical in all groups (512.4±58.4 kg). In the second trial HS bulls were fattened until live weight of approximately 580 kg. In this study 30 Hungarian Simmental young bulls (mean body weight 300 kg, age: 275 days) were used. The three dietary treatments (n=10) consist of three target F/C ratios of 660:330, 750:250 and 800:200 g/kg DM, the control group received a ration consisting of 33 % commercial concentrate and 66 % maize silage, whilst the high roughage groups received 75 % vs. 80 % maize silage and 25 vs. 20 % concentrate, which included 25 % linseed supplementation. Moreover, a diet of each group consisting 10 kg grass hay/day. Each group was fed twice a day, water was offered *ad libitum*. In the first trial the linseed supplemented concentrate were fed in the last month of growing-finishing period, whereas in the second trial during the whole growing-finishing period. Slaughtering of the animals was performed at a commercial abattoir after captive bolt stunning. One hour after slaughter, the dressed carcasses were weighed (hot carcass weight), split into two sides, were chilled at 4°C for 24 h, and the right side was divided into lean meat, bone, fat and tendon. After a 24 h chilling in the first experiment only *longissimus* (LD), in the

second experiment *longissimus* (LD) *semitendinosus* (ST) and *psoas major* (PM) samples were taken from the right carcasses. The fatty acid composition of samples was determined according to method described by Holló *et al.* (2001). Data processing was made by SPSS program package.

Table 1

Experimental design			
Group	Breed	n	Feeding
I.	HF	10	<i>Grass silage, grass, low concentrate with linseed</i>
II.	HG	10	
III.	HF	10	<i>Maize silage, hay, high concentrate</i>
IV.	HG	10	
I.		10	<i>Maize silage, hay moderate concentrate</i> Forage to concentrate ratio 660:330
II.	HS	10	<i>Maize silage, hay, moderate concentrate with linseed</i> Forage to concentrate ratio 750:250
III.		10	<i>Maize silage, hay, moderate concentrate with linseed</i> Forage to concentrate ratio 800:200

Results and Discussions

Certainly higher final weight was recorded in the intensively fed bulls at the end of fattening; differences between breeds were not significant (Table 2).

Table 2

Traits	Animal performance and carcass traits						
	1st experiment				2nd experiment		
					Control	Linseed supplemented groups	
	Intensive		Extensive		660:330	750:250	800:200
	HF (I)	HG (II)	HF (III)	HG (IV)	F/HC	F/LC1	F/LC2
Initial weight, kg	307.00	278.00	303.00	281.05	303.30	298.50	298.40
Final live weight, kg	564.20a	545.80a	472.60b	466.90b	625.00	616.90	617.20
Daily gain, g/d	1279.60a	1332.30a	764.00b	837.20b	1.18†	1.09††	1.12
Dressing percentage, %	55.61a	55.87a	52.83b	52.68b	58.62	58.82	58.93
Lean (%)	65.80a	67.45ab	67.85b	70.96c	71.68	71.85	71.81
Bone (%)	9.18a	10.60b	4.23c	4.82a	18.65†	18.41	17.91††
Fat (%)	19.71a	17.69b	22.96c	20.24c	8.58	8.65	9.23
Tendon (%)	5.32a	4.27b	4.96b	3.98b	1.15	1.10	1.08

† P<0.010, a, b P<0.05

The extensive feeding resulted in less fat deposition and leaner carcass, on the other hand the HG bulls had leaner meat content in both feeding groups, than the HF.

The average final body weight was in F/LC 1 group the lowest (616.90 kg) at the same time this group has the longest fattening period (269.30 d). As a consequence to this the average daily gain in this group was the lowest, but for these traits no relevant differences have been established among groups. The groups with higher forage to linseed concentrate ratio showed lower bone percentage, but higher dressing percentage and more lean and fat proportion in the body. The widest forage to linseed concentrate group (F/LC 2) has the highest fat percentage in the right half carcass compared to other two groups. The F/LC 1 group showed the highest lean percentage. Among groups there were no significant differences for all fattening, slaughter and dressing data except for daily gain, and bone percentage at the level of $P < 0.01$. Findings reveal that extensive fed animals had lower intramuscular fat (HF: 1.34, HG: 1.55) level than that of intensive ones (HF: 2.10, HG: 2.78). Extensive fed HG the ratio of SFA/UFA of *longissimus* could have been more favorably altered, than in case of the HF bulls. On the other hand the HG deposited more SFA in muscle tissues opposite to HF bulls. The higher forage to concentrate ratio and the linseed supplementation caused an increase in intramuscular fat level in all muscles, although these differences were not significant (F/HC: 2.12, F/LC1: 2.58, F/LC2: 2.67). At the same time the influence of muscle proved statistical differences. Muscle *psoas major* (PM) was shown higher fat content than the other two muscles (LD: 2.26, ST: 1.53, PM: 3.59). *Psoas major* (PM) contained more SFA ($P < 0.001$) and lower MUFA ($P < 0.01$) comparing to other two muscles. The P/S ratio and *n-6/n-3* ratio were not differed among muscles. In nutritional guidelines there are separate recommendations for *n-6* and *n-3* classes of PUFA, there is evidence of beneficial effects of *n-3* PUFA in the prevention of cardiovascular disease and cancer in contrast to opposite effects indicated for *n-6* PUFA (Simpoulos, 1991). The amount of *n-3* and *n-6* fatty acids was significant higher in extensive fed groups. In the *n-6* fatty acid content of beef, there was a significant difference between breeds; HG had in both feeding groups a lower value, consequently their ratio of *n-6/n-3* fatty acid is more advantageous concerning the human nutrition (Table 3).

