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EFFECT OF COCONUT OIL SUPPLEMENTATION ON THE CARCASS COMPOSITION AND MUSCLE PHYSICOCHEMICAL CHARACTERISTICS IN LAMBS

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Abstract: A study was carried out with 10 male lambs of Bulgarian dairy synthetic population. The animals were divided in two groups- control and experimental as the diet of the latter was supplemented with coconut oil in amount 20g/d per animal for a period of 90 days. After finishing the experiment, complete slaughter analysis was done on the half carcasses of the animals from both groups and pH 24h, colour, water holding capacity, content of myoglobin, fat, protein, moisture and ash in *m. Longissimus dorsi* and *m. Semimembranosus* were determined. The coconut oil supplementation led to significant increase of the contents of the subcutaneous ($P<0.001$) and intermuscular fat ($P<0.05$) in the half carcass and its individual parts as well, and influenced significantly the colour of the muscles which was darker in the lambs of the experimental group. Specific deposition of fats in dependence on the location in the carcass was observed. The content of subcutaneous fat was lowest in the neck and highest in the loin, whereas that of intermuscular fat was lowest in the leg and highest in the shoulder of the lambs. Significantly higher water holding capacity ($P<0.05$) in *m. Longissimus dorsi* and myoglobin content in *m. Semimembranosus* ($P<0.01$) were observed, due to the differences in the type of the muscles.

Key words: lambs, coconut oil, carcass, muscles

Introduction

In order to achieve high productivity and intensive growth the ruminant animals need high energy diets. A way to increase the energy content of the diet is the inclusion of various fat sources. The addition of fats prevents the development of ruminal acydosis, facilitates the absorption of the fat-soluble nutrients *(Perez et al., 2002)* and increases the energy efficiency by the possibility for direct inclusion

of long chain fatty acids in the lipid synthesis *(Clinquart et al., 1995; Machmüller et al., 2000).*

Coconut oil is an alternative source of fat, rich in energy that contains about 921 g/kg saturated fatty acids, 62 g/kg monounsaturated fatty acids and 16 g/kg polyunsaturated fatty acids *(Bhatt et al., 2011).* Its addition to the diets of ruminants has in some cases a negative effect on the digestibility, due to changes in the population of the microorganisms in the rumen *(Machmüller and Kreuzer, 1999).*

The kind of fats, included in the diet has various effects on the digestion as well as on the deposition and distribution of the carcass fat *(Castro et al., 2005)* and meat quality. The aim of the present study is to determine the effect of the coconut oil supplementation on the carcass composition and physicochemical characteristics of muscles in lambs.

Materials and Methods

The study was carried out with 10 male lambs of Bulgarian dairy synthetic population, divided in control and experimental group (5 animals each). The initial live weight of the lambs from the control group was 18.04±2.6 kg, and that of the animals from the experimental group - 18.12±2.74 kg. The lambs from both groups were fed concentrate (20% maize, 30% barley, 50% soy meal and vitamin premix - 0.0013 g/ animal) and hay. The chemical composition of the diet and hay is presented in Table 1 and 2 respectively.

Table 1. Chemical analyses of the diet

	Group	
Item, %	Control	Experimental
Crude protein	23.77	25.16
Crude fiber	12.76	9.98
Fat	2.47	6.19
Non-nitrogen compounds	54.26	53.6
Ash	6.74	5.08

Table 2. Chemical analysis of the hay

Item	%
Crude protein	7.32
Crude fibers	31.98
Fats	2.05
Non-nitrogen compounds	51.49
Ash	6.65

The lambs from the experimental group received additionally coconut oil in amount 20 g/day/animal for a period of 90 days. After finishing the experiment the animals from both groups were slaughtered and complete slaughter analysis was done to the carcass halves. Two muscles - *m. Longissimus dorsi (m.LD)* and *m. Semimembranosus (m.SM)* were carefully dissected from each left half of the carcasses. Samples for physicochemical analysis were taken from both muscles and the following traits were determined: pH 24h, colour (R/525nm), water holding capacity *(Grau and Hamm, 1952),* myoglobin content *(Hornsey et al., 1956),* fat content (Soxhlet), protein content (Kjieldal), moisture and ash.

