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Effect of feeding management from grass to concentrate feed on growth, carcass characteristics, meat quality and fatty acid profile of Timahdite lamb breed

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ABSTRACT

Thirty male Timahdite lambs were divided into 3 groups (n = 10) and raised during 3 months under pasture (PP), pasture and concentrate (PC), and closed feeding systems with concentrate and hay (CC).

Lambs were slaughtered at an average age of 276 ± 6 days and a mean live weight of 41 ± 1 kg. Carcass's conformation was studied by the measurements method.

Instrumental meat quality and fatty acid profile in the *semimembranous* muscle were analyzed. Results showed that the feeding systems did not affect (P > 0.05) the lambs' average daily gain and the carcass quality, except the hind limb compactness index (P < 0.05), while they affected significantly the subcutaneous fat color and meat characteristics (P < 0.05). Lambs from PP and PC groups showed higher lightness and yellowness indexes (L^* and b^*) of subcutaneous fat, normal meat ultimate-pH, higher water holding capacity and greater meat lightness color compared to CC group (P < 0.05).

The study of fatty acid profile showed that, compared to CC lambs, PP lambs had better percentage of polyunsaturated fatty acids (PUFA), especially n-3 fatty acids, with lower n-6/n-3 ratio apart from greater percentage of conjugated linoleic acid (P < 0.01).

Based on these results, it is concluded that better quality meat was produced on open pastoral system of feeding with optimum PUFA.

1. Introduction

Over the recent years, rapid changes in consumer preferences were observed pertaining to meat consumption combined with an increased public interest in nutrition and healthy eating (Verbeke et al., 2010; Hocquette et al., 2012). As a result, the demand for high quality and healthy food products, such as organic and traditional food, throughout the world has increased, particularly in industrialized countries (Guerrero et al., 2010). Natural feeding management is considered in some sort as organic feeding management since it is usually based on extensive grazing on natural or established pastures with minimal or no feed supplements (Wileman et al., 2009). On the mountains and hills, sheep and lambs consume a variety of grasses, herbs and browse. As snow melts with the beginning of spring, fresh, nutritive, and non-contaminated pasture becomes available which is the case in the Middle Atlas area in Morocco. This area is considered the cradle breed of Timahdite lambs which are traditionally produced by taking advantage of mountainous and mountain foothills pasturelands (Boujenane, 2005). However, a present tendency in the Middle Atlas area is towards intensive lamb fattening operations based on consumption of concentrates. Some Timahdite lambs' farmers are changing their traditional feeding managements by providing grazing lambs with energy-rich feed supplement, out of snowing period, in order to reach better weight gain at slaughter. This supplementation may alter the traditional Middle Atlas lamb quality. Little is known regarding the effects of such supplementation on growth performances and meat quality of Middle Atlas' lambs. This study investigated the impact of change in feeding management influence of Timahdite grass lambs on feed intake, growth performances and carcass and meat quality. Differences in carcass traits, muscle pH, fat and meat color, cooking loss and fatty acid composition of three diverse feeding managements are reported.

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2. Material and methods

2.1. Animals and feeding management

This trial was conducted in the central plate of the Moroccan Middle Atlas region and lasted 3 months from March to May 2014 when 30 male Tiamhdite-breed lambs were slaughtered and sampled at age of 276 ± 6 days old and a pre-determined live weight of 41 ± 1 kg. Lambs had been exclusively grazing with their mother before the trial until their weaning at 179 ± 2 days of age. At that time allocated to three treatments (n = 10) taking into account the initial lamb live weight (**ILW**). The treatments were:

(i) Grazing (**PP**): lambs averaging 26.08 kg initial live weight were grazed on a natural pasture during 12 h a day (06:00 to 18:00 h) until slaughter. On pasture, a sample of pastoral plants was taken by cutting it at 3 cm above the ground. The sampling was made taking a surface of 200 cm^2 of grass 100 times per ha at equal distance (i.e. 10m). The samplings were pooled and two subsamples analyzed for botanical composition.
(ii) Indoor lambs (**CC**): lambs weighed on average 27 kg, remained indoors and received at average a supplement of 0.690 kg of oat hay and 0.625 of commercial concentrate meal/day (18% crude protein, 2% fat, 0.3% phosphorus and 0.6% calcium, 10% minerals, 11% crude fiber on dry matter basis, and 900 IU of vitamin A, 200 IU of vitamin D and 90 IU of vitamin E per kg of feed).This system aimed to reply the commonly used management in that region.
(iii) Grazing with supplement for lambs (**PC**): The same management as PP, but these lambs received the half of the hay and concentrate quantities given to CC group before going to pasture. Lambs weighing on average 25.91 kg.

