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Effect of Feeding Systems on Meat Goat CLA

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***Abstract*—**The objective of this study was to investigate the effect of tropical forage source and feeding system on fatty acid composition and antioxidant activity in meat goats. Twenty male crossbred goats (Boer x Saanen), were included in the current study and the study design was assigned to be a 2 x 3 factorial in completely randomized design. All goats were slaughtered after 120 days of experimental period. Dietary tropical roughage sources were grass (Mulata II) and legume (Verano stylo). Both types of roughage were offered to the experimental meat goat as 3 feeding regimes; cut-and-carry, silage and grazing. All goats were fed basal concentrate diet at 1.5% of body weight, and they were fed *ad libitum* the roughages. Chemical composition, fatty acid profile and antioxidation activity of dietary treatments in all feeding system and *longissimus dorsi* (LD) muscles in all groups were quantified. The results have shown that the fat content in both types of studied roughage sources ranged from about 2.0% to 4.0% of DM and the fatty acid composition of those was mainly C16:0, C18:2n6 and C18:3n3, with less proportion for C18:1n9. The free-radical scavenging activity of the Mulato II was lower than that of the Verano stylo. The free-radical scavenging activity of the Mulato II was lower than that of the Verano stylo. For LD muscle, the fatty acid composition was mainly C16:0, C18:0 and C18:1n9, with less proportion for C18:2n6. The LD muscle of the goats fed with Mulato II and the Verano stylo by grazing had highest free-radical scavenging activity, compared to those fed with cut-and-carry and silage regime, although there were rather high unsaturated fatty acids in LD muscle. Thus, feeding the meat goats with the Mulato II and Verano stylo by grazing would be beneficial effect for consumers to intake high unsaturated fatty acids and lower risk for oxidation from goat meat.

***Keywords*—**Feeding system, goat, CLA, meat.

I. Introduction

THE consumers currently pay attention for healthy food. The contents of unsaturated fatty acids in meat are important composition for consumer's health [1]. However, increasing unsaturated fatty acids in meat will elevate the risk of oxidation, producing free radicals in meat. Free-radicals are involved in the oxidation of lipids that is a primary cause of rancidity development and shelf-life reduction in many kinds of food [2]. Therefore, due to potential heal risks of synthetic antioxidants. There are an increasing demand and a great interest for natural antioxidants. In recent years, a great number of animal- and plant- derived proteins and their hydrolysates have been found to possess significant free radical-scavenging capability and antioxidant activity [3], [4]. In this study, we have studied the effect of species of tropical forage and feeding regime on chemical & fatty acid composition and free radical-scavenging activity of feeds and muscle of goats.

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II. Materials and Methods

A. Animals and Diets

Twenty male goats, crossbred Boer x Saanen, with BW 10 kg. Dietary treatments were Mulata II grass offered by cut-and-carry, silage & grazing and Verano stylo offered by cut-and-carry, silage & grazing, they were fed *ad libitum*. The animals were fed basal concentrate diet at 1.5% of body weight. Period length was 120 days.

B. Chemical Analysis

One subsample was analyzed for DM, CP, EE and Ash concentration as described by AOAC [5]. The fatty acid composition of the intramuscular fat in longissimus dorsi (LD) muscle was analyzed after extraction and methylation by the procedure described by Metcalfe [6]. Fatty acid methyl esters (FAME) were analyzed by Gas Chromatography (GC).

C. DPPH Assay

Briefly, the antioxidant activity of the extracts, on the basis of the scavenging activity of the stable 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical, was determined by method described by Braca et al. [7], [8]. Aqueous extract (0.1 ml) was added to 3ml of a 0.001 M DPPH in methanol. After a 30 min incubation period at room temperature the absorbance was read against a blank at 517nm. Inhibition free radical DPPH in percent (I%) was calculated in following way:

$$I\% = (Ablank - Asample)/Ablank) \times 100$$

where Ablank is the absorbance of the blank solution and Asample is the absorbance of the test compound.

D. Statistical Analysis

Data was statistically analyzed according to 2 × 3 factorial in complete randomized design (CRD) using the PROC GLM procedure by SAS program. Significant differences among treatments were determined using Duncan's News Multiple Range test.

