

## Effect of weaning and sex on meat fatty acid profile of grazing lambs

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Twenty Tsigai and Suffolk crossbreed lambs in grazing conditions were used to investigate the effect of weaning status (weaned vs. unweaned) and sex on fatty acid composition of meat. Six males and four females were included in both groups, the weaned lambs group (WL) and the unweaned lambs group (UL). The fatty acid profile of *Musculus longissimus lumborum et thoracis* intramuscular fat (IMF) were determined by gas chromatography and analysed by analysis of variance. WL displayed higher proportion of t11-C18:1 ( $P < 0.001$ ), n-6 polyunsaturated fatty acid (PUFA) C18:2 ( $P < 0.01$ ) and C20:4 ( $P < 0.05$ ), n-3 PUFA C18:3 ( $P < 0.05$ ), C20:5 ( $P < 0.01$ ), C22:5 ( $P < 0.05$ ), C22:6 ( $P < 0.05$ ) and the total PUFA ( $P < 0.01$ ) in IMF than UL. On the contrary, IMF of UL had higher proportion of the medium-chain saturated fatty acids (SFA) such as C12:0 ( $P < 0.01$ ), C14:0 ( $P < 0.01$ ) and C16:0 ( $P < 0.01$ ), the total SFA ( $P < 0.05$ ) and the total monounsaturated fatty acids (MUFA) ( $P < 0.05$ ). The weaning status had no significant effect on n-6/n-3 ratio, however the ratio was satisfactory low in both groups. The sex had no effect on a profile of essential and health beneficial fatty acids in meat of lamb. In conclusion, meat of weaned lambs in grazing system might be considered to obtain a higher proportion of healthy n-3 fatty acids compared to unweaned lambs.

**Keywords:** fatty acids, intramuscular fat, lamb meat, weaned lambs, unweaned lambs

### 1 Introduction

The lamb meat production in Slovakia is characteristic by major production of the light lambs. This is caused by predominance of local dual purpose sheep breeds used for milking, as Improved Valachian and Tsigai and their crossbreeds. However production of heavy carcass lambs are increasing in recent years due to growing interest of using crossbreeds for grazing in pastures, which are not suitable for dairy sheep. There is also a growing interest of consumers in the origin of an animal product. Products from small local farms, which produce lambs from grazing system are more sought after. Recent reviews reported information of the impact of pasture-based systems on meat quality (De Brito et al., 2017; Howes et al., 2015). One of the important meat quality parameters is the fatty acid profile (Woods – Fearon, 2009). The degradation of forage in the rumen is a complex process largely affected by rumen microorganism. Lambs fed only with forage have greater microbial diversity than lambs fed with concentrate and hay (Belanche et al., 2019). In fact, it has been observed that microbiome of grazing ruminants have a positive effect on more favourable fatty acid profile (French et al., 2000). Meat obtained from pasture raised lambs contains a higher amount of polyunsaturated fatty acids (PUFA), than lambs fed by high concentrate diet (Enser et al., 1998; Jacques et al., 2016).

The fatty acid composition of suckling lambs is related to composition of maternal milk (Velasco et al., 2001) and it varies according to the length of lactation and quantity of consumed forages.

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The aim of this study was to determine how weaning affects the fatty acid profile of intramuscular fat of crossbred lambs, originating from the natural grazing system.

## 2 Material and methods

### 2.1 Animal management

The present experiment was conducted on twenty Tsigai and Suffolk crossbred lambs, which were randomly assigned to the two experimental groups. The first group (WL) consisted of ten weaned lambs (six males and four females) continuously grazed in a natural pasture. Ten lambs (six males and four females) in the second group (UL) were unweaned and were grazed in a natural pasture with their mothers. Lambs were born in the sheep barn and were fed by ewes' milk, meadow hay and concentrate *ad libitum*. WL lambs were weaned after reaching 10 kg of body weight. UL had unrestricted access to ewes' milk whole time during experiment. The trial lasted fifteen weeks after fourteen days adaptation of lambs to the pastoral conditions. The floristic composition of pasture was typical for foothills in Slovakia and pasture was rich in *Trifolium pretense*, *Lolium perenne*, *Lolium multiflorum*, *Festuca rubra*, *Poa Pratensis* and *Trifolium repens*. Average live body weight of lambs before slaughter was 38.7 kg for WL lambs and 38.6 kg for UL lambs. Animal care and management procedures followed the EU Directive 2010/63/UE, which concerns the protection of animals used in scientific experiments. Lambs were slaughtered in the experimental slaughterhouse of Slovak University of Agriculture in Nitra.

### 2.2 Fatty acid profile analysis

Muscle samples (*Musculus longissimus lumborum et thoracis*, MLLT) were taken for determination of fatty acid profile of intramuscular fat of experimental lambs. Sample of each animal were collected after twenty-four hours carcass chilling. Capillary gas chromatography was used to determine the proportion of the individual FA and FA isomers. The fatty acid methyl esters (FAME) preparation and gas chromatography determination is described in Margetin et al. (2018). The fatty acid profile of intramuscular fat was detected in grams of individual FAME with content  $>0.5$  g/100 g was 1.1% for the entire analytical procedure and five replicated samples.

