# QUALITY OF MEAT FROM LAMBS FED SUNFLOWER CAKE AND LINSEED WITH OR WITHOUT VITAMIN E SUPPLEMENT

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***Abstract-***The study was carried out with 36 ram lambs (18 prolific-dairy Kołuda sheep (KS) and 18 $F_1$ (Ile de France × KS) sheep) fattened to 32-37 kg body weight. Lambs were fed *ad libitum* concentrate mixtures with hay. The control group (C) diet was based on cereal components and rapeseed meal (RM). Experimental groups received 23.5% sunflower cake and 5% linseed (group SCL) or the same ingredients supplemented with 0.2% vitamin E (group SCL+E). The use of sunflower cake and linseed for intensive fattening to high weight standards reduced the fat content of *m. longissimus dorsi*, and supplementation of the oilseed diet with vitamin E increased this effect by a factor of two. Feeding oilseed diets with or without vitamin E had no considerable effect on the physicochemical traits and organoleptic score of muscle tissue, with a tendency towards better colour score, lower natural losses and poorer instrumental tenderness. Crossing Kołuda sheep with Ile de France rams increased the intramuscular fat content, with small changes in physicochemical traits and a tendency towards better organoleptic scores for meat.

***Index Terms-***lambs, feeding, vegetable oils, vitamin E, meat quality

## I. INTRODUCTION

With increasing production of biofuel components from oilseeds (mainly rapeseed and sunflower in Europe), there is a need to utilize large amounts of byproducts (rapeseed cake and sunflower cake) as feed. These cakes are a valuable energy and protein feed for farm animals, have a beneficial effect on production results and enable fatty acid composition of milk and meat to be modified to improve its health benefits. The dominant fatty acids in sunflower oil are oleic acid C18:1 c9 (about 19%) and linoleic acid C18:2 (about 70%). To increase the positive results of feeding sunflower cake, it is often used with linseed whose fat contains mainly alpha-linolenic acid C18:3 (Borys, Borys, Grześkiewicz & Grześkowiak 2009a; Borys, Kaczor & Pustkowiak 2009b).

Feeding livestock with diets rich in unsaturated fatty acids (UFA) increases the UFA content of milk and meat products, which makes them more susceptible to oxidation (Migdał et al. 2008). The food so modified can be protected against oxidation by supplementing oilseed diets with vitamin E, which is the most effective antioxidant. The use of good-quality forages (pastures) rich in vitamin E or the addition of synthetic vitamin E to the diets has a beneficial effect not only on the quality and nutritive value of products but also on the health status and productivity of animals. These findings were confirmed for fattened lambs and their meat by Borys et al. (2009b), Salvatori, Pantaleo, Di Cesare, Maiorano, Filetti. & Oriani (2004) and Wood et al. (2008).

The aim of this study was to determine the effect of fattening lambs with concentrates containing sunflower cake and linseed supplemented with vitamin E on chemical composition, selected physicochemical traits and sensory score of meat with regard to breed origin of the lambs.

## II. MATERIALS AND METHODS

The study was conducted in two replications with a total of 36 ram lambs (18 sheep of the prolific-dairy Koluda Sheep (KS) and 18 $F_1$ sheep from the commercial crossbreeding of Ile de France meat lambs to KS animals (IF×KS)) fattened intensively from weaning at 7-8 weeks of age (about 21 kg body weight) to 32-37 kg body weight. Lambs were fed *ad libitum* in 3 groups (each having 50% KS and 50% IF×KS animals) with concentrates supplemented with grass hay. The control group (C) diet was based on cereal components (>50%) and rapeseed meal (RM; 20%). Experimental groups received ground wheat and RM was replaced with 23.5% sunflower cake and 5% linseed (group SCL) or the same ingredients supplemented with 0.2% vitamin E (Polfamix E; group SCL+E). Compound feeds consumed by the lambs from the compared groups were similar in terms of protein and fibre content, whereas SCL diets, compared to C diets, contained 85% more fat (9.26 vs. 5.01% in DM) and 7.4% less fibre.

