IMPACT OF DDGS SUPPLEMENTED DIET WITH OR WITHOUT VITAMIN E AND SELENIUM SUPPLEMENTATION ON FATTY ACID PROFILE OF BEEF

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Abstract – The impact of supplementation of vitamin E or organic selenium in dried distillers grains with solubles (DDGS–) diet on fatty acid composition in two meat cuts of finishing Holstein bulls was investigated. Twenty-four Holstein bulls were allotted to treatments in three groups of eight bulls per group for a 100-day trial. The treatments were adequate Se and vitamin E supplementation in control group (C), supranutritional vitamin E supplementation in vitamin Group E (E), supranutritional Se supplementation in selenium group (Se). At similar age slaughtering Group C had higher slaughter/ carcass weight and EUROP fat score than Se counterparts. The killing out percentage and proximate composition of muscles differed among treatments. Inclusion of the vitamin E or Se supplement led to expected increases (P<0.05) in vitamin E and Se contents of the brisket and loin. Higher vitamin E concentration caused significant lower SFA and greater PUFA. Higher Se level influenced significant SFA content of brisket and PUFA levels of both muscles. Vitamin E or Se dietary treatments in DDGS supplemented diet resulted in beef meat cuts considerable beneficial PUFA/SFA ratio but markedly higher n-6/n-3 PUFA ratio, moreover greater health index in both meat samples opposite to Group C.

Key Words – vitamin E, Selenium, DDGS, cattle, fatty acid profile

I. INTRODUCTION

Due to beneficial effects, supplementation of animal diets with vitamin E and Se has been strongly proposed as a production strategy in cattle production.

The use of dried distiller's grains with solubles (DDGS) in cattle diets has increased in recent years. Corn DDGS is a good source of PUFA due to its high fat content and previous report showed that DDGS appears to alter fatty acids profile resulting a greater PUFA/SFA ratio in beef [3].

On the other hand, it should be considered that a greater proportion of highly peroxidisable PUFA (prooxidant) has negative influence on the oxidative stability of beef. Oxidative stability of beef depends on the balance between pro and antioxidant components. The balance between the pro and antioxidant compounds in beef can be ensured by antioxidant supplementation, with the dietary inclusion of antioxidant elements such as vitamin E and selenium. As new feeding system is introduced, exploring the effects on carcass value and consumer satisfaction traits is essential.

As a consequence of this, the main aim of present work was to determine the influence of DDGS supplemented diet with or without vitamin E and selenium on fatty acid profile of beef in order to evaluate meat healthiness.

II. MATERIALS AND METHODS

Experiments were conducted in commercial private cattle fattening farm (Bull Farms Ltd.) Twenty four Holstein young bulls were included in the experiment. Animals were assigned randomly to one of three dietary treatments, with 8 animals per treatment. All of the animals were fattened under semi-intensive conditions, *ad libitum* maize silage, grass hay and moderate concentrate. The diet was supplemented with 20 % DDGS. Treatments included vitamin E supplementation 1 NE alfa-tocopheryl-acetat/animal/day (Lutavit E50, BASF)) for vitamin Group E (E), 2 mg selenium supplementation/animal/day (Sel-Plex-2300, Saccharomyces cerevisiae CNCM, I-3060 Alltech) for Selenium group (S); any supplementation over the experimental period for control group. The bulls in the control group

received sufficient vitamin E and Se as the requirement for growing cattle. The length of experimental period was 100 days. The average final weight and age of bulls were 499+67 kg, and 502+87 day, respectively.

The animals were slaughtered at similar live weight at the commercial abattoir according to the Hungarian Standard. The carcasses were assessed for conformation and fatness according to the EUROP system. The carcasses were assessed by trained operators for conformation (an 18 point scale: scale 1 (poorest) to 18 (best)) and fatness (a 15 point scale: scale 1 (leanest) to 15 (fattest)) according to EU beef carcass classification scheme with the use of subclasses. One hour after slaughter, the dressed carcasses were weighed (hot carcass weight), split into two sides, were chilled at 4 Co for 24 hours, and the samples have been taken after 24-hour chilling from the right half carcass from two commercial meat cuts (brisket, loin) from muscles (M. superficial pectoral (SP), M. longissimus dorsi (LD) to determine the vitamin E and selenium content as well as fatty acid profile of beef.

