INFLUENCE OF EXTRUDED COMPOUND FEED ON LAMBS PRODUCTIVITY AND FATTY ACID CONCENTRATION IN MEAT

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Abstract. In this study, effects of using extruded compound feed on lambs productivity and fatty acid concentration. A total of 24 Lithuanian blackhead breed sheep were assigned into 2 groups (12 lambs in each group). I was control group, II experimental, where farm ratio was supplemented with extruded compound feed Lambs were weighed after being born, 21st day of age, 2 months age, 3 months age, 4 months age and 6 months age, i.e. before slaughter. Weighings were performed before morning feeding. Lambs were slaughtered at 6 months of age. The pH value was determined with pHmeter INOLAB3, meat colour measured (L*, a*, b*) with Minolta color meter firm Chroma Meter 400, drop losses – by Grau and Hamm method, meat cooking losses by method of Schilling. The fatty acid concentration were determine by chromatographic analysis, gas chromatograph Shimadzu GC -2010 Plus.

No statistically significant effect was observed on productive performance of lambs during in the experimental period. At the end of the trial, lambs weight in experimental groups increased, in II group – 3 percent ($P>0.05$). Carcass yield in experimental group increased 19 percent ($P<0.05$), compared to the control group. The data of saturated fatty acid in experimental group decreased 1.10 percent ($P<0.05$), monounsaturated fatty acid increased 1.98 percent ($P<0.05$), but polyunsaturated fatty acid decreased 0.88 percent ($P<0.05$) compared to control group. On lamb meat technological properties, statistically significant result were get in water holding capacity – it increased 3.36 percent ($P<0.05$) and pH value- it decreased 0.04 point ($P<0.05$). When analysed data of lamb meat colour, we determined that lightness (L*), in experimental group, this parameter decreased by 5 percent ($P<0.05$), redness (a*) – 10 percent ($P>0.05$), yellowness (b*) – 12 percent ($P<0.05$) compared to the control group. So, in conclusion, extruded compound feed increased productivity of lambs, carcass yield, chemical composition, water holding capacity and monounsaturated fatty acid of lamb meat.

Keywords: lamb, extruded feed, fatty acid

Introduction

Red meat is an important source of a range of fatty acids, including the long-chain n-3 fatty acids (Wyness et al. 2011). Meat fatty acid composition depends on several factors, with diet being one on the most relevant (Raes et al., 2004; Schmid et al., 2006; Wood et al., 2008). Lamb meat is valuable from a nutritional point of view forits high CLA content, which can exert positive effects on human health (Schmid et al., 2006). SFA have been considered as a risk factor for human health. Intramuscular fatty acid composition can be manipulated by feeding strategies, even in ruminants, despite rumen biohydrogenation processes (Leheska et al., 2008; Warren et al., 2008). The proportion of SFA and unsaturated fatty acid in meat obtained from lambs subjected to different regimes highlights a better fatty acid profile in meat obtained from artificially reared lambs from a nutritional and health-promotingpoint of view. In particular, unsaturated fatty acids are consid-ered hypolipidemic as they reduce both plasma cholesterol and triglycerides, and a low intake of saturated fat and an increased polyunsaturated to SFA ratio are associated with a lower risk ofhuman coronary heart disease (Oriani et al., 2005). It is widely recognized that improving the fatty acid profile of ruminant product has promising prospects for livestock production, as well as to improve human health (Sinclair, 2007). These health promoting fatty acids include conjugated linoleic acid (CLA) and omega-3 fatty acid (Bas et al., 2007; Raes et al., 2004). An effective way to increase the concentration of these bioactive fatty acids in ruminant derived food products is by changing the animal diet ingredients (Dannenberger et al., 2005; Tsiplakou et al., 2010).

Use of locally available resources enhances opportunities for sustainable intensification of smallholder livestock production systems. The nutritional quality of the feed resources, however, needs to be ascertained (Tagoe, 2012). Ruminant meats have been associated with an increase in the risk of cardiovascular diseases, due to their high content of saturated fatty acids (SFA) (Givens, 2005; Arbex et al., 2015). However, ruminant meats may also be a good dietary source of some nutrients with health benefits including a number of fatty acids (FA) such as long chain-polyunsaturated FA (LC-PUFA), n-3 PUFA in particular, and conjugated linoleic acid (CLA) isomers. The decrease of SFA and the increase of health-beneficial FA have been a main topic of ruminant meat research.

