

Relationships between rumen protozoa, biohydrogenation and bioactive fatty acids deposition on lamb muscle

Alexandra E. Francisco^{1,2*}, José Santos-Silva^{1,2}, Paula Portugal¹, Susana P. Alves,^{2,3} Rui J. B.Bessa^{2,3}

¹ Instituto Nacional de Investigação Agrária e Veterinária, Pólo Investigação da Fonte Boa (INIAV-Fonte Boa), 2005-048 Santarém, Portugal;

²Centro de Investigação Interdisciplinar em Sanidade Animal (CIISA), Avenida da Universidade Técnica, 1300-477 Lisboa, Portugal;

³Faculdade de Medicina Veterinária, Universidade de Lisboa, Pólo Universitário do Alto da Ajuda, 1300-477 Lisboa, Portugal

Abstract

Protozoa can comprise up of half of rumen biomass and their membranes present a high content on polyunsaturated fatty acids (PUFA) and on biohydrogenation (BH) intermediates with healthy properties, such as vaccenic ($\text{t}11\text{-}18:1$) and rumenic ($\text{c}9,\text{t}11\text{-}18:2$) acids. By this reason, protozoa can act as potential reservoirs of such fatty acids in rumen, which can flow out and be deposited in meat and milk. Ciliate protozoa may also stabilize rumen pH by regulating starch fermentation in rumen, what may help to control the changes on the normal pattern of BH that occur when ruminants are fed with high-starch diets and that favors the synthesis of the unhealthy $\text{t}10\text{-}18:1$ instead of $\text{t}11\text{-}18:1$ (*trans*-10 shift). This study investigated the associations between the abundance of protozoa in rumen and the proportion of $\text{t}10\text{-}18:1$, $\text{t}11\text{-}18:1$, $\text{c}9,\text{t}11\text{-}18:2$ and of PUFA in the whole rumen content and in the meat of growing lambs. Data were derived from four production trials performed by our research team (N=116 lambs) and ciliate protozoa abundance (cells/ml rumen liquor) was assessed by microscopic counting. Global principal component analyses and Spearman correlation coefficient were applied. A large variation between lambs was observed for protozoa abundance, that ranged between 0 (N=11 lambs) and 2.79×10^6 ciliates/ml rumen liquor. Nine genera of ciliates were identified: *Isotricha*, *Dasytricha*, *Entodinium*, *Diplodinium*, *Eudiplodinium*, *Polyplastron*, *Diploplastron*, *Epidinium* and *Ophryoscolex*, being *Entodinium* the most abundant genus, averaging 4.94×10^5 cells/ml of rumen liquor. In general, ciliates were positively correlated with $\text{t}11\text{-}18:1$; $\text{c}9,\text{t}11\text{-}18:2$ in rumen and meat and negatively correlated with $\text{t}10\text{-}/\text{t}11\text{-}18:1$ ratio in rumen and meat and with $\text{t}10\text{-}18:1$ and PUFA in rumen. For $\text{t}11\text{-}18:1$ and $\text{c}9,\text{t}11\text{-}18:2$, in both rumen and meat, the highest positive correlations were found with the genus *Entodinium* ($P < 0.001$). Also, $\text{t}10\text{-}18:1$ was mainly negatively correlated with *Entodinium* ($\rho = -0.63$, $P < 0.001$) in rumen and $\text{t}10\text{-}/\text{t}11\text{-}18:1$ ratio in both rumen ($\rho = -0.70$, $P < 0.001$) and meat ($\rho = -0.21$, $P = 0.035$). The results suggest an association between rumen fauna and meat nutritional quality and that the intensity of that link may depend of the ciliates community structure. Rumen protozoa are positively linked to the deposition of bioactive fatty acids that are benefits to the human health and negatively related to the occurrence of the *trans*10-shift.

Keywords: Rumen, protozoa, biohydrogenation, bioactive fatty acids, lamb meat

Funding acknowledgements: Financial support through the European Fund for Regional Development (ERDF) (ALT20-03-0145-FEDER-000040-ValRuMeat-Valorização da carne de ruminantes em sistemas intensivos de produção), the PTDC/CVT/103934/2008, and UID/CVT/00276/2013 projects and individual fellowships to A. Francisco (SFRH/BD/68773/2010) and S. P. Alves (SFRH/BPD/76836/2011), from Fundação para a Ciência e Tecnologia are acknowledged.