Raw *longissimus dorsi* (l.d.) muscle was analysed for:
- water content by drying the sample at 105°C to constant mass,
- protein content by the Kjeldahl method (PN-75/A-04018) using a Tecator analyser,
- fat content using the Soxhlet method according to Polish Standard PN-73/A-82111,
- drip loss from muscle sample, expressed as a percentage weight loss during 48-hour storage at +4°C,
- water holding capacity (WHC) by the Grau and Hamm method,
- shrinkage loss of muscle weight during cooking to an internal temperature of 70°C,
- organoleptic score of meat colour by a panel of 5 judges, using Soicarni standards on an 8-point scale (1 = pale, 8 = dark),
- L*, a* and b* colour values using a Minolta CR 400 colorimeter,
- marbling by the organoleptic method using marbling standards (5-point scale, 1 = devoid, 5 = abundant).

Tenderness of l.d. muscle was measured on cooked samples using Warner-Bratzler (WB) shear machine. pH value was determined 24 h postmortem using a Radiometer PHM 80 Portable pH meter with a combination electrode. Electrical conductivity (EC) was measured 24 h postmortem with a PQM-L KOMBI instrument. These two parameters were measured at 3 locations of l.d. muscle (at the 6th-7th thoracic vertebrae and at the 1st-2nd and 3rd-4th lumbar vertebrae). Sensory characteristics of cooked l.d. was evaluated by a panel of 5 judges on 5-points scale.

The results were analysed statistically using analysis of variance (STATISTICA 8.0) and an orthogonal array with three factors (feeding method, breed origin, replication), a model with interactions. Significant differences between the feeding groups were estimated using Duncan's test.

## III. RESULTS AND DISCUSSION

### Basic chemical composition

Feeding oilseed diets and the vitamin E supplement had no clear effect on the water and protein content of *m. longissimus dorsi* (l.d.) (Table 1). Surprisingly, the fat content of l.d. muscle decreased in lambs from groups SCL and SCL+E in relation to group C by 14.0% (NS) and 29.7% ($P \leq 0.05$), respectively. An equally surprising effect of using oil components on reducing the intramuscular fat content was found by the present author (Borys et al. 2009a) when rapeseed cake and linseed were used. This supports a hypothesis that the level and source of dietary fat differentiate the rate of fatty tissue deposition at different body and carcass sites. It appears that in the case of meat, similarly to milk production in ruminants, the increased production of the trans-10 cis-12 isomer of CLA during oilseed feeding inhibits the synthesis of tissue (intramuscular) fat. This effect was conclusively confirmed for cow's and sheep's milk fat (Bauman, Mather, Wall & Lock 2006) and is known as "milk fat depression" (MFD). With regard to tissue fat synthesis, this phenomenon is more complex and has been conclusively confirmed in growing mice.

It is notable that the use of vitamin E supplement (SCL+E) increased differences in intramuscular fat content in relation to group C by a factor of two. The addition of vitamin E to the concentrate diet made it possible to obtain meat with intramuscular fat content of 1.5-2.5%, which is regarded as the reference range for lamb meat. Similar results of using vitamin E were obtained in the present author's earlier study (Borys et al. 2009a) in which sunflower cake was replaced with rapeseed cake.

Crossing Koluda sheep with Ile de France rams only caused a tendency towards elevated fat content of muscle tissue (9.8% higher in IF×KS than in KS, NS). The tendency towards greater carcass fatness and muscle marbling in crossbreds sired by Ile de France rams is reflected in the present authors' other studies (Borys B. & Borys A. 2002), in which this breed showed a propensity for fat accumulation when fattened intensively to high weight standards. This inclination was significantly greater than in Merino, East Friesian and prolific Finn and Romanov sheep, which were the main breed components of the Koluda sheep. Replication of the experiment did not result in significant differences in the content of l.d. muscle components.