According to some researchers, extrusion cooking of extruded seeds is a process which may improve the performance of animals (Diaz et al., 2006). An appropriate processing temperature is critical for the elimination of heat-labile anti-nutritional factors found in legume seeds (Nalle et al., 2011). The extrusion process increases both the digestibility of individual feed components and the destruction of pathogens (Nalle, 2009). However, some studies have shown that the reduction in protein digestibility caused by thermal treatment is the result of protein aggregation (Wang, 2000 and Carbonaro et al., 2005). Fatty acid composition of lamb muscle is affected by phenotypic factors such as diet, age and breed (Berthelot et al., 2014, Fisher et al., 2000, Salvatori et al., 2004, Ekiz et al., 2013, Souza et al., 2013, Radunz et al., 2009 and Ponnampalam et al., 2001). The former consumed meat with higher levels of antioxidants, trace minerals and essential n-3 fatty acids but lower in n-6 and trans fatty acids (Ulijazek et al., 2013).

Nevertheless, little information exists with respect to the performance of growing animals and the chemical composition and meat fatty acid profile from sheep fed with extruded compound feed. This study aimed to evaluate the effects of providing increasing dietary levels of extruded compound feed on lamb growing dynamic and meat fatty acid concentration from lamb.

Material and Methods

The experimental was carried out with 24 Lithuanian blackhead breed lambs were assigned into 2 groups (12 lambs in each group). First one was control group, II experimental, where farm ratio was supplemented with extruded compound feed. Lambs were weighed after being born, 21st day of age, 2 months age, 3 months age, 4 months age and 6 months age, i.e. before slaughter. Weighings were performed before morning feeding. Lambs were slaughtered at 6 months of age.

Table 1. **Compound feed nutrition value**

Parameter	Control group	Experimental group
Crude protein, g	180.10	183.49
ME-ruminants, MJ	12.96	13.00
Crude fat, g	41.80	42.64
Crude fiber, g	354.70	353.16
Crude ash, g	114.70	122.06
Ca, g	8.23	9.33
P, g	3.86	4.21
Na, g	0.70	1.07

Composition of premix: vitamin A – 19.999 U, vitamin D – 500 U, vitamin E – 9.90 mg, Fe – 20.00 mg, Mn – 20.00 mg, Zn – 20.00 mg, Cu 2.00 mg, I – 0.10 mg, Se – 0.10 mg, Co – 0.10 mg.

Samples were analysed 48 hours after animal‘s slaughter, samples were taken from musculus longissimus dorsi. Before analysis samples were held in + 4°C temperature. Following meat characteristics were analysed: pH with pH meter INOLAB3, meat colour measured (L*, a*, b*) with Minolta color meter firm Chroma Meter 400 drip loss, water holding capacity was determined by the weight loss over 24 hours. it kept hanging bags with net + 4 ° C, meat cooking losses were determine weighing method of cooking meat with circulating water bath for 30 min., At 70 °C, by weighing before and after cooking (Schilling, 1966), tenderness, amount of intramuscular ash, was determined by burning lamb in 700 degrees. The dry matter content was determined drying meat to constant weight (to 105 0C), the fat content was determined by Soxhlet method, the fat extracted with chloroform to 8 hours. Protein content was determined by the Kjeldahl method (King-Brink, Sebranek, 1993);

Extraction of lipids for fatty acid analysis was performed with chloroform/methanol (2:1 v/v) as described by Folch et al. (1957). Fatty acid methyl esters (FAME) were prepared using the procedure of Christopherson and Glass (1969). The samples, according to current standards - ISO 5555: 1997 Animal and vegetable fats and oils. The sampling, prepared in accordance with ISO 661: 1997 Animal and vegetable fats and oils. Sample preparation was selected for the qualitative and quantitative analysis of fatty acids. The sample (100 ± 0,001g homogenized product) were covered with 25 ml of hexane and shaken for 5 min., And then left for 30 minutes, again vigorously. Fat was separated hexane blow away to the tube (4 ml). Fatty acids methylation to methyl esters was used in 2 mol / l KOH anhydrous methanol solution of 0,2 ml was placed in tubes containing extracts. Samples were shaken for 1 min., With (Vortex) mixer for 30 minutes. The top layer of the prepared sample were taken of 2 ml, of which the chromatography was used 2 ml. Chromatographic analysis by gas chromatograph Shimadzu GC -2010 Plus.

Data statistical analysis was performed with the R statistical package. There were signs calculate the arithmetic mean (x), their dispersion characteristics - standard deviations (SD) and coefficient of variation (CV). The estimated influence of the age difference between statistical significance (P). The difference between the average values of reliability at $P<0.05$.