III. Results and Discussion

Results of chemical composition are given in Table I. The EE content of Mulato II grass had higher (P≤0.001) than Verano stylo, while the average NDF content were slightly different between Mulato II grass and Verano stylo. The species and feeding regime had no significant (P>0.05) effect on the CP and ADF content in the experimental diet. Verano stylo had higher content of C16:0 (except for silage) (P≤0.01) and C18:1n9 (P≤0.001), while Mulato II grass had higher composition of C18:3n3. There was no difference for the content of C182n6 for both studied species and all feeding regimes. The Mulato II grass silage had high content of C16:0 and C18:2n6 while C18:3n3 was high in fresh Mulato II grass (cut-and-carry & grazing). The Verano stylo silage had high C18:2n6 and C18:3n3 composition, whereas C18:1n9 was high for Verano stylo offered as cut-and-carry feeding. In addition, the percentage of inhibition free-radical DPPH (I%) of Verano stylo was higher (P≤0.001) than that of Mulato II grass. The Mulato II grass silage had higher (P≤0.01) I% than fresh Mulato II grass (cut-and-carry & grazing), however, the values of I% among feeding regime in Verano stylo were similar (P>0.05). On overview, the CP content of the Mulato II grass and Verano stylo was similar for all feeding regime, but Mulato II grass had high content of fat than the Verano stylo. For fatty acid composition, the main fatty acid content in both sources of forage was C16:0, C18:2n6 and C18:3n3, with less proportion for C18:1n9. The free-radical scavenging activity of the Mulato II grass was lower than that of the Verano stylo. The Mulato II silage had the highest free-radical scavenging activity when compared with the Mulato II offered with other two feeding regimes. These free-radical scavenging activities might be related to unsaturated fatty acid contents in diet.

TABLE I
The Chemical Composition (% On DM), Fatty Acid Profile (G/100 G Total Fat) and the Percentage of Inhibition Free-Radical DPPH (I%) of the Experimental Diets

Items	Mulato II grass						Verano stylo					
	Cut -and-carry		Silage		Grazing		Cut -and-carry		Silage		Grazing	
Chemical composition												
CP	10.1	A	9.61	A	8.71	A	10.42	A	8.27	A	7.77	A
EE	3.83	A	4.03	A	3.84	A	2.30	B	3.00	AB	2.29	B
NDF	65.9	A	62.1	AB	67.72	A	62.75	AB	55.84	B	64.94	A
ADF	36.0	A	36.9	A	32.69	A	31.88	A	36.28	A	32.63	A
Fatty acids compositions												
C16:0	18.2	C	30.30	A	16.32	C	24.75	B	26.76	B	27.42	AB
C16:1	0.71	C	0.76	C	1.00	BC	1.21	AB	1.41	A	1.22	AB
C18:0	0.63	AB	0.44	BC	0.88	A	0.57	AB	0.17	C	0.76	AB
C18:1n9	3.45	C	3.63	C	3.91	C	10.33	A	6.33	B	7.51	B
C18:2n6	20.1	B	26.40	A	18.06	B	26.12	A	19.30	B	23.37	A
C18:3n3	51.6	A	30.46	C	51.21	A	28.86	C	38.84	B	24.57	C
I%	42.5	C	52.53	B	45.82	C	59.21	A	61.61	A	60.97	A

[A, B, C] Means followed by a different letter within the same column are significant different (P< 0.05), ns: not significant different (P>0.05), *P < 0.05; **P < 0.01; ***P < 0.001., SEM: standard error of mean, S = species, Reg = Feeding regime

From the Table II, the CP content in LD muscle of goats fed on Molato II grass seems to be better than those fed on Verano stylo, while species and feeding regime had no significant (P>0.05) effect on dry matter, EE and Ash content. For the fatty acid profile, the concentration of C16:1, C18:2n6, C18:3n6, C20:3n6 and C20:4n6 in LD muscle of goats were detected significant effect of forage species (p≤0.05, p≤0.01, p≤0.001) and feeding regime (p≤0.05, p≤0.01, p≤0.001) effect for C16:1, C18:1n9, C18:2n6, C18:3n6, C20:3n3, C20:3n6 and C20:4n6. For fatty acid classification, forage species had no significant (P>0.05) on saturated fatty acid (SFA), mono-unsaturated fatty acid (MUFA) and poly-unsaturated fatty acid (PUFA), while feeding regime had significant (P≤0.05 and P≤0.01) on MUFA and PUFA. Values of I% were not significantly different between the studied forage species, but were highly significant (P≤0.001) for feeding regime. The concentration of inhibit free-radical DPPH was highest (P≤0.001) in LD muscle from grazing system both species (Mulato II grass and Verano styo). There were inconsistent results of fatty acid composition in LD muscle of goats fed with different forage species and feeding regimes. Obviously, feeding the goats with silage form of Mulato II grass and Verano stylo resulted in lower content of MUFA and PUFA. Bio-hydrogenation in rumen of goat would be an explanation for the inconsistent fatty acid profile. The LD muscle of the goats fed with Mulato II and the Verano stylo by grazing had highest free-radical scavenging activity, compared to those fed with cut-and-carry and silage regime, although there were rather high unsaturated fatty acids in LD muscle. These might be the results of antioxidants in fresh Mulato II grass and Verano stylo. Thus, feeding the meat goats with the Mulato II and Verano stylo by grazing would be beneficial effect for consumers to intake high unsaturated fatty acids and lower risk for oxidation from goat meat.

