EFFECTS OF GRAZING SYSTEMS ON FAT DEPOSITION AND FATTY ACID COMPOSITION OF BODY ADIPOSE TISSUE OF TAN LAMB

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Abstract – This study has been conducted to investigate the effects of different grazing systems on body fat deposition and the fatty acid composition of body fat of Tan lamb. Thirty 3-month-old male Tan lambs (no significant differences in body weight) were divided into 5 groups (A, B, C, D, E) randomly and evenly. They had different grazing time (12h, 8h, 4h, 2h, and 0h) per day and they had different opportunities to take supplementary feedings. After 4 months, all the lambs were slaughtered. Each part of the body fat (subcutaneous fat, abdominal fat, tail fat and kidney fat) was weighed and sampled to analyze the fatty acid composition. The results show that percentage of each part fat to the whole body fat does not present differences significantly but the absolute weight of the same part varied obviously among the groups. The ratios of main fatty acids like LCFA, SFA, MUFA, PUFA, omega-3 and omega-6 show few distinctions among the groups. However, pronounced differences do exist in the fatty acid composition between tail fat and the other parts. Summarily, grazing systems have obvious effects on the fat deposition and but little on fatty acid composition. Locations of fat can change the fatty acid composition obviously.

Key Words – Body fat, Fatty acid profile, Grazing time

I. INTRODUCTION

There is a wide range of sheep farming systems from extensive, based on natural grasslands to very intensive ones, based on natural grazing and supplementary feeding. And the systems which are under comparison are those based mainly on pasture and the indoor ones [1]. Both meat quality [2] and carcass quality [3] vary a lot since lambs follow the two opposite systems. And the feeding systems can affect the deposition of body fat. Lambs housed indoor have more kidney and subcutaneous fat than those grazed on a permanent pasture. While the grazing lambs can get greater percentages of mesenteric and pelvic fat compared to the indoor ones [3]. Many other reports point that the systems can change the fatty acids of intramuscular fat [4, 5, and 6] and the body fat [7, 8] of lambs. However, few papers about the effects of grazing time or grazing systems on fat deposition and fatty acid composition of body fat can be read. The present study was conducted to investigate the influences of grazing systems on the various adipose depots and their fatty acid profiles.

II. MATERIALS AND METHODS

Thirty 3-month-old male Tan lambs (no significant differences in body weight) were divided into 5 groups (A, B, C, D, E) randomly and evenly. Lambs in group A were grazing for 12h per day on a 13-hectare grassland without supplementary feeding throughout the experiment. Lambs in group B were grazing for 8h on a 13-hectare grassland with a 150g-concentrate supplement per day in the former two months and 300g-concentrate supplement per day in the later two months. While the grazing time of group C was for 4h per day, and the concentrate supplement was 150g (the former two months) and 300g (the latter two months). Meanwhile, these three indexes in group D were 2h, 300g and 500g. The four grasslands were linked together and the vegetation on them was similar. Lambs in group E were the control. In this group, all lambs had the same opportunity to the concentrate supplement as group D, and they could take caravans microphylla freely. Besides, 150g (the former two months) and 300g (the latter two months) alfalfa per day was added to the feed of group E. After 4 months, all the lambs were slaughtered and every part body fat were rapidly collected. Then, each part of the body fat (subcutaneous fat, abdominal fat, tail fat and kidney fat) was weighed and all the samples were quickly frozen in liquid nitrogen and then stored at -70 ºC for further analysis. The fatty acid composition was analyzed in Ministry of Agriculture Feed Safety and Bio-availability Evaluation Center (Beijing) by gas chromatography.

All the data were analyzed with SAS (SAS version 8e; SAS Institute, Cary. NC, USA). Fatty acid composition was analyzed using a two-way ANOVA model and a one-way ANOVA model was used to compare the deposition of fat. Then, Duncan's multiple comparison was used to detect statistical differences among different groups. Data were showed as the mean ±SEM. P<0.05 was regarded as the statistical significance.