### Physicochemical traits

Feeding lambs with sunflower cake and linseed diets had no significant effect on most of the analysed physicochemical traits of muscle tissue (Table 2). There were no distinct differences in measurements of $pH_{24}$, $EC_{24}$, water holding capacity and marbling score. The muscles of lambs from the feeding groups compared were characterized by similar lightness (L*) and redness (a*), with a marked tendency for lower yellowness (b*) in the muscles of lambs from the SCL+E group (by 20.4% in relation to group C, NS). Feeding oil plants had a significant and beneficial effect on the colour score of l.d. muscle, which was 16.9% ($P \leq 0.05$) and 22.5% ($P \leq 0.01$) higher in groups SCL and SCL+E compared to group C, respectively. The experimental groups exhibited an unfavourable tendency towards poorer Warner-Bratzler tenderness measurement of l.d. muscle, which was an average of 8.5% higher than in group C (NS). At the same time, however, the muscles of lambs fed oilseeds showed a favourable tendency for lower drip loss than in group C (by an average of 0.46 percentage units (p.u.; NS)), and the muscles of lambs from the SCL+E group showed significantly smaller cooking losses (by an average of 2.4; P≤0.01) compared to the other groups.

Breed origin of the lambs had no significant effect on physicochemical traits of l.d. muscle except the marbling score, which was 16.1% higher for IF×KS than KS animals (P≤0.05). This could be related to the tendency for higher fat content of the muscles of crossbreds (Table 1). The crossbreeding scheme also resulted in a non-significant tendency for higher $EC_{24}$ (by 12.7%), better WB tenderness (lower by 5.1%) and 20.0% lower yellowness.

Replication of the experiment revealed significant differences in some of the physicochemical traits analysed. Generally more favourable parameters were characteristic of the muscles of lambs from the first replication, mainly due to significantly better tenderness, higher lightness score, lower cooking losses and a tendency towards lower marbling score and lower drip loss.

The effect of the experimental factors on physicochemical traits of muscle tissue is considered small and not very distinctive, and the observed differences and tendencies were largely caused by differences in intramuscular fat content. The values of the parameters obtained indicate that the lambs from all feeding and breeding groups produced meat of high quality.

**Sensory analysis**

Feeding the lambs with diets high in oilseeds (28.5%) and rich in polyunsaturated fatty acids (PUFA) did not affect the sensory scores of cooked l.d. muscle – Table 3. The use of sunflower cake and linseed in the diet resulted in a small decrease in the overall score for aroma, juiciness, tenderness and palatability, with a minimal improvement in the group receiving the experimental diet supplemented with vitamin E. Also breed origin of the lambs did not significantly affect the overall sensory score and its constituents, with a tendency for higher scores awarded to the muscles of IF×KS animals compared to KS lambs. Statistically significant differences of 2.1% in favour of the meat of crossbreds emerged for palatability scores (P≤0.10).

Replication of the experiment did not cause clear differences in sensory scores of the muscles except the palatability score, which was an average of 3.0% higher for muscles in the second replication (P≤0.05).

Both the dietary factor and the commercial crossbreeding scheme made it possible to obtain meat of high culinary quality, as evidenced by the organoleptic score averaging 4.59 points, i.e. 92% of the maximum score.

## IV. CONCLUSION

1. The use of sunflower cake and linseed for intensive fattening of lambs to high weight standards reduced the fat content of *m. longissimus dorsi* in relation to the control group, and supplementation of vitamin E increased this difference by a factor of two.
2. Feeding the oilseed diet and its supplementation with vitamin E had no considerable effect on the physicochemical traits and organoleptic score of muscle tissue, with a tendency towards better colour score, lower natural losses and poorer instrumental tenderness of meat.
3. Crossing the prolific-dairy Koluda sheep with Ile de France rams increased the intramuscular fat content, with small changes in physicochemical traits and a tendency towards better organoleptic scores for meat.