Results and discussions

The nutritional characteristics of diets (such as protein, fatty acids, energy, vitamins and minerals) can influence value-adding properties of meat and consequently its quality. Studies on the role of dietary factors in the development of human diseases focus on the possibility of increasing the share of n-3 polyunsaturated fatty acids (PUFAs) in meat and thereby reducing the adverse ratio of n-6PUFAs to n-3PUFAs (n-6/n-3), which in the human diet should ideally be 4:1 (Simopoulos, 2002; Patterson et al., 2012). From the physicians and dieticians point of view, meat, as a healthy food, should contain a small amount of fat with a proper fatty acid (FA) profile, especially with regard to the ratio of omega 3 (n − 3) and omega 6 (n − 6) long chain polyunsaturated acids (LC-PUFA). Within the group of n − 3 FA the most important are α-linolenic acid (ALA; C18:3 n − 3), eicosapentaenoic acid (EPA; C20:5 n − 3) and docosahexaenoic acid (DHA; C22:6 n − 3) (Simopoulos, 2002 and Corino et al., 2014).

In lamb production, more than other species, each country or region has its own specific weight/age and type of carcass criteria, depending on the culture and the customs of the people. Many factors including breed, gender, age/body weight, fatness, depot site, environ- mental condition, diet and rearing management influence lamb fat deposition and composition. Further studied are needed to understand how animal circadian rhythms, diurnal rumination patterns and daily changes in herbage chemical composition could affect lamb fatty composition (Vasta et al., 2012). Increasing *n* − 3 PUFA in meat contributes toward improving consumer health, and would help to combat the negative image of ruminant meat (Cabiddu et al., 2010) and open up a new market to fulfill the consumer's demands.

Table 2. **Influence of extruded compound feed on lamb meat fatty acid concentration, %**

Fatty acid	Group	
	I (control group)	II (experimental)
C10:0	0.34±0.01	0.31±0.02
C12:0	0.74±0.03	0.36±0.03
C14:1 (n-9)	0.33±0.01	0.26±0.04
C14:0	5.40±0.11	4.96±0.09
C15:0	1.83±0.08	1.82±0.07
C16:1(n-7)	3.04±0.04	3.59±0.13
C16:0	21.52±0.15	20.80±0.41
C17:1	1.50±0.01	1.83±0.04
C17:0	2.01±0.04	1.77±0.01
C18:2 (n-6)	4.54±0.06	3.61±0.05
C18:1 (n-9) c	35.73±0.23	36.04±0.51
C18:1 (n-9) t	1.44±0.01	2.30±0.11
C18:0	19.94±0.31	20.50±0.18
C19:1 (n-10)	0.15±0.04	0.14±0.01
C19:0	0.28±0.01	0.24±0.01
C20:4(n-6)	0.11±0.03	0.12±0.04
C20:5(n-3)	0.29±0.02	0.29±0.07
C20:1(n-7)	0.30±0.01	0.31±0.04
n-6/n-3	15.66±0.04	12.44±0.06
C20:0	0.30±0.01	0.34±0.01
C22:0	0.21±0.02	0.40±0.01
Saturated fatty acid, %	52.57	51.47*
Monounsaturated fatty acid, %	42.49	44.47*
Polyunsaturated fatty acid, %	4.94	4.06*

*- data statistically significant at P<0.05

The data of saturated fatty acid in experimental group decreased 1.10 percent (P<0.05), monounsaturated fatty acid increased 1.98 percent (P<0.05), but polyunsaturated fatty acid decreased 0.88 percent (P<0.05) compared to control group. Extruded compound feed increased these fatty acids in lamb meat: Palmitoleic (C16:1) – 0.55 percent (P>0.05), linolenic (C18:1c) – 0.31 percent (P>0.05), stearic (C18:0) – 0.56 percent (P>0.05), compared to the control group, but decreased these fatty acids: lauric (C12:0) -0.38 percent (P>0.05), miristic (C14:0) – 0.44 percent (P>0.05), linoleic (C18:2) – 0.93 percent (P>0.05), compared to the control group. For the rest fatty acid, extruded compound feed did not had effect, data change only slightly.

Overall, final live BW and weigh gain in a pasture finishing environment are influenced by complex and interacting factors that include: plant selectivity by the animal, forage digestibility, and intake, which in turn are influenced by changes in forage mass, nutritive value, and plant secondary metabolite concentrations (Villalba & Provenza, 2009) over the grazing season.

In experimental group born lamb weight was higher, because ewes were fed with extruded compound feed and it effect on weight of lambs. The extruded compound feed din not had any statistical effect on lamb growing dynamic (Table 3). In experimental group born lamb weight increased 51 percent (P>0.05), at 20 days of age, this parameter increased by 30 percent (P>0.05), compared to the control group. After 2 months lambs weight increased 5 percent (P>0.05), after 3 months – 4 percent (P>0.05), after 4 months 6 percent (P>0.05) and at the last trial period, this parameter increased 3 percent (P>0.05) compared to the control group.