The results were statistically evaluated by two-way ANOVA using the *JMP, v.7 (2007)* software.

Results and Discussion

Carcass composition. The results of the two-way ANOVA concerning the amount of the fats deposited in the carcass (Table 3) showed significant effect of both factors-coconut oil supplementation and the location of the fats in carcass. The content of the subcutaneous and intermuscular fat was significantly higher ($P<0.001$; $P<0.05$) in the lambs from the supplemented group in both the half carcass and its individual parts.

Table 3. Tissue content in the lamb carcasses in response to coconut oil supplementation and location

	Location												Significance			
Tissue content, %	½ carcass		Leg		Loin		Shoulder		Neck		Abdomen		Coconut oil supplement	Location	Interaction	SE
	Treatment															
	C[a]	CO[b]	C	CO	C	CO	C	CO	C	CO	C	CO				
Meat	60.84	59.64	66	66.36	63.14	58.98	58.48	56.59	55.41	57.44	56.7	53.72	NS	NS	NS	4.91
Bones	29.35	26.47	25.53	23.6	25.63	24.47	30.59	26.47	40.15	34.93	31.14	31.26	NS	NS	NS	5.4
Intermuscular fat	4.99	6.21	2.82	3.00	3.58	5.74	7.76	9.15	2.20	4.53	5.79	6.98	*	***	NS	2.31
Subcutaneous fat	4.82	7.68	5.64	7.03	7.64	10.80	3.17	7.78	2.23	3.09	6.37	8.04	***	**	NS	2.94

[a] Control group
[b] Experimental group supplemented coconut oil
* P<0.05; ** P<0.01; *** P<0.001

We observed specific deposition of the adipose tissue in dependence on the location in the carcass for both subcutaneous ($P<0.01$) and intermuscular fat

(P<0.001). The content of subcutaneous fat was lowest in the neck and highest in the loin. The lowest intermuscular fat content was determined in the leg whereas the highest was in the shoulder.

The results obtained correspond with the tendencies that we observed *(Popova et al., 2011)* for higher thickness of the subcutaneous fat, measured in different anatomical locations in lambs that received coconut oil supplemented diet, rich in saturated fatty acids. Similar effect of the saturated fatty acids but palm oil was reported by *Solomon et al. (1992)* and *Lough et al. (1994)* in lambs. Results from experiments of others *(Bhatt et al., 2011; Dutta et al., 2008; Castro et al., 2005)* show no effect of the saturated fatty acids from coconut oil on the fat deposition in the carcass. *Marinova et al. (2005)* report increased subcutaneous fat in the leg, thorax and shoulder and decreased in the loin when feeding kids with fish oil supplemented diet.

Influence of the location on the subcutaneous and intermuscular fat deposition in lambs was reported by *Ignatova et al. (2005).* Contrary to our results these authors observe minimal changes in the fat deposition in the leg and shoulder, but more pronounced in the abdomen and loin where there was higher content of intermuscular fat.

No significant difference was observed in the percentage of the meat and bones due to the coconut oil supplementation. We must notice that the changes in these parameters are mainly associated to the intensity of growth and the age of the animals *(Huidobro and Caneque, 1994).*

Physicochemical characteristics of the muscles. The values of pH, measured 24 h *post mortem* (Table 4) were not influenced by the inclusion of the coconut oil in the diet and remained close in both muscles, showing normal development of glycolysis *post mortem*.

The coconut oil supplementation led to significant differences (P<0.05) in the colour, which was darker in the two studied muscles.

No significant influence of the coconut oil was observed on the water-holding capacity, which is in accordance with the results reported by *Bhatt et al. (2011).* Its values differed significantly (P<0.05) between the muscles, as they were higher in *m. Longissimus dorsi,* compared to *m. Semimembranosus*. The water-holding capacity is mainly influenced by the values of pH. In the present study we could not find dependence between these two parameters. In the literature there exists diverse data for the availability of such dependence in sheep, compared to pigs (*Marinova, 2000*).

Differences depending on the metabolic type of the muscles were observed in the myoglobin content. Its values were higher in *m. Semimembranosus,* compared to *m. Longissimus dorsi*, in both control and supplemented group. This is a result of the function of the muscles as the former is of more pronounced oxidative-glycolytic type.