III. RESULTS AND DISCUSSION

Table 1 main body fat content (g) and ratios of fat depots out of the sum body fat content of Tan lambs reared under five grazing systems

	Treatment					P value
	A	B	C	D	E	
Subcutaneous fat(g)	311.5±20.08^{c}	513.8±53.06^{b}	377.3±33.54^{c}	652.8±50.76^{a}	523.3±31.21^{b}	<.0001
Abdominal fat(g)	55.8±7.90	92.5±7.09	70.8±14.39	87.3±10.82	86.8±11.90	0.13
Tail fat(g)	478.5±63.40^{c}	558.0±41.10^{bc}	590.7±65.03^{bc}	836.0±56.00^{a}	696.0±85.95^{ab}	0.0059
Perirenal fat(g)	39.0±4.75^{b}	96.3±9.14^{a}	78.0±7.34^{a}	97.3±11.30^{a}	86.3±5.38^{a}	0.0001
Heart fat(g)	10.83±0.91^{b}	18.0±2.18^{a}	10.3±0.42^{b}	15.7±1.08^{a}	17.2±2.51^{a}	0.0048
RSF	0.35±0.01	0.40±0.03	0.34±0.02	0.38±0.01	0.38±0.02	0.2641
RAF	0.06±0.01	0.07±0.00	0.06±0.01	0.05±0.01	0.06±0.01	0.4099
RPF	0.04±0.00^{b}	0.07±0.01^{a}	0.07±0.01^{a}	0.06±0.01^{a}	0.06±0.01^{a}	0.013
RHF	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.05
RTF	0.53±0.02	0.44±0.04	0.52±0.02	0.50±0.01	0.49±0.03	0.1662

Abbreviations: RSF: Ratio of Subcutaneous fat; RAF: Ratio of abdominal fat; RPF: Ratio of Perirenal fat; RHF: Ratio of Heart fat; RTF: Ratio of Tail fat.
Different superscripts mean significant differences (P < 0.05).

The results (Table 1) showed that the absolute weight of the same part varied obviously among the groups though the percentage of every main part fat to the whole body fat did not present differences significantly. Overall, lambs in group B, D and E get more fat depots though B and D are groups grazed. It can be referred by contrasting group A and B that concentrate supplement can improve the fat deposition of grazing lambs hugely. The results were in agreement with Aurousseau [9, 10]. For individuals, subcutaneous fat can reach 37% of the body fat, and abdominal fat and kidney fat is 7% and 6% respectively, while tail fat is 50% in the whole body fat.

Table 2 Effects of treatment and position on sums of fatty acids of similar types of Tan lambs.

	Treatment					Average value	P value
	A	B	C	D	E		
ΣLCFA							Treatment :0.0456 fat depot: <.0001 Treatment × fat depot:0.34
subcutaneous fat	0.9952±0.0003	0.9958± 0.0002	0.9956±0.0005	0.9947± 0.001	0.9950±0.0005	0.9953^{bc}	
abdominal fat	0.9961±0.0004	0.9961± 0.0003	0.9956±0.0002	0.9955± 0.0005	0.9956±0.0003	0.9958^{b}	
kidney fat	0.9970±0.0001	0.9974± 0.0000	0.9968±0.0004	0.9961± 0.0002	0.9961±0.0006	0.9967^{a}	
tail fat	0.9936±0.001	0.9958± 0.0005	0.9937±0.001	0.9940± 0.0008	0.9958±0.0004	0.9947^{c}	
Average value	0.9954^{ab}	0.9962^{a}	0.9956^{ab}	0.9951^{b}	0.9956^{ab}		
ΣSFA							Treatment