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Table 1. Basic chemical composition of *m. longissimus dorsi*; g/100 g

| Specification | Feeding | | | Breed | | Repe-tition | Inter-aktion | SEM |
|---|---|---|---|---|---|---|---|---|
| | C | SCL | SCL+E | KS | IFxKS | | | |
| n | 12 | 12 | 12 | 18 | 18 | | | |
| Water | 73,38 | 75,91 | 75,79 | 75,67 | 75,71 | NS | NS | 0,163 |
| Protein | 20,57 | 20,47 | 21,06 | 20,83 | 20,56 | NS | NS | 0,162 |
| Fat | 3,00 a | 2,58 | 2,11 a | 2,44 | 2,68 | NS | NS | 0,137 |

aa - P≤0,05, NS - non significant

Table 2. Physicochemical parameters of *m. longissimus dorsi*

| Specification | Feeding (F) | | | Breed (B) | | Repe-tition (R) | Inter-action | SEM |
|---|---|---|---|---|---|---|---|---|
| | C | SCL | SCL+E | KS | IFxKS | | | |
| $pH_{24}$ | 5,77 | 5,78 | 5,81 | 5,80 | 5,77 | NS | NS | 0,021 |
| $EC_{24}$ | 2,92 | 3,12 | 2,76 | 2,76 | 3,11 | NS | NS | 0,136 |
| WHC; % | 34,21 | 32,86 | 33,99 | 33,29 | 34,09 | NS | NS | 0,410 |
| WB tenderness; N | 87,56 | 94,35 | 95,75 | 94,98 | 90,13 | * | NS | 3,984 |
| Colour parameters: L* | 39,56 | 39,73 | 39,19 | 40,13 | 38,85 | NS | NS | 0,448 |
| a* | 12,25 | 12,61 | 12,33 | 12,26 | 12,54 | NS | FxB** BxR* | 0,155 |
| b* | 1,47 | 1,42 | 1,17 | 1,50 | 1,20 | ** | NS | 0,214 |
| Colour evaluation; pts. | 3,02 Aa | 3,53 a | 3,70 A | 3,44 | 3,39 | ** | FxR* | 0,149 |
| Marbling degree; pts. | 1,64 | 1,68 | 1,70 | 1,55 a | 1,80 a | NS | NS | 0,060 |
| Free drip; % | 1,99 | 1,47 | 1,65 | 1,72 | 1,69 | NS | NS | 0,123 |
| Cooking loss; % | 28,79 A | 28,66 B | 26,30 AB | 27,81 | 28,02 | ** | FxB** | 0,555 |

AA, BB, ** - P≤0,01, aa, * - P≤0,05, NS - non significant

Table 3. Sensory assessment of cooked *m. longissimus dorsi*; pts

| Specification | Feeding (F) | | | Breed (B) | | Repe-tition (R) | Inter-action | SEM |
|---|---|---|---|---|---|---|---|---|
| | C | SCL | SCL+E | KS | IFxKS | | | |
| Total (max. 20 pts) | 18,32 | 18,21 | 18,49 | 18,24 | 18,44 | NS | FxR* | 0,094 |
| - in that[1]: flavour | 4,51 | 4,48 | 4,58 | 4,49 | 4,56 | NS | FxR* | 0,031 |
| juiciness | 4,58 | 4,56 | 4,70 | 4,60 | 4,63 | NS | NS | 0,036 |
| tenderness | 4,54 | 4,46 | 4,50 | 4,49 | 4,51 | NS | NS | 0,037 |
| palatability | 4,68 | 4,70 | 4,71 | 4,65 α | 4,75 α | * | NS | 0,028 |

[1] max. 5 pts, αα - P≤0,10, * - P≤0,05, NS - non significant