MEAT QUALITY FROM FATENING BULLS FED SILAGE MADE BY USING DIFFERENT SILAGE ADDITIVES

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Summary. Second cut legume-grass was harvested and ensiled using baler and wrapped with 6 layers of stretch film. The inoculant 'Feedtech' *(2 Pediococcus acidilacticci* and 2 *Lactobacillus plantarum* and *Cellulase)* and chemical additive AIV-2000 (52.3% formic acid, 26.1% ammonium tetraformiate, 5.4% propionic acid, 1.1% ethyl-benzoate) were applied using commercial pump.

Feeding trial (126 days) with fattening bulls was carried out. Fifteen bulls were assigned on the basis of age and initial weight into three groups (C-control, F-silage with inoculant 'Feedtech', A- silage with chemical additive AIV-2000) and fed silages *ad libitum.* Feed intake was increased, respectively, by 0.61 and 0.29 kg DM per animal and day when bulls were fed inoculated 'Feedtech' silage and AIV 2000 treated silage and resulting in higher weight gain of 94 and 86 g per animal and day compared to animals fed ordinary silage.

In F and A group, the pH-values of the long dorsal muscle was, respectively, by 0.41 ($P < 0.001$) and 0.31 ($P < 0.001$)unit lower, colour coefficient by 84.67 ($P < 0.001$) and 73.67 ($P < 0.001$) higher, water binding capacity by 0.05 and 0.13% higher, cooking losses by 0.73 and 0.1% lower and protein value index by 0.22 ($P < 0.025$) and 0.15 unit higher in comparison with the C group.

Silage made by applying inoculant and chemical additive did not affect the chemical composition of ground meat and long dorsal muscle.

Keywords: big bale, inoculant, chemical additive, live weight gain, meat.

SKIRTINGŲ SILOSAVIMO PRIEDŲ ĮTAKA SKERDENOS KOKYBEI IR MĖSOS CHEMINEI SUDĖČIAI

Santrauka. Ankštinių–varpinių antros pjūties žolės silosas buvo pagamintas naudojant ritininį presą. Ritiniai 6 sluoksniais apvynioti specialia plėvele. Inokuliantas „Feedtech“ (2 štamai *Pediococcus acidilactici*, 2 štamai *Lactobacillus plantarum* ir fermentas celulazė) ir cheminis konservantas AIV 2000 (skruzdžių rūgštis – 52,3%, skruzdžių rūgšties amonio druska – 26,1%, propioninė rūgštis – 5,4%, etilo benzoatas – 1,1%) buvo įterpti ritinių gamybos metu naudojant pramoninį dozatorių HP-20.

Šėrimo bandymas (126 dienos) atliktas su penkiolika penimų buliukų, suskirstytų analogų principu į tris grupes. C (kontrolinė) grupė gavo silosą be priedų, F grupė gavo silosą su inokulianto „Feedtech“ priedu ir A grupė gavo silosą su AIV 2000 priedu. Buliukai visų rūšių silosu buvo šerti iki soties. Inokuliantas „Feedtech“ ir cheminio konservanto AIV 2000 priedas padidino siloso SM ėdamumą atitinkamai 0,61 ir 0,29 kg 1 buliukui per dieną bei paros prieaugį atitinkamai 94 ir 86 g 1 buliukui per dieną palyginti su silosu be priedų.

Ištyrus fizinius bei cheminius *M. longissimus dorsi* rodiklius nustatyta, kad F ir A grupėse mėsos pH atitinkamai buvo 0,41 ($p < 0,001$) ir 0,31 ($p < 0,001$) vieneto mažesnis; šių grupių mėsa buvo sodresnės spalvos – 84,67 ($p < 0,001$) ir 73,67 ($p < 0,001$) vieneto), pasižymėjo geresniu vandens rišlumu (0,05 ir 0,13%), mažesniais virimo nuostoliais (0,73 ir 0,1%) bei aukštesniu baltymų pilnavertiškumo rodikliu – 0,22 ($p < 0,025$) ir 0,15 vieneto.

Silosas su inokulianto „Feedtech“ ir cheminio konservanto AIV 2000 priedu neturėjo esminės įtakos maltos mėsos ir *M. longissimus dorsi* cheminei sudėčiai.

Raktažodžiai: ritiniai, inokuliantas, cheminis konservantas, paros prieaugis, mėsa.