Laboratory examinations were carried out in the Analytical Laboratory of Kaposvár University, Faculty of Agricultural and Enviromental Sciences. The chemical composition and fatty acid profile determination as well as selenium content were made as described by Holló *et al.* [4]. The Se-content was determined by a fluorometry method. The determination is based on the method written in Hungarian Food Codex [5]. Total vitamin E concentration in muscles was measured according to method by Csapó and Csapó-Kiss [2].

The concentrations of fatty acids were expressed as a percentage of total fatty acid methyl esters. Twenty-six fatty acids were analyzed in this study. Besides individual fatty acids, 7 groups of fatty acids were calculated (SFA, MUFA, PUFA, n-6 fatty acids, n-3 fatty acids, n-6/n- 3 ratio, and Health Index (HI)). HI = (Total MUFA + Total PUFA) / (4 × C14:0 + C16:0).

For the statistical evaluation was used the IBM SPSS 20.0 software (2011). In addition to basic statistical results (mean, SD), the effect of diet was evaluated with multivariate analysis of variance, general linear model (GLM) III. The differences between the groups were evaluated with LSD test, the level of significance was set at $P<0.05$. In Table 1, significance level at $P<0.1$ was shown, too.

III. RESULTS AND DISCUSSION

At similar age slaughtering, the Control group had the highest slaughter weight (536±81 kg) in line with hot carcass weight. Animals in Se-group showed significantly lower slaughter (464±56 kg) and carcass weight than that of in other two groups. Carcass dressing percentage was 53% and the majority of carcasses were classified to conformation class R- and to fat classes 2- (Group C) and 1+ (Group E and Se). Dietary vitamin E did not affect hot carcass weight and EUROP grading, but dressing percentage was affected by the vitamin E supplementation, in line with previous findings. Similarly to vitamin E supplementation the dietary inclusion of Se resulted lower killing out percentage (52%) in Group Se, and moreover mainly due to lower carcass weight significant lower EUROP fat grade than Group C. Intramuscular fat content was greater in the Group C, and between muscles, the content were greater in brisket, than in loin. The intramuscular fat contents of loin in supplemented groups are considerably lower than the content of 2 to 2.5% reported to be optimal for beef eating quality. The dietary treatment effect on protein content of muscles was significant; the highest protein level was measured for Group E. A significant difference was observed for ash content between muscles, greater level measured in brisket than in loin. Compared with Group C, higher ash contents were recorded in both muscles from supplemented groups.

The effect of vitamin E supplementation of animals on muscle vitamin E concentrations is well documented. The vitamin E supplementation of cattle results in higher vitamin E concentrations in meat cuts. In agreement with the previous findings the vitamin E concentration of both cuts in Group E was more than 1.5–fold greater than that measured in Group C (brisket: 6.1 vs. 3.6 µg/g; loin: 5.2 vs. 3.1 µg/g). In line with O'GRADY *et al.* [6] results muscle vitamin E concentrations were not significantly affected by dietary Se supplementation (brisket: 3.5 vs. 3.6 µg/g; loin:

3.3 vs. 3.1 µg/g). ARNOLD *et al.* [1] stated that oxidative stability can be influenced effectively, if vitamin E content in beef reached 3-3.5 µg/g. Both muscles of all animals in Group E contained vitamin E level above the mentioned threshold value.