### 2.3 Statistical analysis

The data were analysed using the ANOVA Procedure with the help of the SAS software (version 9.3, by application Enterprise Guide 4.2). Mean values and standard deviation (SD) are reported in tables. Differences between treatments were tested for significance. The level of significance was established at  $P \leq 0.05$  until  $P \leq 0.001$ .

## 3 Results and discussion

Table 1 presents the effects of the weaning status and sex on fatty acid composition of the *M. longissimus lumborum et thoracis* intramuscular fat. Similarly to Cañeque et al. (2001) and Velasco et al. (2004), the medium-chain saturated fatty acids (SFA) such as C12:0 (lauric acid), C14:0 (myristic acid) and C16:0 (palmitic acid) significantly predominated in unweaned lambs. It could be caused by greater proportion of these fatty acids in fat of consumed ewes' milk (Velasco et al., 2001). Of the other SFA studied, differences in proportions of C17:0 (margaric acid) and C18:0 (stearic acid) were not significant between weaned and unweaned lambs. The proportion of the total SFA was higher ( $P < 0.05$ ) in unweaned lambs compared to weaned lambs (47.3 vs. 43.5 g/100 g FAME respectively). The most abundant fatty acid in meat of lambs was c9-C18:1 (oleic). Intramuscular fat of unweaned lambs contained significantly higher ( $P = 0.01$ ) proportion of oleic acid in comparison to weaned lambs (31.9 vs. 25.9 g/100 g FAME respectively). This findings are not in agreement with Cividini et al. (2014) and Velasco et al. (2004). The major isomer of trans C18:1 acids in meat of lambs was t11-C18:1 (vaccenic acid). Vaccenic acid is a precursor of c9,t11-C18:2 (Conjugated linoleic acid, CLA) and in lamb meat could play an important role for the endogenous synthesis of CLA. The weaned lambs displayed higher values of vaccenic acid than the unweaned lambs ( $P < 0.001$ ). However, the differences in proportion of rumenic acid and the total CLA between weaned and unweaned lambs were not significant. In concordance with Cividini et al. (2014) the total monounsaturated fatty acids (MUFA) significantly ( $P < 0.05$ ) predominated in unweaned lambs. On the contrary proportions of the total PUFA were predominated in weaned lamb meat (22.2 vs. 13.6 g/100 g FAME,  $P < 0.01$ ). Likewise, the weaned lambs displayed greater proportions of essential PUFA C18:2n-6 (linoleic acid, LA) and also C18:3n-3 ( $\alpha$ -linolenic acid, ALA) than unweaned lambs. Cañeque et al. (2001) reported different findings, where proportion of ALA was greater in unweaned lambs. In meat of weaned lambs there were also observed higher

proportion of long chain PUFA particularly C20:5n-3 (EPA), C22:5n-3 (DPA) and C22:6n-3 (DHA) which are beneficial for human nutrition. When compared to the recommended n-6/n-3 ratio 4:1, our results indicate that both, weaning and unweaning of lambs in grazing system led to the low n-6/n-3 ratio in intramuscular fat. However, in our study the weaning status had no significant effect on this ratio.

**Table 1** Effect of the weaning status and sex on the fatty acid profile of intramuscular fat of grazing lambs (mean  $\pm$  SD)