Introduction. During recent years there has been increased interest in use of legumes for silage in low input systems of animal production in the northern Europe. Legume crops can be difficult to ensile due to a high buffering capacity and a low WSC content. In addition, extensive degradation of protein can occur during ensilage. In Lithuania, weather conditions do not always permit sufficient wilting of crop. The formic acid based additives were recommended to ensure good fermentation of wet crops. The use of biological additives can improve the fermentation characteristics and quality of silages (Speijers et al, 2002).

The objective of using silage additives is to ensure that lactic acid bacteria dominate the fermentation, which results in well-preserved silage and reduced DM losses (Me Donald et al., 1999; Henderson, 1989; Frank et al, 1996). It is known that organic acids restrict silage fermentation (Selmer-Olsen et al., 1997) and bacterial inoculants stimulate lactic-acid fermentation (Muck et al, 2001; Andrieu et al., 1996). However, both treatments decrease nutrient losses, improve silage quality, milk or meat production, and nitrogen efficiency in cattle. Further research is needed to determine the effect of varying additives and levels of addition.

Diet is known to affect carcass characteristics and meat quality. Meat quality and its technological properties are influenced by the feeding system, feed quality and various feed additives (Brzoska et al, 1999; Balcaen et al, 2002; Therkildsen et al, 1998). Because energy intake influences growth rate and carcass fatness: higher energy intake tends to increase the fatness of animal carcasses. Meat quality is a complex trait, referring to the compositional, visual and sensory traits of a carcass, or its retail cuts. Composition generally refers to the relative amounts of lean, fat and bone, but this definition can be broadened to include partitioning between the fat depots and also distribution within both the fat and lean depots. Visual aspects of meat quality include the colour and texture of lean and fat and for some markets the level of intramuscular fat in the lean (Moloney et al., 1999).

Important aspects of meat quality are shelf-life (colour and lipid stability), flavour and human nutritional value, all of which are affected by components of the animals diet such as antioxidants and fatty acids. Tissues from lamb finished on swards containing white clover were reported to contain more linoleic and a-linolenic acid and less eicosapentaenoic acid (EPA, 20:5 n-3) (Vipond et al., 1993) compared to animals fed grass.

Red or white clovers increased 18:2 and 20:4 in muscle phospholipid and 18:2 and 18:3 in neutral lipids. C22:6 n-3 was not affected by feed but was significantly higher in Hereford steers. Muscle contents of trans 18:1 and conjugated linoleic acid (CLA) did not differ significantly between diet. Studies have also shown that higher energy-finished carcasses have a higher amount of intramuscular fat than lower energy-finished carcasses regardless of backfat thickness, resulting in improved marbling score in higher energy-finished carcasses. Therefore, higher energy-finished carcasses are better quality graded than lower energy-finished carcasses (Khadem et al., 1995; Crouse et al., 1984).

The purpose of our study was to compare the efficiency of different silage making technology on carcass composition, meat quality and feed conversion rate.

Materials and methods. Second cut legume-grass (72% red clover, 20% - timothy, 8% - other, DM content – 180 gkg^{-1}) was cut on 23-24 August, 2002 and ensiled using baler 'GREENLAND-RF-130' and wrapped with 6 layers of stretch film. 50 round big bale silages were made without additive (C group), 50 – treated with bacterial inoculant 'Feedtech' (2 *Pediococcus acidilacticci* and *2 Lactobacillus plantarum* and *Cellulase*), 10^6 cfu g^{-1} grass (F group) and 50 - treated with chemical additive AIV-2000 (52.3% formic acid, 26.1% ammonium tetraformiate, 5.4% propionic acid, 1.1% ethyl-benzoate), application rate – 6 l t^{-1} (A group). Due to the rain DM content was low.

Three groups of animals (n=5) were used in feeding trial. Each silage was offered *ad libitum* to Lithuanian Black- and- White fattening bulls during 126 days experimental period following 20 days preliminary period. Concentrates were offered at the same level to the all groups of bulls. The silages intake was recorded once per week and the bulls were weighed each month.

At the end of the trial, bulls were slaughtered for control data. The bulls (3 animals from each group) were slaughtered according to the standard (Galviju skerdenos, 1994). Afterwards, hot carcass weight was determined. During the slaughter, fat found in the abdominal cavity (from kidneys, stomach and intestines) was collected and weighed. The dressing percentage was calculated by dividing the hot carcass weight by the finish weight. In 24 hours after chilling the carcass at 0-4°C, was weighed and dressed by separating bones, tendons and meat. The morphological composition of carcass was calculated by weighing bones, tendons and meat separately, and by dividing these weights by the chilled carcass weight. A sample *of M. longissimus dorsi* (11-13th thoracic vertebrae) was collected from the left side of each carcass for meat quality analysis. The meat from the left side of each carcass was ground, and the average sample of 400 g ground meat was taken for analysis. Meat samples from each carcass were put into polyethylene bags with the plastic tags inside. Meat samples were analysed at the Chemical Laboratory of the Lithuanian Institute of Animal Science. Statistical analysis was carried out by means of procedures described by *STATISTIKA* for *Windows* (Sakalauskas, 1998).