Based on literature data the Se content of beef may vary depending on the Se content of the soil, the feedstuffs grown on that soil, and whether the animal has been supplemented with Se. As expected the group having received Se supplementation had significantly greater concentrations of Se in muscles (SE: 83.42 µg/kg) than those having not received dietary supplementation (E:61.72 µg/kg and C:51.73 µg/kg). Selenium content of muscles in the current study was increased in meat samples from Group Se markedly. Samples from Group Se contained significantly more Se (82.58+7.79 µg/kg and 83.94+9.81 µg/kg) compared to Group C (49.14+8.49 µg/kg 54.32+5.95 µg/kg), whereas vitamin E supplementation resulting intermediate Se concentration (58.20+6.84 µg/kg, 65.82+2.83 µg/kg) in muscles. Se content was not affected significantly in meat cuts, however higher Se concentration was observed in loin (longissimus muscle: 68.89+14.63 µg/kg) opposite to brisket (*Pectoralis* muscle: 61.23+15.50 µg/kg).

Treatments differences in fatty acids composition were mainly for supplemented versus non-supplemented groups for both muscles (Table 1.). In supplemented groups decreased concentrations of SFA and greater levels of PUFA were observed. Briskets from control bulls due to higher intramuscular fat content tended to have the greatest SFA content, too. This difference is largely attributed to increased levels of the myristic and palmitic acids, as well as greater percentage of C 12:0, C 15: C 17:0 in brisket of Control group. From human nutritional point of view the lauric (C12:0), myristic (C14:0), and palmitic (C16:0) acids deserve attention. These are the primary fatty acids associated with increasing plasma low-density lipoprotein and total cholesterol concentrations in the human body. Palmitic acid (C 16:0) is the main end product of de novo fatty acid synthesis, this can be elongated to stearic (C 18:0) acid. C 18:0 is the main end product of linoleic (C 18:2 n-6) and linolenic acid (C 18:2 n-3) biohydrogenation process, too. In our study lower C 18:0 was measured in the brisket of control bulls (P<0.1) compared to the same value measured in Group SE.

Table 1 The fatty acid profile (mean$_{SD}$) of intramuscular fat from the brisket and loin of bulls fed DDGS diets containing either with or without a dietary supplement