Fatty acid (g/100 g FAME)	Weaning status		Sex		P-values	
	WL	UL	M	F	WS	Sex
Lauric (C12:0)	0.07 $\pm$ 0.022	0.18 $\pm$ 0.019	0.10 $\pm$ 0.017	0.14 $\pm$ 0.025	0.002	0.275
Myristic (C14:0)	1.36 $\pm$ 0.224	2.34 $\pm$ 0.191	1.69 $\pm$ 0.172	2.01 $\pm$ 0.248	0.004	0.303
Palmitic (C16:0)	18.0 $\pm$ 0.72	21.1 $\pm$ 0.61	19.3 $\pm$ 0.55	19.7 $\pm$ 0.79	0.004	0.671
Palmitoleic (c9-C16:1)	0.61 $\pm$ 0.045	0.66 $\pm$ 0.039	0.66 $\pm$ 0.035	0.60 $\pm$ 0.050	0.371	0.339
Margaric (C17:0)	1.33 $\pm$ 0.050	1.27 $\pm$ 0.043	1.37 $\pm$ 0.039	1.24 $\pm$ 0.056	0.378	0.068
Stearic (C18:0)	20.4 $\pm$ 1.17	19.8 $\pm$ 1.00	19.9 $\pm$ 0.90	20.3 $\pm$ 1.30	0.672	0.832
Oleic (c9-C18:1)	25.9 $\pm$ 1.38	31.2 $\pm$ 1.18	29.1 $\pm$ 1.06	28.0 $\pm$ 1.53	0.010	0.553
Elaidic (t9-C18:1)	0.24 $\pm$ 0.009	0.24 $\pm$ 0.008	0.23 $\pm$ 0.007	0.24 $\pm$ 0.010	0.994	0.917
Vaccenic (t11-C18:1)	3.69 $\pm$ 0.155	2.46 $\pm$ 0.132	3.16 $\pm$ 0.119	3.00 $\pm$ 0.172	<0.001	0.465
Linoleic (C18:2 n-6)	9.79 $\pm$ 1.054	5.38 $\pm$ 0.899	7.00 $\pm$ 0.810	8.17 $\pm$ 1.167	0.005	0.422
Rumenic (c9, t11-C18:2)	1.15 $\pm$ 0.085	1.00 $\pm$ 0.072	1.10 $\pm$ 0.065	1.05 $\pm$ 0.094	0.202	0.672
$\gamma$ -linolenic (C18:3 n-6)	0.06 $\pm$ 0.009	0.16 $\pm$ 0.007	0.13 $\pm$ 0.007	0.10 $\pm$ 0.010	<0.001	0.021
$\alpha$ -linolenic (C18:3 n-3)	3.19 $\pm$ 0.226	2.44 $\pm$ 0.193	2.93 $\pm$ 0.174	2.70 $\pm$ 0.250	0.020	0.463
Arachidonic (C20:4 n-6)	2.45 $\pm$ 0.342	1.26 $\pm$ 0.292	1.83 $\pm$ 0.263	1.88 $\pm$ 0.379	0.016	0.916
EPA (C20:5 n-3)	1.47 $\pm$ 0.176	0.72 $\pm$ 0.150	1.19 $\pm$ 0.136	1.00 $\pm$ 0.195	0.005	0.422
DPA (C22:5 n-3)	1.55 $\pm$ 0.200	0.84 $\pm$ 0.170	1.20 $\pm$ 0.154	1.18 $\pm$ 0.221	0.014	0.933
DHA (C22:6 n-3)	0.44 $\pm$ 0.064	0.21 $\pm$ 0.054	0.33 $\pm$ 0.049	0.32 $\pm$ 0.071	0.014	0.918
SFA	43.5 $\pm$ 1.29	47.3 $\pm$ 1.10	45.0 $\pm$ 0.99	45.8 $\pm$ 1.43	0.035	0.642
MUFA	34.4 $\pm$ 1.39	38.6 $\pm$ 1.18	37.2 $\pm$ 1.07	35.8 $\pm$ 1.54	0.030	0.471
PUFA	22.2 $\pm$ 1.83	13.6 $\pm$ 1.58	17.6 $\pm$ 1.40	18.2 $\pm$ 2.02	0.002	0.797
LC n-6 PUFA	2.78 $\pm$ 0.377	1.57 $\pm$ 0.321	2.17 $\pm$ 0.290	2.18 $\pm$ 0.417	0.025	0.993
LC n-3 PUFA	3.50 $\pm$ 0.430	1.82 $\pm$ 0.367	2.78 $\pm$ 0.331	2.54 $\pm$ 0.477	0.008	0.691
n-6 PUFA	12.6 $\pm$ 1.36	6.95 $\pm$ 1.161	9.17 $\pm$ 1.047	10.3 $\pm$ 1.51	0.006	0.531
n-3 PUFA	6.69 $\pm$ 0.621	4.26 $\pm$ 0.530	5.71 $\pm$ 0.478	5.24 $\pm$ 0.688	0.008	0.587
CLA	1.37 $\pm$ 0.080	1.16 $\pm$ 0.068	1.30 $\pm$ 0.061	1.23 $\pm$ 0.089	0.055	0.563
n-6/n-3	1.90 $\pm$ 0.172	1.60 $\pm$ 1.147	1.60 $\pm$ 0.132	1.90 $\pm$ 0.191	0.194	0.206
C18:3 n-6/C18:3 n-3	3.13 $\pm$ 0.351	2.18 $\pm$ 0.299	2.35 $\pm$ 0.270	2.95 $\pm$ 0.389	0.049	0.224

WL – weaned lambs; UL – unweaned lambs; M – males; F– females; WS – weaning status, SD – standard deviation

The factor sex had effect only in C18:3n-6 ( $\gamma$ -linolenic acid, GLA), where intramuscular fat in males shows higher proportion than in females (0.125 vs. 0.095 g/100 g FAME,  $P < 0.05$ ). According to Cividini et al. (2008) and Kosulwat et al. (2003), the fatty acid profile of male intramuscular fat tended to have higher proportion of PUFA, while females tended to have higher proportion of MUFA, which was not confirmed in our experiment.

#### 4 Conclusions

In the condition of current study, weaned lambs in grazing condition might be considered as more appropriate source of essential and n-3 fatty acids, which have a positive effect on human health in contrast with unweaned lambs, which

displayed higher proportion of saturated and monounsaturated fatty acids. The results of present work displayed no effects of sex on important fatty acid in intramuscular fat of lambs were observed.

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