Meat quality of Tunisian local breed lambs supplemented with olive pomace blocks

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Animal feed cost in Tunisia is extremely high and the search for alternative solutions is imperative. In this study, we tested the supplementation of weaned lambs with olive pomace-based blocks to evaluate their effect on meat quality and profitability of lamb fattening. For this purpose, we divided sixteen weaned male lambs of the "Noir de Thibar" breed into two distinct groups of 8 lambs each. The experiment was conducted over a period of 3 months. Each group received 700 g of oat hay/lamb/day and a specific feed supplement: Control group (group C) received 500 g of commercial feed concentrate/lamb/day during the 3 months of the fattening experiment. The set of lambs supplemented with feed blocks (set B) received 200 g of feed blocks containing 32% olive meal and 300 g of feed concentrate/lamb/day. The carcass yield of the control lambs (C) was higher than that of the lambs in the other group. The lambs' consumption of feed blocks resulted in a decrease in the redness and yellowing of the meat they produced. Supplementation with feed blocks as well as feed restriction reduced the concentration of lauric and myristic acids (saturated fatty acids) in the intramuscular fat of the lambs compared to the control group, and lambs fed with feed blocks based on oilcake produced meat with high percentage of oleic acid (monounsaturated fatty acid) compared to lambs consuming contaminated feed concentrates.

Keywords: Olive cake, feed blocks, Carcass characteristics, Meat quality, Intramuscular fatty acids

INTRODUCTION

The formulation of feed concentrates is expensive as they are based on imported corn and soybean meal and their availability is limited in developing countries (Ben Salem et al, 2002). On the other hand, feed blocks are a cost-effective alternative as they may include a high proportion of local agro-industrial by-products such as olive cake (Atti and Ben Salem, 2008). Processing of olives in the olive oil industry produces large amounts of olive cake (≈800 kg of olive cake/t of olives, Martín García et al., 2003). Olive cake was previously used in pig (Joven et al., 2014), goat (Ben Salem et al., 2003) and sheep diets (Ozdogan et al. 2017, Chiofalo et al., 2004). However, Awawdeh and Obeidat (2013) have shown that olive cake is more nutritious for small ruminants than for other animals.

Olive meal contains a high proportion of oleic acid (75% of total fatty acids). Data on the response of lambs to supplementation with olive cake-based feed blocks in the Mediterranean region are limited (Ben Salem and Znaidi, 2008). This experimental study is designed to test the effects of block feed supplementation on lamb carcass and meat quality.

MATERIALS AND METHODS

The experiment was conducted at the farm of the Agriculture School of Mateur, located in the North East of Tunisia. The farm has an area of 80 ha, belonging to the humid bioclimatic zone and has an average annual rainfall of 550 mm.

Livestock, diets and experimental design

We used a total of 16 male lambs of local Tunisian breed in a three-month fattening experiment. Lambs were weaned and treated against internal and external parasites. They were divided into 2 distinct groups of similar live weight; each group was composed of 8 lambs.

All the lambs received 700 g of oat hay /lamb/day, produced locally on the farm. In addition, each group received a particular feed supplement: Group (C) is the control group, which received 500 g of feed concentrate per lamb per day, specially formulated for sheep fattening. The olive cake-based feed blocks were made manually using the ingredients listed in table 1, and following the procedure of Ben Salem and Nefzaoui (2003). The feed blocks were ground and mixed with the concentrate pellets before being offered to the animals. The daily amount of feed was distributed to the lambs in two equal meals: The first part was given in the morning (8:00 am) and the second in the afternoon (3:00 pm).

The barn was divided into 2 separate compartments of 20 m2 (5 m × 4 m) each and housed a set of 8 lambs receiving a special feed treatment (C, B). Each section was equipped with two metal troughs, one for serving oat hay and the other for concentrates, and a plastic tub regularly filled with clean water (twice a day) for the animals to drink freely. The duration of the experiment was three months.

Carcass measurements

At the end of the feed experiment, two lambs of identical weight and age from each lot were slaughtered. The lambs were individually weighed before slaughter. The slaughtered lambs were skinned, the head and legs removed and the carcass eviscerated. Shortly thereafter, the weight of the hot carcass and the internal organs (heart, lungs, liver, kidneys and digestive tract) were measured. The warm carcass weight was measured 24 hours after slaughter.

Chemical composition of feeds

Chemical composition of oat hay, blocks and commercial feed concentrate (Table 2) was analyzed according to the methods of the Association of Official Analytical Chemists (AOAC, 1995).

Feed blocks were analyzed for: a) dry matter content, after oven drying at 105°C until weight stabilization (≈ 48 h); b) organic and mineral matter content, following muffle oven incineration for 4 h and for c) crude protein content, according to the procedure of Kjeldhal (AOAC, 1990). Likewise, the fiber composition of the feed blocks was analyzed according to the method of Van Soeste et al. (1991) for acid detergent fiber (ADF), neutral detergent fiber (NDF), and acid detergent lignin (ADL) content (Table 3).

Meat characteristics

Samples (5 g) of longissimus dorsum muscle were cut to measure myoglobin concentration and color parameters (L*: lightness, a*: redness, and b*: yellowing) of lamb meat. The color of the meat was evaluated using a Biobase chromameter operating according to the CIEL*a*b* system (International Commission on Illumination, 1976).

To analyze the fatty acid content of the meat samples, we extracted total intramuscular lipids in a chloroform/methanol solution (2:1, v/v), following the protocol of Bligh and Dyer (1959). Next, fatty acid methyl esters (FAMEs) were generated by transalkaline methylation (Christie, 1982). Finally, the FAMEs were identified using a gas chromatograph (GC 8000 TopThermoQuest). Fatty acid composition was expressed as a percentage of total fatty acids.

