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Effect of morning *vs.* afternoon grazing on intramuscular fatty acid composition in lamb

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ABSTRACT

The aim of this study was to assess whether different grazing management affect animal performance and meat fatty acid composition. Thirty-five lambs were divided into three groups: 12 lambs grazed from 9 am to 5 pm (8h group); 11 lambs grazed from 9 am to 1 pm (4hAM group) and 12 lambs grazed from 1 pm to 5 pm (4hPM group). The trial was conducted over 72 days. The 8h lambs had greater DMI ($P<0.0005$) and final body weight ($P<0.05$) than the 4hPM and 4hAM lambs while carcass weight was not different between the three groups. The meat of the 4hPM lambs contained greater ($P<0.05$) percentages of polyunsaturated fatty acids, C18:2 *cis*-9 *trans*-11 and lower saturated fatty acids and C18:0 than the meat of the 8h and 4hAM lambs. It is concluded that allowing lambs to graze during the afternoon rather than during 8 h does not compromise the carcass yield and results in a healthier meat fatty acid profile.

1. Introduction

Meat fatty acid composition is strongly affected by the type of diet offered to the animals. In the case of ruminants, it is now largely accepted that when animals are fed green herbages their meats contain greater amounts of the "health promoter" fatty acids – such as polyunsaturated fatty acids (PUFA), rumenic acid (RA) and *n*-3 fatty acids – and lower proportion of saturated fatty acids (SFA) compared to the meat from animals fed concentrates indoors (Aurousseau, Bauchart, Calichon, Micol, & Priolo, 2004; Santos-Silva, Bessa, & Santos-Silva, 2002). Therefore, allowing the animals to graze on green pastures is highly desirable under the perspective of improving meat nutritional properties.

In most Mediterranean areas the grazing flocks are attended by a shepherd whose salary is a production cost for the farm. Overgrazing and improper grazing management are responsible for land degradation (Ronchi & Nardone, 2003) thus leading to a lower herbage nutritional quality. Therefore it is of certain interest to evaluate the possibility of limiting the daily access at pasture of the animals rather than allowing them to graze during the whole day. Nevertheless, the restriction of the grazing time should satisfy animal energy and nutrient requirements without compromising animal performances.

Herbage chemical composition changes during the day: some authors (Avondo et al., 2008; Orr, Penning, Harvey, & Champion, 1997) reported that the fatty acid (FA) profile, crude protein (CP), water soluble carbohydrates (WSC), starch and digestible organic matter in herbages change all along the day. In a study conducted with dairy goats allowed to graze either in the morning or in the afternoon, Avondo et al. (2008) have found that the FA composition of milk was affected by the grazing time. However so far there are no studies in which the effects of the grazing time on ruminant meat fatty acid composition have been investigated.

The aim of the present study was to assess whether the restriction of time at pasture, either in the morning or in the afternoon, affects animal feed intakes, growth performance and meat FA composition compared to a traditional grazing system in which animals are allowed to graze for the whole day.

2. Materials and methods

2.1. Animal management

The experiment was conducted in an experimental farm located in Southern Italy (38°38′ N, 16°04′ E) from March to May 2010. Thirty-five Merinizzata Italiana male entire lambs born in the same farm, after weaning (70 d ± 15 of age) were blocked in groups of 4 on a descending body weight (BW) basis and, within block, assigned randomly to one of three groups and destined to the experimental treatments described below. All the animals were allowed to graze at pasture on a 1 ha ryegrass (*Lolium perenne*) sward. The choice of a sown monophyte sward was adopted in order to avoid herbages selection by the animals. As in southern Italy spring is a quite raining season (100 mm rainfall per

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month in the period March–April 2010), the fields did not require irrigation. Twelve lambs (group 8h) grazed from 9 am to 5 pm, other 11 lambs (morning grazing, 4hAM) grazed from 9 am to 1 pm and 12 lambs (afternoon grazing, 4hPM) grazed from 1 pm to 5 pm. The lambs were allowed to graze on 9 parcels (3 for the 8h lambs, 3 for the 4hAM group and 3 for the 4hPM group) and to each parcel one sub-group of 4 lambs was assigned. Each day, at the end of the set time allowed at pasture, each sub-group of lambs was penned indoor in a multiple box and had *ad libitum* access to water. Before the commencement of the experiment, the animals were adapted to the experimental conditions over a 20 d period in which they were conducted at pasture at the time established for each group and in stall received an amount of hay which was gradually reduced till elimination from the diet. Therefore, the experimental trial started when the animals were 90 days old. All the animals were weighed weekly. The experimental feeding trial had a duration of 72 days. Herbage intakes at pasture were estimated twice (days 15th and 65th) as described by Avondo, Bordonaro, Marletta, Guastella, and D'Urso (2002) and by D'Urso, Avondo, Bordonaro, Marletta, and Guastella (1998). On the same day of the intake recordings, herbage was sampled at 3 different hours in the parcels for the 4hAM and 4hPM groups and at 6 different hours from parcels for the 8h group. Herbage samples were vacuum-packed and frozen at −30 °C pending chemical analyses.

2.2. Slaughtering and muscle sampling

At the end of the experimental period, the lambs were fasted overnight and were transported to a commercial abattoir. Animals were slaughtered by stunning with a captive bolt and successive throat cut. Within 20 min of slaughter, the *longissimus dorsi* muscle was excised from the right side of the carcass, wrapped in aluminium foil, vacuum-packaged and frozen at −25 °C pending fatty acid analysis.