Results and discussion. The results of feeding trial indicated that average daily intake of 'Feedtech' treated silage and AIV-2000 treated silage increased, respectively, by 0.61 and 0.29 kg^{-1} DM compared than control bulls (Table 1). The value of metabolizable energy of control silage was – 8.67 MJ 1 kg^{-1} DM, of 'Feedtech' treated silage – 9.59 MJ 1 kg^{-1} DM and AIV-2000 treated silage – 9.47 MJ 1 kg^{-1} DM. Due to the higher energy concentration in treated silages the daily contribution of metabolizable energy for animals in F and A group was, respectively, by 4.9 and 2.8 MJ higher. Besides, intake of digestible protein was, respectively, by 0.08 and 0.04 kg d^{-1} higher, too, in comparison with the C group (1 kg^{-1} DM control silage content 91.41 g digestible protein, 1 kg^{-1} DM 'Feedtech' silage – 98.18 g and 1 kg^{-1} DM AIV-2000 silage - 99,16 g).

Table 1. **Results from fattening bulls feeding intake trials**

	Intake kgd^{-1}				ME MJd^{-1}	BW gain	
	silage DM	Concentrate DM	Total DM	Digestible protein		kgd^{-1}	Total kg
C	7.86	1.86	11.09	0.95	106.6	1.120	141.2
F	8.47	1.86	11.70	1.03	111.5	1.214	153.0
A	8.15	1.86	11.38	0.99	109.4	1.206	152.0
sed	0.07	0.0	1.21	0.02	6.21	0.271	2.31

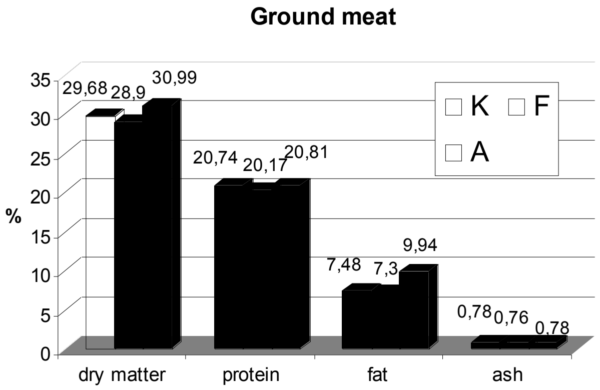
Animals in all groups consumed the same daily amount of concentrated feed (1.86 kg^{-1} DM), molasses (0.52 kg^{-1} DM) and hay (0.85 kg^{-1} DM). The growth rate of bulls in all groups was high. The average daily gain was from 1.120 to 1.214 kgd^{-1}. Hovewer, the body weightgain of bulls fed 'Feedtech' and AIV-2000 treated silage was, respectively, by 8.36 and 7.64% higher than C group.

Different silages had a little influence on several carcass quality traits. The F and A bulls tended to have higher carcass yield compared with C group. The analysis of the morphological composition of carcass showed that the meat: bone ratio in F and A groups was insignificantly higher, therefore, the muscling score in these groups was, respectively, by 0.29 and 0.18 unit higher than that in the C group (Table 2).

Table 2. **Control slaughter data**

Item	Silage		
	C	F	A
Finish weight, kg	488.33±16.41	461.67±15.90	460.00±18.03
Hot carcass weight, kg	249.27±11.49	238.97±9.27	235.43±9.15
Hot carcass dressing percentage, %	51.00±0.63	51.74±0.48	51.20±1.02
Abdominal fat weight, kg	9.76±0.40	9.47±0.27	9.62±0.32
Abdominal fat yield, %	2.00±0.14	2.05±0.08	2.09±0.06
Weight of carcass and abdominal fat, kg	259.00±11.16	248.43±9.44	245.03±9.44
Carcass and abdominal fat yiled, %	53.00±0.50	53.80±0.52	53.29±1.08
Chilled half carcass weight, kg	115.63±5.43	108.07±4.10	106.93±4.88
Morphological composition:			
muscles and fat	78.83±0.32	80.27±0.91	79.87±0.55
bones	18.68±0.26	17.78±0.87	18.14±0.57
tendons	1.95±0.06	1.96±0.05	2.00±0.02
Muscling score	4,22±0,51	4,51±0,41	4,40±0,32