TABLE II
CHEMICAL COMPOSITION, FATTY ACID PROFILE (G/100 G TOTAL FAT) TABLE II- CHEMICAL COMPOSITION, FATTY ACID PROFILE (G/100 G TOTAL FAT) AND THE PERCENTAGE OF INHIBITION FREE-RADICAL DPPH (I%) IN LONGISSIMUS DORSI (LD) MUSCLE

Items	Mulato II grass						Verano stylo					
	Cut-and-carry		Silage		Grazing		Cut-and-carry		Silage		Grazing	
Chemical compositions												
Moisture	75.16	A	72.00	A	74.43	A	74.38	A	73.27	A	73.36	A
CP	22.28	A	20.98	AB	20.28	B	19.57	B	19.32	B	19.19	B
EE	1.72	A	1.16	A	1.98	A	1.89	A	1.19	A	2.04	A
Ash	1.13	A	1.09	A	1.14	A	1.04	A	1.01	A	1.09	A
Fatty acids profile												
C16:0	23.79	A	23.6	A	20.31	A	19.29	A	24.86	A	21.18	A
C16:1	0.37	C	1.29	B	0.26	C	1.25	B	0.53	C	1.75	A
C18:0	24.84	AB	19.97	AB	22.4	AB	16.27	B	27.89	A	21.44	AB
C18:1n9	35.73	A	19.28	B	38.18	A	33.85	A	29.69	A	34.34	A
C18:2n6	6.51	B	9.43	A	4.45	BC	6.48	B	3.97	C	5.72	BC
C18:3n6	0.03	C	0.23	BC	0.03	C	1.08	A	0.33	B	1.07	A
C20:3n3	0.13	B	0.57	A	0.13	B	0.10	B	0.20	B	0.19	B
C20:3n6	0.36	C	0.05	BC	0.80	B	1.25	A	0.33	C	1.55	A
C20:4n6	1.64	CD	1.21	D	2.70	BC	4.48	A	0.74	D	3.69	AB
SFA	48.63	AB	41.79	AB	42.70	AB	37.29	B	55.55	A	39.79	B
MUFA	36.10	A	23.36	B	38.44	A	34.37	A	30.93	AB	35.15	A
PUFA	11.58	AB	9.58	AB	8.12	CB	13.29	A	5.36	C	12.23	A
I%	20.02	B	15.83	B	26.19	A	18.43	B	20.49	B	26.56	A

[A, B, C, D] Means followed by a different letter within the same column are significant different (P< 0.05), ns: not significant different (P>0.05), *P < 0.05; **P < 0.01; ***P < 0.001., SEM: standard error of mean, S = species, Reg = Feeding regime

There are many methods of feeding goats. Feeds should be offered in such a way to minimize mold growth or fecal contamination that reduces intake. Mineral mixes must remain dry and should be replenished at two-week intervals to avoid caking. Feed troughs should be designed to facilitate removal of feces and leftover feed. Troughs generally require a bar running above the length of the trough to keep goats from defecating in them [9].

IV. CONCLUSION

The results of this study indicated that, LD muscle of the goats fed with fresh Mulato II and Verano stylo (cut-and-carry & grazing) had highest unsaturated fatty acid and high for inhibition free-radical scavenging activity, compared with silage. Thus, feeding the meat goats with the Mulato II and Verano stylo by grazing would be beneficial effect for consumers to intake high unsaturated fatty acids and lower risk for oxidation from goat meat.

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REFERENCES

[1] Devendra C, Potential of sheep and goats in the less developed countries. *J Anim Sci*, 51 (1980) 461-473.
[2] Zhang M, Mu T H, Wang Y B & Sun M J, Evaluation of free radical-scavenging activities of sweet potato protein and its hydrolysates as affected by single and combination of enzyme systems. International, *J Food Sci and Technol*, 47(2012) 696-702.
[3] Kudo K, Onodera S, Takeda Y, Benkrblia N & Shiomi N, Antioxdative activity of some peptide isolated from hydrolyzed potato protein extract, *J Functional Food*, 1 (2009) 170-176.
[4] Yang B, Yang H, Li J, Li Z & Jiang Y, Amino acid composition, molecular weight distribution and antioxidant activity of protein hydrolysates of soy sauce lees, *Food Chemistry*, 124(2011) 551-555.
[5] AOAC, Official methods of analysis association of official chemists. Washington, D.C. 1990.
[6] Metcalfe L D, Schmitz A A & Pelka J R, *Anal Chem*, 38 (1966) 514.
[7] Braca A, Tommasi D, Nunziatina, Bari, Lorenzo, Di, Pizza, Cosimo, Politi, Meteo, Morelli and Ivano,. Antioxidant priciples from Bauhinai terapotensis. *J Natural Products*, 64 (2001) 892-895.
[8] Gulluce M, Sahin F, Sokmen M, Ozer H, Daferera D & Sokmen A, Antimicrobial and antioxidant properties of the essential oils and methanol extraction from *Mentha longifolia* L., *Ssp*. *Longifolia*, *Food chemistry*, 103 (2007) 1449-1456.
[9] Hart S, Meat Goat Nutrition. In: Proc. 23rd Ann. Goat Field Day, Langston University, Langston, OK. (2008) 58-53.