Item	Vitamin E suppl.		Selenium suppl.		Control	
	brisket	loin	brisket	loin	brisket	loin
C14:0	$1.98_{0.6}^{b}$	$1.61_{0.5}^{b}$	$1.65_{0.5}^{b}$	$1.58_{0.2}^{b}$	$3.01_{0.5}^{a}$	$2.65_{0.6}^{a}$
C16:0	$24.14_{4.0}$ b	$22.02_{3.1}^{b}$	$22.22_{2.3}^{b}$	$21.91_{1.2}^{b}$	$28.50_{1.8}^{a}$	$27.18_{2.5}^{a}$
C16:1	$2.39_{0.5}^{ab}$	$2.32_{0.5}$ ab	$1.99_{0.4}$ b	1.840.4 b	$2.88_{0.7}^{a}$	$2.39_{0.4}^{a}$
C18:0	$20.49_{0.9}^{AB}$	20.071.0	$22.35_{3.3}^{A}$	23.754.0	$19.43_{4.0}^{B}$	$19.95_{3.3}$
C18:1 t-1	$2.32_{0.5}^{ab}$	$2.94_{1.1}$	$2.68_{0.9}^{a}$	3.040.9	$1.81_{0.3}^{b}$	$1.89_{0.3}$
C18:1 t-2	$1.67_{0.2}^{a}$	$1.79_{0.2}^{a}$	$1.55_{0.2}^{ab}$	1.550.2 b	$1.41_{0.1}^{b}$	$1.49_{0.1}^{b}$
C18:1*n*-9c	$33.30_{2.8}$	$33.66_{2.7}^{ab}$	$34.16_{2.2}$	31.602.0 b	$35.70_{2.8}$	$35.67_{3.3}^{a}$
C18:2*n*-6	$5.88_{2.8}^{a}$	$7.14_{2.3}^{a}$	$5.90_{1.7}^{a}$	$6.81_{1.6}^{a}$	$2.45_{0.5}^{b}$	$3.39_{0.8}^{b}$
C18:3*n*-6	$0.03_{0.0}$	$0.04_{0.0}$	$0.03_{0.0}$	$0.04_{0.0}$	$0.03_{0.0}$	$0.03_{0.0}$
C18:3*n*-3	$0.39_{0.1}^{B}$	$0.44_{0.1}^{b}$	$0.46_{0.3}^{AB}$	$0.46_{0.1}^{b}$	$0.56_{0.1}^{A}$	$0.70_{0.1}^{a}$
c9,t11CLA	$0.29_{0.1}$	$0.34_{0.1}^{C}$	$0.40_{0.1}$	0.410.1A	$0.35_{0.1}$	$0.35_{0.1}^{B}$
C20:4*n*-6	$2.81_{2.5}^{a}$	$3.04_{1.5}^{a}$	$2.18_{1.2}^{a}$	$2.50_{1.2}^{a}$	$0.21_{0.3}^{b}$	$0.56_{0.7}^{b}$
C22:5*n*-3	$0.60_{0.4}^{a}$	$0.61_{0.3}^{a}$	$0.53_{0.3}^{a}$	$0.50_{0.2}^{ab}$	$0.09_{0.1}^{b}$	$0.20_{0.1}^{b}$
C22:6*n*-3	$0.04_{0.0}^{a}$	$0.05_{0.0}^{a}$	$0.03_{0.0}^{ab}$	$0.04_{0.0}^{ab}$	$0.01_{0.0}^{b}$	$0.02_{0.0}^{b}$
SFA	$48.36_{4.6}^{b}$	$45.66_{3.5}^{b}$	$48.28_{4.5}^{b}$	$49.54_{4.7}^{ab}$	$53.00_{3.1}^{a}$	$51.98_{2.8}^{a}$
MUFA	$40.67_{3.2}$	$41.77_{2.0}$	$41.34_{3.0}$	$38.94_{2.6}$	$43.07_{3.4}$	$42.54_{3.4}$
PUFA	$10.86_{6.4}^{a}$	$12.57_{4.4}^{a}$	$10.27_{3.4}^{a}$	$11.52_{3.4}^{a}$	$3.83_{0.8}^{b}$	$5.49_{1.8}^{b}$
n-6	$9.31_{5.8}^{a}$	$10.85_{4.0}^{a}$	$8.61_{3.1}^{a}$	$9.88_{2.9}^{a}$	$2.77_{0.8}^{b}$	$4.13_{1.6}^{b}$
n-3	$1.25_{0.7}^{A}$	$1.36_{0.5}$	$1.22_{0.7}^{AB}$	$1.20_{0.4}$	$0.69_{0.1}^{B}$	$0.99_{0.3}$
P/S	$0.24_{0.2}^{a}$	$0.28_{0.1}^{a}$	$0.22_{0.1}^{a}$	$0.24_{0.1}^{a}$	$0.07_{0.0}^{b}$	$0.11_{0.0}^{b}$
n-6/*n*-3	$7.52_{2.0}^{a}$	$8.08_{2.2}^{a}$	$7.97_{2.6}^{a}$	$8.44_{1.2}^{a}$	$4.03_{0.9}^{b}$	$4.11_{0.6}^{b}$
HI	$1.70_{0.6}^{a}$	$1.98_{0.5}^{a}$	$1.84_{0.4}^{a}$	$1.80_{0.3}^{a}$	$1.16_{0.1}^{b}$	$1.29_{0.2}^{b}$

a,b means significant differences among groups P<0.05, A, B means significant differences among groups P<0.01

The average SFA content of loin was 52% in Group C, significantly differed from SFA detected in Group E. The same individual saturated fatty acids differences were detected between dietary treatments for loin as well as for brisket except for C 18:0. The MUFA content of muscles varied between 39 and 43%, significant differences were detected for C 14:1, C16:1 and C 20:1 fatty acids. In this study C 18:1 trans isomers was found significantly higher

proportion in supplemented groups than that of in muscles of control group. Contrary to trans isomers higher level of C 18:1 cis fatty acid in loin of control group was observed than in Group SE. Cis-9, trans-11 CLA are considered highly beneficial to human health differed ($P<0.1$) among treatments in case of loin; highest was in Se-group, followed by Group C, and lowest was in Group E. Based on our data Se supplementation might improve the proportion of CLA level in loin.