2.3. Muscle fatty acid analyses

Intramuscular fatty acids were extracted according to Folch, Lees, and Stanley (1957). Briefly, a 5 g homogenised *longissimus dorsi* sample was blended with chloroform/methanol (2:1, v/v) solution, filtered, placed in a separator funnel and mixed with saline solution (0.88% KCl). After separation into two phases, the aqueous methanol fraction was discarded and the chloroform lipid fraction was washed with distilled water/methanol (1:1, v/v). After a further filtration and evaporation by means of a rotary evaporator, lipid extracts were transferred to test tubes. Duplicates of 100 mg of lipids were methylated using 1 ml of hexane and 0.05 ml of 2 N methanolic KOH (I.U.P.A.C., 1987). Gas chromatographic analysis was performed with a Varian model Star 3400 CX instrument equipped with a CP 88 capillary column (length 100 m, internal diameter 0.25 mm, film thickness 0.25 ml; Sigma). The oven temperature was set at 140 °C for 4 min then was increased up to 220 °C at a rate of 4 °C/min. Helium was used as career gas at a flow rate of 0.7 ml/min; the temperature of the injector was set at 220 °C with an injection rate of 120 ml/min and an injection volume of 1 μl. The detector (FID) temperature was set at 260 °C. Retention times and area of each peak were computed using the Varian Star 3.4.1. software. The individual fatty acid peaks were identified by comparison of retention times with those of known mixtures of standard fatty acids (37 component FAME mix, 18919–1 AMP, Supelco, Bellefonte, PA) run under the same operating conditions.

2.4. Herbage analyses

For each parcel and for each sampling date (15th and 65th days of the feeding trial), the herbage samples randomly collected at different hours of the day were pooled together to obtain two sub-samples (one for day 15th and one for day 65th) representative for the whole parcel. Therefore, for each paddock allotted to a different grazing management (8h, 4hAM and 4hPM), a total number of six samples (3 parcels × 2 sampling dates) were analysed. Herbage fatty acids were analysed according to Gray, Rumsby, and Hawke (1967). Herbage DM, CP and NDF were determined according to AOAC (1995); WSC was determined by a modified anthrone method (Deriaz, 1961).

2.5. Statistical analysis

For herbage chemical composition, data were analysed by ANOVA with repeated measures, with a model considering the grazing management (8h *vs.* 4hAM *vs.* 4hPM), the date of sampling (15th *vs.* 65th day of feeding trial) and their interaction as fixed factors, while the individual grass samples were considered as random factors. When the interaction was not significant ($P>0.05$), it was removed from the model. When the ANOVA was significant ($P<0.05$), means were separated by pairwise comparison. For animal growth performance, intake and muscle fatty acid composition, data were analysed by ANOVA as a completely randomised design, with a model that included treatment effects and experimental error. Individual animals were considered as experimental units. When the ANOVA was significant ($P<0.05$), means were separated by Tukey's test pairwise comparison.

3. Results

3.1. Herbage chemical composition

Herbage DM was not different between the three swards and DM values increased ($P<0.0005$) from d 15th to day 65th (Table 1). No differences were found for CP, NDF and WSC content among the herbages from the 8h, 4hAM and 4hPM swards. However, regardless of the pasture management, the CP was higher and the NDF content was lower at the beginning of the experimental period (d 15th) compared to the end of the feeding trial (d 65th). The WSC/PG ratio was not different between the three swards but changed between the first and the second sampling date, being higher ($P=0.005$) at d 65th than d 15th (0.44 *vs.* 0.36, respectively). The 8h herbage contained greater percentages of C14:0 compared to the 4hPM herbage ($P<0.05$; Table 1); at d 15th the concentration of C16:0 was higher in the 4hAM herbage compared to the 8h and 4hPM paddocks, while at d 65th the 4hPM herbage presented the lowest C16:0 concentration among the three swards. The percentage of C18:3 *n*-3 (linolenic acid, LNA) was higher in the 4hPM swards compared to the 4hAM one ($P<0.0005$) both at the beginning and at the end of the experimental period; in all the pastures the concentration of this fatty acid decreased ($P<0.0005$) from d 15th to d 65th of experimental trial.

3.2. Feed intake and animal growth performance

Lambs allowed to graze for the whole day had higher DMI compared to the other two groups of lambs ($P<0.001$; Table 2). The 8h lambs had a higher ($P<0.01$) growth rate and final body weight than the other two groups of animals. Nevertheless, the carcass weight did not differ ($P>0.05$) among the three groups, being on average 7.12 kg.

3.3. Muscle longissimus dorsi fatty acid composition

Table 3 reports *longissimus dorsi* muscle fatty acid composition. There were no differences ($P=0.174$) between the intramuscular fat (IMF) content of the three groups of lambs, being this value on average 1154 mg/100 g fresh meat. The proportion of C10:0, C12:0, C14:1 *cis*-9, C15:0, C15:1 and C17:1 was not affected ($P>0.05$) by the feeding system. The proportion of C14:0 was in tendency ($P=0.062$) higher in the meat of the 8h and 4hAM lambs compared to the 4hPM group. The meat of the 4hAM lambs presented a greater proportion of C16:0 compared to the meat from the 4hPM lambs (+8%; $P<0.05$),