At the beginning of the trial, the lambs were individually identified by their tag number. All animals were allowed to adapt to feeds and house conditions for two weeks before the measurements started.

PP and PC animals were supplied fresh water when returning from pasture while CC group was supplied fresh water *ad libitum*.

During the study, the lambs were weighed on a monthly basis until they reached to live weight of slaughter. Lambs average daily gain (**ADG**) was calculated by the difference between final and initial weights divided by the total number of days. At the same time, commercial concentrate and oat hay intake of PC and CC groups was calculated by measuring the feed that the lambs had not consumed.

Feed intake of these lambs were adjusted on the basis of the previous month's intake to obtain a daily gain similar to that of lambs in the PP group to avoid a possible effect of growth rate on meat quality. Pasture intake was estimated through hand clipping technique described by Bourbouze (1980) by measuring the animals' intake rates and recording and analyzing their jaw movements. Daily dry matter intake (DMI/d) was computed as follows:

$$\mathrm{DMI/d\,(gDM/animal/day) = Intake\,Rate\,(\mathbf{IR}) \times Grazing\,Time\,(\mathbf{GT})};$$

IR is the product of intake per bite (bite mass) and bite rate, and GT is the product of mean meal duration and number of meals.

To measure bite rate and grazing time, individual lambs' daily movements on pastures were filmed monthly by camera and registered for 6 animals from each grazing group (PP and PC) during 3 days for each animal along the trial. Then, the daily animal's behavior on pasture was observed each 30 min to estimate the grazing time and bite rate was calculated on the different pastoral plants present on the pasture during 5 min/animal/day. Four repetitions for each animal per day were considered to calculate the bite rate.

The intake per bite or bite mass was estimated through simulation of 200 bites of lamb using hand clipping technique. The simulated ration was dried in laboratory under temperature of 120 °C during 24 h to determine its dry matter (**DM**) weight.

After the third weight, lambs were weighted weekly during 21 days until they reached the predetermined slaughter live weight (~41 kg).

Animals reached that weight were transferred for about 80 km to the local slaughter house. The CC lambs were slaughtered at first, followed by the PC and then the PP lambs. Slaughter period lasted twenty days.

After a 16 h fast, lambs were weighed again (slaughter live weight, **SLW**) and slaughtered by the Halal method by severing the throat and the major blood vessels in the neck to assure maximum bleeding.

2.2. Carcass measurements

Immediately after slaughter, hot carcasses were weighed (**HCW**) and weight of full and empty digestive tract was measured. Empty live weight (**ELW**) was obtained by subtracting the weight of the digestive contents (leftovers that remained) from SLW. The dressing percentages were then calculated as follows:

$$\mathbf{HCW/SLW}\,(\%) = \text{Hot carcass weight} \times 100/\text{SLW}.$$

Measurements on carcasses were carried out using a ribbon and a distance gauge to determine carcass conformation indices as cited by Bonvillani et al. (2010) for internal carcass length (**L**: length from cranial edge of the symphysis pelvis to the cranial edge of the first rib), carcass compactness (**HCW/L**), hind limb length (**F**: length from perineum to distal edge of the tarsus), buttock width (**G**: widest buttock measurements in a horizontal plane on the hanging carcass) and hind limb compactness (**G/F**). Digestive tract contents were calculated as the difference between full and empty digestive tract.

2.3. Carcass and meat quality assessment

The carcasses were let for 6 h at ambient temperature (21 °C) and then transported to a cold room set to 4 °C. *Semimembranous* muscles of the right legs were excised to measure meat color, water holding capacity and ultimate-pH and followed by wrapping with an oxygen permeable film without contact to meat surface. This was kept in the 162 dark at 4 °C.

A Minolta CR410 spectro-colorimeter was used to obtain L^*, a^*, and b^* readings on caudal subcutaneous fat and *semimembranous* muscle color. Caudal subcutaneous fat from the tail root recorded, at 24 h post mortem, at three locations randomly selected but avoiding blood blots, discolorations and less covered areas. Muscle color measured after 24 h of cutting time and air exposure. Values were recorded at two locations randomly selected from the cranial surface of each piece to obtain a representative mean value, and color was measured with the samples resting on a white surface. Additional reflectance data collected include Hue angle H^*, a measurement where a vector radiates into the red-yellow quadrant, and the color saturation index Chroma C^*. These indices were calculated according to Murray (1995), as:

$$\text{Hue angle} = \text{arctangent}\,(b*/a*) \times [360/(2 \times 3.14)]\ \text{and}$$

$$\text{Chroma} = (a*^2 + b*^2)0.5$$

At 24 h after cutting time, ultimate-pH was measured by a meat pH meter and samples of 20 g from every *semimembranous* muscle were taken to determine the Water Holding Capacity (**WHC**)