The chemical composition of ground meat and *M. longissimus dorsi* showed no significant differences between the groups. There was a tendency towards lower content of dry matter, protein and fat in the ground meat (in A group tendency towards go up) and higher content of this nutritive matter in the long dorsal muscle in F and A group in comparison with the C group (Fig.1). There were reliability differences between the groups for the composition of high molecular weight fatty acids in the long dorsal muscle. 0.58 (P<0.001) and 0.80 (P<0.025) % increase of polyunsaturated acid C 18:2 in the fat was determined in the F and A groups (Table 3). Acid 18:2 is part of the group of omega 6 acids (Wood, 1997), which restrict risk of coronary heart disease with increasing mean serum LDL-cholesterol levels (Aro, 2002).



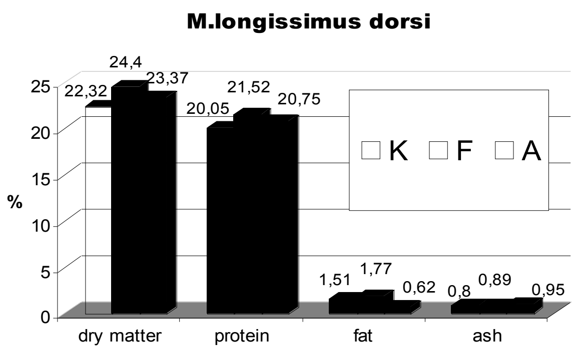


Fig.1. **Chemical composition of meat, %**

However, there was a tendency determined towards higher content of saturated and unsaturated fatty acids in F and A groups in abdominal fat in comparison with the C group (Fig.2).

In F and A groups, the pH-values of the *M. longissimus dorsi* was by 0.41 (P < 0.001) and 0.31(P < 0.001) unit lower, colour coefficient by 84.67 (P < 0.001) and 73.67 (P<0.001) unit higher, water binding capacity by 0.05 and 0.13% higher, cooking losses by 0.73 and 0.1% lower and protein value index by 0.22 (P < 0.025) and 0.15 unit higher in comparison with the C group (Fig.3). The nutritive value of these muscle was higher (Лори ,1973).Live muscle pH is 7 or above. After slaughter, glycogen gradually converts to lactic acid and pH declines until after rigor mortis is completed. If animals are calm at slaughter, ultimate pH may be as low as 5.0 and is usually in the 5.3 to 5.6 range. Low ultimate pH ranges are associated with tender meat of high quality and suitable for curing. A pH of 4.6 or below destroys C. Botulinum and is a "kill step" for traditionally fermented sausage (Bender, 1992). With the pH getting lower than the normal value (pH 5.3), the meat color is getting pale, and with the pH getting higher than normal, the meat color is getting darker. Some production factors affecting final muscle pH are level of nutrition, and pre-slaughter and postmortem handling (Kim, 1994).

Table 3. **Fatty acid composition in *Musculus longissimus dorsi* fat, % of total fatty acids**

Item	Group		
	C	F	A
Myristic 14:0	1,06±0,12	1,06±0,17	0,77±0,06
Isopalmitic16:0	0,11±0,01	0,20±0,03	0,30±0,10
Palmitic 16:0	44,38±1,23	42,41±0,95	36,40±0,36****
Isostearicm 18:0	0,10±0,03	0,20±0,05	0,27±0,02**
Stearic 18:0	8,10±0,30	12,87±0,32*****	13,01±1,26**
Σ_1 saturated	53,75	56,74	50,75
Myristoleic 14:1	0,12±0,03	0,02±0,01	0,08±0,04
Palmitoleic 16:1	2,12±0,54	1,29±0,36	2,00±0,02
Oleic 18:1	43,44±0,84	40,69±0,41*	45,59±0,61
Σ_2 unsaturated	45,68	42,00	47,67
16:2	0,09±0,03	0,12±0,03	0,22±0,04
Linoleic 18:2	0,37±0,01	0,95±0,04*****	1,17±0,23**
Linolenic 18:3	0,11±0,02	0,17±0,02	0,19±0,04
Σ_3 polyunsaturated	0,57	1,24	1,58
$\Sigma_4 = \Sigma_2 + \Sigma_3$	46,25	43,24	49,25

*P < 0,05; **P < 0,025; ***P < 0,01;**** P<0.005; *****P < 0,001.