Sites of fat deposition within the carcass and fat composition are related to species and breed of animal (Wood et al., 2008). Data of influence of extruded compound feed on lamb carcass yield is presented in Table 4. Pre-slaughter weight in experimental group was 4 percent higher (P>0.05), compared to the control group. When analysed data of carcass weight, we determined that in experimental group this parameter increased 23 percent (P>0.05) compared to the control group. Carcass yield also had tendency increased 19 percent (P<0.05) compared to the control group.

Table 3. **Influence of extruded compound feed on lamb growing dynamic, kg**

Age of lamb	Group	
	I (control group)	II (experimental)
Born lamb weight	2.61±0.75	3.93±0.59
20 days	6.04±1.32	7.88±0.56
2 months	15.04±2.13	15.75±1.38
3 months	19.04±2.27	19.80±2.02
4 months	27.01±2.17	28.68±1.59
6 months	38.33±4.62	39.67±1.92

Table 4. **Influence of extruded compound feed on lamb carcass yield**

Parameter	Group	
	I (control)	II (experimental)
Pre-slaughter weight, kg	38.32±4.62	39.67±1.92
Carcass weight, kg	14.67±1.77	18.04±0.90
Carcass yield, %	38.33±2.16	45.50±1.21*

*- data statistically significant at P<0.05

Chemical composition of lamb meat is presented in Table 5. Amount of dry matter in experimental group increased 0.49 percent (P>0.05), protein – 2.11 percent (P>0.05), fat – 0.12 percent (P<0.05), ash – decreased 0.07 percent (P<0.05) compared to the control group. Other authors have not reported any effects of other protein sources on chemical lamb meat composition (Scerra et al., 2011; Lanza et al., 2011; Lestingi et al., 2015).

Table 5. **Influence of extruded compound feed on lamb meat chemical composition, %**

Parameter	Group	
	I (control)	II (experimental)
Dry matter	24.73±0.75	25.22±0.53
Protein	18.40±1.48	20.51±0.85
Fat	2.60±0.21	2.72±0.12*
Ash	1.16±0.03	1.09±0.06*

*- data statistically significant at P<0.05

During post-mortem aging, substantial improvements in meat palatability attributes such as tenderness, flavour, and/or juiciness occur likely due to a structural breakdown of muscle by endogenous proteases (Huff-Lonergan and Lonergan, 2005, Kemp et al., 2010, Kim et al., 2014 and Kristensen and Purslow, 2001). In our experiment, water holding capacity in experimental group increased 3.36 percent (P<0.05), cooking losses decreased by 4.65 percent (P>0.05), drop losses and meat hardness between groups left nearly same.

Previous research has found that optimal lamb tenderness occurs when carcase pH is 6 over the carcase temperature range 18 °C and 35 °C (Thompson et al., 2005). In our experimental (table 6) pH value in experimental group decreased 0.04 point compared with control group.

Table 6. **Influence of extruded compound feed on lamb meat technological properties**

Parameter	Group	
	I (control)	II (experimental)
Water holding capacity, %	57.41±1.38	60.77±1.11*
Cooking losses, %	27.98±0.90	23.33±1.73
Drop losses, %	3.50±0.38	3.33±0.96
pH	5.64±0.05	5.60±0.03*
Hardness, kg/cm3	1.56±0.12	1.51±0.12
Colour		
L*	43.00±1.56	40.84±0.79*
a*	15.97±0.55	14.43±1.33
b*	6.78±0.68	5.99±0.27*

A customer's first appraisal of lamb meat quality is based upon its colour, linking colour to both perceived and actual values. Colour has been the focus of numerous lamb meat studies, generally sharing an aim to achieve acceptable and resilient colour. A bright-red colour is associated with freshness (Carpenter, Cornforth, & Whittier, 2001). When analysed data of lamb meat colour (table 6), we determined that lightness (L*), in experimental group, this parameter decreased by 5 percent (P<0.05), redness (a*) – 10 percent (P>0.05), yellowness (b*) – 12 percent (P<0.05) compared to the control group.

Conclussions

So in conclusions, extruded compound feed increased productivity of lambs by 3 percent (P>0.05), carcass yield – 19 percent (P<0.05) in lamb meat. The lamb's ratio supplemented with extruded compound feed had effect on monounsaturated fatty acid, it increased by 1.98 percent (P<0.05) but decreased saturated fatty acid - 1.1 percent (P<0.05). For chemical meat composition and meat technological properties it did not had negative effect.

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Received 28 June 2016
Accepted 01 August 2016