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Inclusion of aerial part and condensed tannins extract from *Cistus ladanifer* L. in lamb diets – Effect on fatty acid composition of subcutaneous fat

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Take home message *Cistus ladanifer* condensed tannins extract improves the fatty acid profile of lamb subcutaneous fat

Introduction Modulation of the ruminal biohydrogenation (BH) has been appointed as an effective approach to reduce saturation in ruminant fat and increase its contents in healthy fatty acids (FA) like polyunsaturated fatty acids (PUFA) and conjugated linoleic acid isomers (CLA). Plants and plants extracts rich in condensed tannins (CT) has been shown to be able to modulate the ruminal BH of dietary unsaturated FA (Vasta and Bessa, 2012). *Cistus ladanifer* L. (rockrose) is a shrub quite abundant in Mediterranean region containing high levels of CT. The aim of the study was to evaluate the effect of two levels of aerial part and CT extract from *C. ladanifer* in lamb diets on FA composition of subcutaneous (s.c.) fat.

Materials & methods Thirty crossbred Merino Branco ram lambs with an average body weight of 19.8 ± 1.86 kg (mean ± s.d.) were randomly assigned to individual pens, and six pens were attributed to each diet. Four diets were formulated considering two levels of *C. ladanifer* CT (1.25 and 2.5% of CT) and two ways of CT supply (*C. ladanifer* aerial part composed by leaves and soft stems *vs.* CT extract obtained from *C. ladanifer* aerial part). Diet without CT sources was also prepared. The five diets were: L – basal diet composed of dehydrated Lucerne supplemented with soybean oil (60 g/kg); CL1.25 – L plus 125 g/kg *C. ladanifer*; CL2.5 – L plus 250 g/kg *C. ladanifer*; Ex1.25 – L plus 20.5 g/kg *C. ladanifer* CT extract; and Ex2.5 – L plus 41 g/kg *C. ladanifer* CT extract. All diets were isoenergetic. Crude protein content was 162, 147, 133, 154 and 155 g/kg DM in L, CL1.25, CL2.5, Ex1.25 and Ex2.5 diets, respectively. The trial lasted for 35 days after an adaptation period of 7 days. Subcutaneous fat lipids were extracted and FA were transesterified and analysed according to Oliveira *et al*. (2016). Data were analysed using the Mixed procedure of SAS, considering diet as main effect.

Table 1 Effect of *Cistus ladanifer* (CL) and *Cistus ladanifer* condensed tannins extract (Ex) on fatty acid composition fatty (mg/g of total fatty acids) of subcutaneous fat.

Fatty acids[1]	Diets					*P*-value
	L	CL1.25	CL2.5	Ex1.25	Ex2.5	
16:0	214 ± 4.3	214 ± 6.4	211 ± 6.9	215 ± 5.9	209 ± 6.0	0.949
18:0	182 ± 6.9^{b}	199 ± 10.2^{ab}	223 ± 11.1^{a}	200 ± 9.5^{ab}	216 ± 9.6^{a}	0.028
18:1 *cis*-9	294 ± 7.0^{a}	278 ± 10.4^{ab}	239 ± 11.4^{c}	253 ± 9.6^{bc}	270 ± 9.8^{ab}	0.004
18:1 *trans*-11	72.6 ± 4.67^{b}	54.1 ± 6.91^{c}	70.9 ± 7.55^{bc}	96.7 ± 6.42^{a}	67.6 ± 6.53^{bc}	0.001
18:2 *cis*-9, *trans*-11	17.3 ± 0.78^{a}	12.3 ± 1.16^{b}	12.5 ± 1.27^{b}	17.0 ± 1.08^{a}	13.1 ± 1.10^{b}	<0.001
18:2 *n*-6	37.0 ± 2.41	43.7 ± 3.56	37.3 ± 3.89	40.3 ± 3.30	42.0 ± 3.36	0.467
18:3 *n*-3	8.37 ± 0.379^{b}	10.3 ± 0.56^{a}	9.00 ± 0.612^{ab}	9.47 ± 0.520^{a}	10.5 ± 0.53^{a}	0.011
SFA	495 ± 8.0	506 ± 8.7	532 ± 9.2	501 ± 7.9	512 ± 8.0	0.083
PUFA	49.1 ± 2.78	58.2 ± 4.12	50.3 ± 4.50	53.6 ± 3.82	56.5 ± 3.89	0.295

[1]Adjusted for total lipids content; SFA, saturated fatty acids; PUFA, polyunsaturated fatty acids; Values are means ± standard error of the mean. Means within a row with different superscript letters are significantly different (P<0.05)

Results The 18:1 *cis*-9 was the major FA present in s.c. fat (239-294 mg/g total FA, Table 1), followed by 16:0 (213 mg/g total FA) and 18:0 (182-223 mg/g total FA). The 18:1 *cis*-9 and 18:0 in s.c. fat were affected by dietary treatments (P<0.05), with higher levels of 18:1 *cis*-9 in L diet than in CL2.5 and Ex1.25 diets and lower levels of 18:0 in L diet than in CL2.5 and Ex2.5 diets. Vaccenic acid (18:1 *trans*-11) was the predominant biohydrogenation intermediate in s.c. fat (54.1-96.7 mg/g total FA), presenting higher content in Ex1.25 diet than in all other diets (P<0.001). The CLA isomer, 18:2 *cis*-9, *trans*-11 was higher in L and Ex1.25 diets when compared with other diets (P<0.001; 17.2 *vs.* 12.6 mg/g total FA). The content of 18:3*n*-3 was lower in L diet than in CL1.25, Ex1.25 and Ex2.5 diets (P=0.011). Totals of saturated FA (509 mg/g total FA) and PUFA (53.5 mg/g total FA) were not affected by treatments.

Conclusion Dietary supplementation with 1.25% of *C. ladanifer* CT extract resulted in the highest 18:1 *trans*-11 contents in s.c. fat, suggesting the higher production of this *trans*-FA during ruminal BH than in other diets. Despite the higher availability of 18:1 *trans*-11 to endogenous synthesis of the 18:2 *cis*-9, *trans*-11, in Ex1.25 diet the 18:2 *cis*-9, *trans*-11 content was similar to L diet, which may be due to downregulation of Stearoyl-CoA desaturase (SCD) activity. The SCD activity is intrinsically related with fat deposition level (Bessa *et al.*, 2015), which was low in the present work (Guerreiro *et al.*, 2018, unpublished data). *Cistus ladanifer* CT extract might be a good approach to enhance the nutritional value of ruminant fat, but further studies are needed to ensure the endogenous synthesis of 18:2 *cis*-9, *trans*-11.

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