subcutaneous fat	0.5577±0.013	0.5854±0.021	0.6448±0.031	0.5756±0.008	0.5595±0.013	0.5846^{b}	:0.4591 fat depot:
abdominal fat	0.6591±0.032	0.6321±0.026	0.6214±0.016	0.6723±0.023	0.6367±0.009	0.6443^{a}	<.0001 Treatment
kidney fat	0.6194±0.012	0.6504±0.006	0.6152±0.017	0.6418±0.016	0.6188±0.013	0.6295^{a}	× fat depot:
tail fat	0.4246±0.064	0.4933±0.015	0.4626±0.061	0.4944±0.023	0.4961±0.021	0.4743^{c}	0.2619
Average value	0.5652	0.5903	0.5972	0.6005	0.5760		
Σ MUFA							
subcutaneous fat	0.3909±0.017	0.3722±0.028	0.3030±0.037	0.3861±0.008	0.4015±0.015	0.3707^{b}	Treatment :0.0499
abdominal fat	0.2748±0.034	0.2783±0.029	0.3017±0.032	0.2658±0.032	0.3099±0.009	0.2861^{d}	fat depot: <.0001
kidney fat	0.3238±0.013	0.2939±0.006	0.3368±0.015	0.3130±0.016	0.3352±0.014	0.3200^{c}	Treatment × fat
tail fat	0.3208±0.032	0.4512±0.014	0.3871±0.030	0.4520±0.022	0.4462±0.017	0.4118^{a}	depot: 0.0042
Average value	0.3276^{b}	0.3489^{ab}	0.3271^{b}	0.3500^{ab}	0.3748^{a}		
Σ PUFA							Treatment
subcutaneous fat	0.0514±0.007	0.0422±0.008	0.0522±0.008	0.0383±0.006	0.0390±0.005	0.0446^{b}	:0.0082 fat depot:
abdominal fat	0.066±0.003	0.0896±0.022	0.0769±0.021	0.0619±0.017	0.0534±0.004	0.0696^{b}	0.0003 Treatment
kidney fat	0.0568±0.003	0.0557±0.002	0.048±0.002	0.0452±0.001	0.0459±0.002	0.0505^{b}	× fat depot:
tail fat	0.2546±0.088	0.0555±0.003	0.1503±0.091	0.0535±0.004	0.0576±0.006	0.1139^{a}	0.0027
Average value	0.1072^{a}	0.0608^{b}	0.0756^{ab}	0.0496^{b}	0.0491^{b}		
Σ omega-3							Treatment
subcutaneous fat	0.0050±0.001	0.0033±0.002	0.0029±0.001	0.0022±0.001	0.0020±0.000	0.0031^{c}	: <.0001 fat depot:
abdominal fat	0.0131±0.001	0.0124±0.001	0.0099±0.001	0.0065±0.000	0.0037±0.000	0.0091^{a}	<.0001 Treatment
kidney fat	0.0113±0.000	0.0097±0.000	0.0070±0.000	0.0452±0.001	0.0029±0.000	0.0073^{b}	× fat depot:
tail fat	0.030±0.000	0.0036±0.000	0.0034±0.000	0.0050±0.000	0.0041±0.000	0.0034^{c}	<.0001
Average value	0.0081^{a}	0.0072^{ab}	0.0060^{b}	0.0042^{c}	0.0032^{c}		
Σ omega-6							Treatment
subcutaneous fat	0.0441±0.006	0.0371±0.007	0.0471±0.008	0.0351±0.005	0.0346±0.006	0.0396^{b}	: 0.0082 fat depot:
abdominal fat	0.0435±0.002	0.0443±0.002	0.0353±0.007	0.0320±0.005	0.0448±0.002	0.040^{b}	0.0002 Treatment
kidney fat	0.0387±0.002	0.0397±0.001	0.0348±0.001	0.0342±0.001	0.0389±0.002	0.0372^{b}	× fat depot:
tail fat	0.2465±0.091	0.0429±0.002	0.1391±0.094	0.0404±0.003	0.0437±0.005	0.102^{a}	0.001
Average value	0.0932^{a}	0.0410^{b}	0.0573^{b}	0.0352^{b}	0.0406^{b}		

Abbreviations: LCFA: long-chain fatty acid (C>12); SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acids;
Different superscripts mean significant differences ($P < 0.05$).

Similarly to the fat deposition, the ratios of main fatty acids like LCFA, SFA, MUFA, PUFA, omega-3 and omega-6 of the whole fatty acids in the same part show few distinctions on absolute values which are similar with Velasco's research [7] among the groups (Table 2). However, pronounced differences do exist in the fatty acid composition between each part especially in tail fat. The percentage of SFA of tail fat is 47% which is not good for diet of humans [11], while it shows 58%, 64% and 62%, respectively in the other three parts (subcutaneous fat, abdominal fat and kidney fat). And the ratios of MUFA and PUFA of these four parts (tail fat, subcutaneous fat, abdominal fat and kidney fat) are 41%, 37%, 29%, 32% and 11.4%, 4.5%, 7.0%, 5.1%, respectively. Both MUFA and PUFA are believed helpful to humans [11]. The other parameters of tail fat are just like the other parts or have no lightspots.

IV. CONCLUSION

The present results show that grazing systems have obvious effects on the fat deposition and but little on fatty acid composition. Locations of fat can change the fatty acid composition obviously. Thus, the results of this study suggest an attractive implication to study the development and utilization of tail fat.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support of the projects of China Agricultural Ministry (200903060 and CARS-39).

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