According to our finding the average linoleic acid (C18:2 n-6) content was in brisket and in loin of control group 2.5% and 3.4% respectively. Linoleic acid proportion was more than 2-fold higher in supplemented groups. Significant muscle effect on fatty acid composition was detected only for C 18:2 n-6 and C 18:3 n-6 fatty acids. The linolenic acid (C 18:3 n-3) content was greater in the brisket and the loin of control group compared to same values of E supplemented group, and value of loin detected in Se supplemented group. The long chain fatty acids belonging to n-3 and n-6 fatty acid family were generally higher in muscles of supplemented groups. However, in loin no significant differences were observed between control and Se supplemented group for C 22:5 n-3 and C 22:6 n-3 and in brisket for C 22:5 n-3. This non difference might occur due to biohydrogenation of docosahexenoic acid (C 22:6 n-3) converting into behenic acid (C 22:0) in Group Se. At the same time, it seems that including high levels of vitamin E in the diet resulted in higher levels of n-3 fatty acids somehow modify long chain fatty acid synthesis. Besides this, higher level ($P<0.05$) of n-6 fatty acids were in both muscles supplemented groups than in the control group.

A previous report [3] showed that feeding DDGS appears to alter fatty acid profiles of beef. In our study, the PUFA/SFA ratio was considerably better in E and Group Se due to dietary supplementation than that of control DDGS diet group, however less than the lowest limit recommended to improve human health (0.45). It can be difficult to recommend a ratio when individual fatty acids within groups/families can have decisevely different biological effects, namely the n-6/n-3 ratio did not change favourably in supplemented group due to greater content of n-6 fatty acids. From this point of view the Control group showed desirable value.

Health index (HI) is a ratio which was calculated directly from sum of MUFA and PUFA in numerator and C14:0 and C16:0 in denominator, consequently this greater HI value is beneficial. According to data, Group E and Group Se had markedly higher health promoting effect than the Control group.

IV. CONCLUSION

Adding a supplement containing vitamin E or Se during the finishing period of Holstein bulls, successfully produced greater contents of these desirable components in the resulting beef. The vitamin E or Se enriched beef ~~occur~~ induced changes in some other fatty acid composition characteristics of beef. It is concluded supplementing the diet with vitamin E or selenium in DDGS diet generally enhanced the overall meat healthiness (PUFA/SFA ratio, Health Index)~~.~~.

REFERENCES

1. Arnold, R.N., Scheller, K.K., Arp, S.C., Williams, S.N., Buege, D.R., Schaefer, D.M. (1992). Effect of long- or short-term feeding of alfa-tocopheryl acetate to Holstein and Crossbred beef steers on performance, carcass characteristics, and beef color stability. J. Anim. Sci. 70:3055–3065.
2. Csapó J., Csapó-Kiss Zs. (2003). Food Chemistry. Mezőgazda Publ., Budapest
3. Depenbusch, B.E., Drouillard, J. S., Loe, E. R., Higgins, J.J., Corrigan, M.E., Quinn M.J. (2008). Efficiency of monensin and tylosin in finishing diets based on steam-flaked corn with and without corn wet distillers grains with solubles. J. Anim. Sci. 86:2270–2276.
4. Holló G., Ender K., Lóki K., Seregi J., Holló I., Nuernberg, K. (2008). Carcass characteristics and meat quality of Hungarian Simmental young bulls fed different forage to concentrate ratios with or without linseed supplementation. Arch. Tierz. 51:517-530.
5. Hungarian Food Codex (1990). SE-determination. 489.
6. O'Grady, M.N., Monahan, F.J., Fallon R.J., Allen P.(2001). Effects of dietary supplementation with vitamin E and organic selenium on the oxidative stability of beef J. Anim. Sci., 79:2827-2834.