Effect of weight of slaughter and feeding regimen on conjugated linoleic acid and *trans* fatty acid content in lamb meat: a meta-analysis approach

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ABSTRACT - A meta-analysis approach was used in order to synthesize findings of six trials comparing 177 individual data of CLA, vaccenic acid (VA) and total *trans* fatty acids (TFA) of lamb's meat: "slaughter weight" (0-14kg, 14-18kg, 18-24kg and >24kg), "muscle" (*longissimus dorsi,* and other muscles); "feeding regimen": milk (pre-weaned animals fed maternal milk); pasture (weaned grazing animals) and "confined" (weaned animals reared indoor and fed hay and concentrate). The fixed effects included in the model. Results showed that the meat from lambs slaughtered at 14-18kg and from grazing animals maximized the content of CLA and VA and minimized the content of others TFA.

Key words: Meta-analysis, Lamb, Meat, CLA.

Introduction - In the past years many studies have been carried out to find effective strategies to improve the nutritional characteristics of lamb meat. In particular breed, sex, age/weight of slaughter, muscle, feeding regimen were tested in order to evaluate the effect on the content of conjugated linoleic acid (CLA) in intramuscular fat (Secchiari *et al.*, 2001; Priolo *et al.*, 2003; Santos-Silva *et al.*, 2003; Demirel *et al.*, 2004; Diaz *et al.*, 2005; Maranesi *et al.*, 2005; Valvo *et al.*, 2005; Lanza *et al.*, 2006; Serra *et al.*, 2009). In many cases the strategies able to increase CLA content in meat determined a contemporaneous increase of *trans* fatty acids (TFA), a fatty acid class with recognized unhealthy properties (Crupkin and Zambelli, 2008). On the other hand the dangerous effect on human health of TFA does not include vaccenic acid (VA), the main TFA contained in food from ruminants. VA seems to have positive properties being the principal precursor of CLA tissues synthesis (Taniguchi *et al.*, 2004; Kuhnt *et al.*, 2007). Actually the researches on CLA and TFA show a marked variation in response to the same variation effect and findings are many times not unique and, some times, contradictories due to confounding action of the trial effect. In our study a meta-analysis approach is used in order to synthesize findings of some trials in which was tested the effect of weight of slaughter, muscle and feeding regimen on CLA and VA content of meat from lambs.

Material and methods - One hundred seventy seven individual data of CLA, VA and total TFA content of lamb meat, analyzed in the same laboratory by means of gas-chromatograph apparatus, were from six trials, two of which are published (Morbidini *et al.*, 2007; Serra *et al.*, 2009). Three variation factors were selected: "weight of slaughter" (0-14 kg, 14-18 kg, 18-24 kg and >24 kg), "muscle" (*longissimus dorsi,* LD and other muscles as *semimembranosus* and *triceps brachii*) and "feeding regimen":

milk (pre-weaned animals fed maternal milk), pasture (weaned grazing animals), confined (weaned animals reared indoor and fed hay and concentrate). Data are analyzed by using the following mixed linear model:

$$Y_{ijkn} = \mu + W_i + M_j + R_k + S_n + \varepsilon_{ijkn}$$

where Y = dependent variable (CLA, VA, others TFA, VA/total TFA); W_i fixed effect of weight of slaughter; M_j, fixed effect of muscle; R_k, fixed effect of feeding regimen; S_n, random effect of the study; ε, random residual. The study was included as random effect, because it is a block variable that, if ignored, could have serious consequences on the estimation of parameters of the regression model.

Results and conclusions - Table 1 shows the content of CLA, VA, other TFA and VA/total TFA ratio as affected by the slaughter weight, muscle and feeding regimen in meat from lambs. Slaughter weight significantly affected the CLA content that reached the highest value at 14-18 kg. Animals slaughtered at this weight the lambs were fed with milk and increasing amount of roughage. In this case, CLA and VA in meat fat could derive from both maternal milk and rumen fermentation. Weight of slaughter affected also the VA/total TFA, being higher in animals slaughtered less than 18 kg, indicating that VA increased less than other TFA with the slaughter weight. In conclusion at 14-18 kg intramuscular fat content of CLA and VA were maximized. The effect of muscle reached the statistic significance only for VA. LD muscle showed a lower value of VA than other muscles, probably due to a different ratio between lipid fraction of intramuscular fat (polar and non polar lipids).

Feeding regimen affected both CLA and TFA meat content. In particular CLA was higher in meat from grazing lambs than in lambs fed hay and concentrate, while animals fed maternal milk showed an intermediate value. Meat from lambs fed milk and pasture showed a higher VA content than meat from confined animals. Nevertheless, milk regimen showed a marked different behavior that pasture with respect to other TFA: lambs fed only maternal milk produced meat higher both in VA and in other TFA, while lambs fed pasture produced meat higher in VA but not in other TFA. Finally meat

Table 1. Effect of the slaughter weight, muscle and feeding regimen on CLA, TFA and VA content in lamb meat (g FA/100 g TL) (LSM±SE).

	CLA	P	VA	P	Other TFA	P	VA/total TFA	P
Weight, kg								
0-14	0.81^{b}±0.15		1.11±0.17		0.94±0.55		0.66^{a}±0.06	
14-18	0.98^{a}±0.15	**	1.34±0.17	0.07	1.04±0.54	0.70	0.64^{a}±0.06	**
18-24	0.79^{b}±0.15		1.24±0.17		1.20±0.55		0.58^{b}±0.06	
>24	0.61^{b}±0.16		1.12±0.18		1.43±0.56		0.49^{b}±0.06	
Muscle								
LD	0.78±0.15	0.71	1.08±0.15	*	1.15±0.51	0.98	0.59±0.05	0.86
others	0.81±0.14		1.33±0.16		1.15±0.52		0.59±0.06	
Feeding regimen								
milk	0.80^{ab}±0.15		1.36^{a}±0.16		1.37^{a}±0.53		0.56^{a}±0.06	
pasture	0.94^{a}±0.15	**	1.40^{a}±0.16	**	0.16^{b}±0.52	**	0.74^{b}±0.06	**
confined	0.65^{b}±0.15		0.85^{b}±0.16		1.93^{b}±0.53		0.48^{c}±0.06	

***, P<0.01; *, 0.01<P<0.05. Values with different letters on the same column are different*

from "confined" animals was lower in VA and high in other TFA. As a matter of fact the VA/total TFA ratio was different in all the three feeding regimen, being higher in "pasture" and lower in "confined" animals. In conclusion pasture seemed to be the more effective strategy in order to improve the nutritional quality of lamb meat, because grazing lambs produce a meat characterized by a high content of CLA and of VA but not of other TFAs.

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