Table 4. Physicochemical characteristics of *m. Longissimus dorsi* and *m. Semimembranosus* in lambs in response to coconut oil supplementation and muscle

	Muscle				Significance			
Items	*m.LD*		*m.SM*					SE
	Coconut oil supplement				Coconut oil supplement	Muscle	Interaction	
	C[a]	CO[b]	C	CO				
pH 24h	5.52	5.52	5.53	5.45	NS	NS	NS	0.11
Colour (R/525nm)	32.48	31.41	31.69	30.93	*	NS	NS	0.77
Waterholding capacity, %	35.46	35.58	34.6	34.36	NS	*	NS	1.51
Moisture, %	76.07	75.71	76.54	75.71	NS	NS	NS	0.86
Myoglobin, mg/g	2.78	2.95	3.13	3.56	NS	**	NS	0.35
Fats, %	3.38	2.97	2.5	2.45	NS	NS	NS	0.89
Protein, %	19.63	19.94	19.95	19.64	NS	NS	NS	0.49
Ash, %	1.03	1.06	1.06	1.04	NS	NS	NS	0.04

[a] Control group
[b] Experimental group supplemented coconut oil
*P<0.05; ** P<0.01

The content of intramuscular fat is an important factor associated with the sensory and healthy parameters of meat. In this study we did not observe significant difference in the fat content in the muscles due to coconut oil. This is agreement with the results of *Bhatt et al. (2011),* who do not find significant difference in the intramuscular fat content in lambs fed diets with different percentage of coconut oil. *Solomon et al. (1992)* reported no effect of palm oil on the fat content in lambs.

The content of protein, as well as the moisture and the ash in the muscles did not change in response to coconut oil supplementation. Similar results are reported by *Manso et al. (2009)*, in lambs fed diet supplemented with palm oil.

Conclusion

The coconut oil supplementation led to significant increase of the content of the subcutaneous (P<0.001) and intermuscular (P<0.05) fats in the half carcass as well as in its individual parts and influenced significantly the colour of *m. Longissimus dorsi* and *m. Semimembranosus* which was darker in the supplemented group.

Specific deposition of fat in dependence on the location in the carcass was observed. The content of subcutaneous fat was lowest in the neck and highest in the loin, whereas that of intermuscular fat was lowest in the leg and highest in the shoulder of the lambs

The water holding capacity in *m. Longissimus dorsi* and the myoglobin content in *m. Semimembranosus* were significantly higher ($P<0.05$; $P<0.01$) due to the differences in the type of muscle.

Uticaj dodavanja kokosovog ulja na sastav trupa i fizičko-hemijske osobine mišića jagnjadi

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Rezime

Studija je sprovedena na 10 muških jagnjadi bugarske mlečne sintetičke populacije. Životinje su bile podeljene u dve grupe-kontrolnu i eksperimentalnu , u ishranu je kasnije dodato kokosovo ulje u količini od 20 g/dan po životinji za period od 90 dana. Po završetku ogleda, kompletnom analizom nakon klanja na polutkama iz obe grupe životinja utvrđeni su pH 24h, boja, sposobnost vezivanja vode, sadržaj mioglobina, masti, proteina, vlage i pepela u m. Longissimus dorsi i m. Semimembranosussu. Dodavanje kokosovog ulja je dovelo do značajnog povećanja sadržaja potkožnih ($P <0,001$) i intermuskularnih masti ($P<0.05$) u polutkama i njihovim pojedinim delovima, kao i do tamnije boje mišića kod eksperimentalne grupe jagnjadi. Specifično taloženje masti je primećeno u zavisnosti od lokacije u polutkama. Sadržaj potkožne masti je bio najniži u vratu a najveći na slabinama, a intermuskularne masti najniži u nogama i najveći u ramenom pojasu jagnjadi. Značajno veća sposobnost vezivanja vode ($P<0,05$) u M.Longissimus dorsi i sadržaj mioglobina u M. Semimembranosus ($P <0,01$) su utvrđene, zbog razlike u vrsti mišića.

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