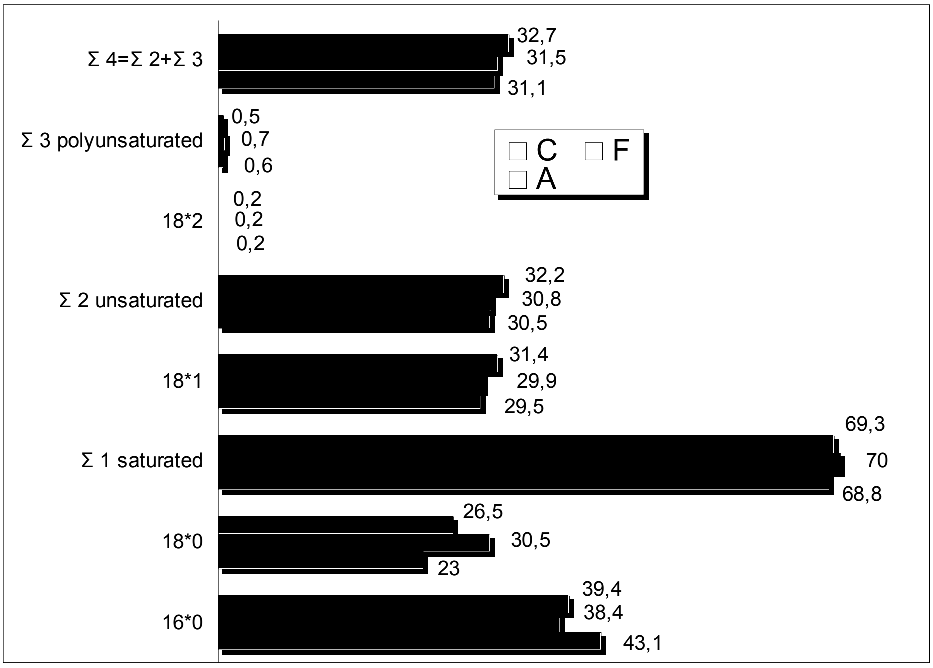


Fig.2 . **High molecular weight fatty acid composition in abdominal fat, % of total fatty acids**

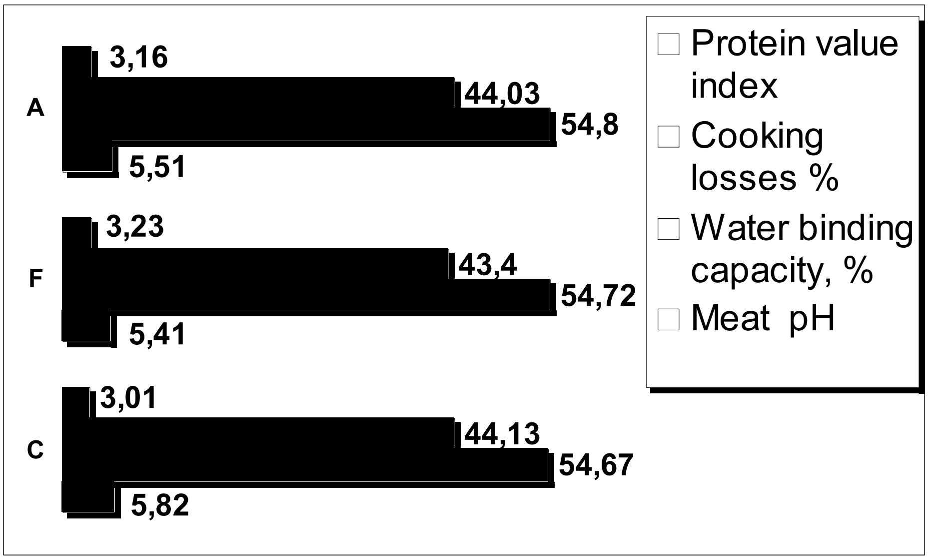


Fig.3. **Physicochemical indicators of *Musculus longissimus dorsi***

Conclusion. Application of inoculant 'Feedtech' and chemical additive AIV-2000 had a positive effect upon the quality of the fermentation process and the nutrient levels in legume-grass silage with a low content of DM (21-24%).

Silage treated with inoculant and chemical additive had a positive influence on the growth rate of animals. The daily gain of bulls fed inoculated and chemical additive silage was by 8.36 and 7.64% higher, compared to animals fed ordinary silage.

Inoculant and chemical additive did not affect the chemical composition of ground meat and *M. longissimus dorsi*, however the nutritive value and physicochemical indicators of these muscle tender to be higher.

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