The higher forage to concentrate ratio and the linseed supplementation caused an increase in the *n-3* fatty acids as a consequence of this significant decrease the *n-6/n-3* ratio. At the same time there was no influence of muscle type on the level of *n-6* and *n-3* fatty acids. The beef from linseed supplemented, low concentrate groups contained more *n-3* fatty acids, and thus also more favorable was the *n-6* to *n-3* fatty acids ratio; however the ratio was slightly higher than the recommended value. The process of biohydrogenisation also results in the production of CLA intermediates. It is recognized that CLA has numerous positive effects on the human health (Nuernberg *et al.* 2002). The *c-9, t-11* CLA content of LD was influenced either by the breed ($P < 0.01$) or by the feeding ($P < 0.001$) (Figure 1.). The CLA in intramuscular fat in LD of HG was higher, than that of HF considering any groups. On the other hand in case of the extensive feeding can be the CLA content in muscle two times higher.

Table 3

Traits	1st experiment				2nd experiment		
	Intensive		Extensive		Control	Linseed supplemented groups	
	HF	HG	HF	HG	660:330 F/HC	750:250 F/LC1	800:200 F/LC2
<i>n-3 fatty acids (%)</i>							
LD	1.30a	1.13a	4.14b	5.05b	0.60a	1.53b	1.29b
ST					0.54a	1.28b	1.19b
PM					0.53a	1.27b	1.10b
<i>n-6 fatty acids (%)</i>							
LD	11.26a	7.05a	14.8b	14.44b	8.69a	8.50b	6.80b
ST					8.22a	7.81b	7.55b
PM					8.01a	7.81b	6.57b
<i>n-6/n-3 ratio</i>							
LD	9.27a	6.24b	3.61c	2.86c	19.78a	7.04b	6.63b
ST					19.07a	7.35b	7.52b
PM					19.40a	7.30b	7.12b

a, b P<0.05

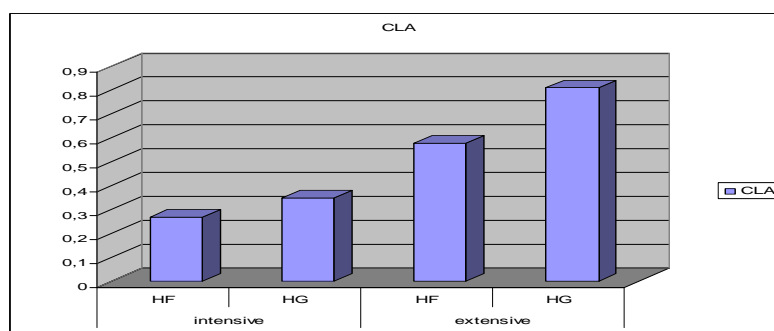


Figure 1: Changes of CLA content (%) in longissimus muscle (1. experiment)

The muscle type had higher effect on amount of CLA than diet. PM contained significantly higher CLA, than other two muscles. CLA-content of muscles was slightly higher in higher forage linseed supplemented groups, except for ST in F/LC 1 group.

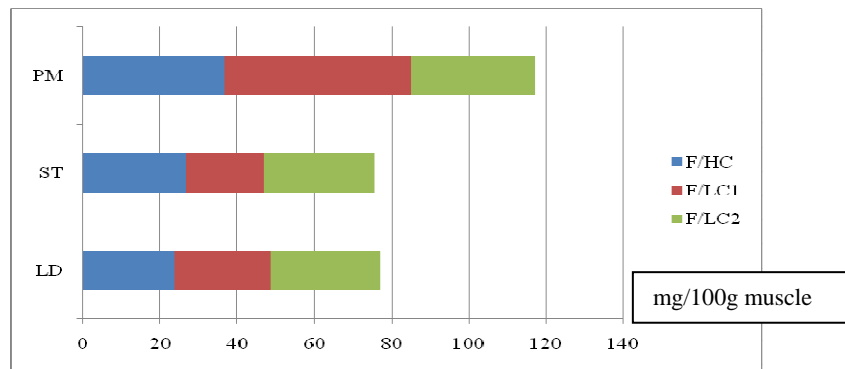


Figure 2: Changes of CLA content (mg/100g) in *longissimus* (2. experiment)

Conclusions

The fatty acid composition of intramuscular fat of beef can be favorably modified by feeding grass and concentrate supplementation which is rich in *n*-3 fatty acids, however the beef of HG has a more beneficial impact on human health (CLA content, *n*-6/*n*-3 ratio), than that of HF bulls.

The different forage to concentrate ratio with/without linseed supplementation did not significantly affect the performance and slaughter traits. The wider forage to linseed concentrate ratio caused slightly higher dressing percentage, meat and fat proportion and lower bone in carcass.

The effect of muscle type on chemical composition of muscles is more significant than that of the diet. However, it seems that intramuscular fat level tended to increase in low concentrate linseed supplemented groups.

SFA and MUFA were affected by muscle type, *n*-3 fatty acids and *n*-6/*n*-3 fatty acid ratio by diet. The level of *cis*-9 *trans*-11 CLA (mg/100 g) was influenced by muscle type, but not by diet.

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