Statistical analysis

Differences between the treatments were analyzed using the one-way analysis of variance and the means were compared using the Tuckey multiple comparison test.

RESULTS

Growth performances

The evidence for the effects of dietary treatment (B and C) is presented in table 4. Average daily gain (ADG) was reduced by supplementing lambs with blocks of olive meal ($p<0.05$). Oat hay consumption by lambs was the same for both experimental treatments. The feed block fed lambs had the lowest feed conversion rate ($p<0.05$).

Carcass quality

The weight of the carcasses (hot or cold) of the dietary block or compensatory growth groups did not differ significantly ($p>0.05$) from the weight of the carcasses of the control group (Figure 1). The proportion of lean meat, fat and bone in the carcass of lambs was not affected ($p>0.05$) by the dietary treatments followed in our experiment.

Meat quality

Myoglobin content in meat is statistically similar ($p>0.05$) among the three experimental groups, but we measured a slightly higher concentration in the meat produced by the controlled lambs (Figure 2). Mechanism from the compensatory growth batch was the lightest ($p<0.05$), and the meat produced by the lambs fed with olive cake blocks was characterized by lower redness and yellowness ($p<0.05$) than the meat from the other two batches of lambs.

The saturated fatty acid (SFA) content in the meat produced by lambs fed olive cake blocks (batch B) has no effect ($p>0.05$) on the polyunsaturated fatty acid (PUFA) concentration in the lamb meat (Table 5).

The proportion of saturated fatty acids was significantly higher in the control compared to batch B. The elevated proportion of long-chain fatty acids in batch (B) was mainly due to the increased percentage of C18:1. This is probably due to the polyphenols contained in olive pomace which may decrease the microbial activity involved in the bio-hydrogenation process of oleic acid to stearic acid in the rumen. Lowering saturated fatty acids and increasing unsaturated fatty acids may improve the nutritional quality of the meat (Keli et al., 2009). This improvement may be of interest to human health because of the multiple benefits of reducing saturated fatty acids and increasing long-chain unsaturated fatty acids, which Pariza (1999) suggests is an important goal of feeding strategies.

In the same way, this study showed that the incorporation of pomace in the ration of sheep leads to a variation in the nutritional quality of the meat and in particular in the monounsaturated fatty acids. The improved total unsaturated fatty acid content is associated with the partial protection of these acids against bio-hydrogenation by means of the lignin and polyphenols contained in olive pomace (Ayadi et al., 2009).

DISCUSSION

Growth performances

In a similar manner to our results, Ben Salem et al. (2002) demonstrated that the average daily gain of lambs supplemented with concentrate was higher ($p<0.001$) than that of lambs consuming olive cake-based feed blocks (OC-FB). In addition, Ozdogan et al. (2017) showed that lambs fed mixed feeds containing 25% OC had similar body weight gain and average daily gain as the control group ($p>0.05$).

By including 25% OC in mixed feeds fed to lambs, dry matter intake is increased by 10% (Ozdogan et al., 2017). OC supplementation also improves ($p=0.04$) feed intake by cows (Joven et al., 2014).

Carcass quality

In addition, Atti and Ben Salem (2008) have reported comparable carcass weights ($p>0.05$) among lambs receiving CO-FB and lambs receiving a high amount of concentrates. Also, carcass weights were not affected by the inclusion of 32% OC in the lambs' diet (Vera et al., 2009). Moreover, the level of OC in the lamb diet (0%, 12.5%, or 25%) would not affect hot or cold carcass weight ($p>0.7$, Ozdogan et al., 2017). Conversely, a high level of OC (30%) in lamb diets decreases their carcass yield (Mioč et al., 2007).

With respect to carcass composition, Momani Shaker et al. (2003) reported that a diet composed of 25% OC does not have substantial effects on the carcass composition of lambs. In addition, the inclusion of olive oilcake in the formulation of compound feeds (149 g/kg) does not affect carcass quality of Awassi lambs (Abo Omar et al. 2012). More recently, Hamdi et al. (2016) detected no difference ($p>0.05$) in carcass characteristics due to OC supplementation in Barbarinel lambs. On the other hand, muscle weight was higher ($p<0.001$) in the carcass of lambs receiving dietary concentrates than in the carcass of lambs supplemented with OC-FB, as concentrates are higher in crude protein (Atti and Ben Salem, 2008). The same authors found that supplementation with feed blocks increased the proportion of fat in the carcass of lambs more than concentrate consumption. In conclusion, dietary treatments have no impact on the increase of bone weight (Atti and Ben Salem, 2008). This is because bone maturity is early (Wallace, 1948) and bone growth is related to age rather than nutrition (Murray et al., 1974).

Meat quality

In accordance with our results, those of Joven et al.(2014) prove a decrease in pork clarity (L*) and yellow color (b*) due to increasing levels of OC in the diet (0, 100 and 150 g/kg). While Ozdogan et al.(2017) found that the inclusion of 25% OC in the mixed diet fed to lambs had no effect ($p>0.05$) on meat color parameters (L*, a*, or b*). Similarly, Longissimus muscle color is not altered by CB supplementation of Barbarin lambs (Hamdi et al., 2016) nor by feed blocks formulated with CB (Priolo et al., 2002).

Before discussing the effect of CB-FB administration to lambs on the fatty acid composition of their meat, it is important to mention that the oleic acid (C18:1) content of CB is significant: 679 g/kg total fatty acids (TFA, Joven et al., (2014)), 758 g/kg TFA (Vargas-Bello-Pérez et al., 2013) and 75% TFA (Mele et al., 2013).

Distributing oilcake for grapevine feeding increases the concentration of monounsaturated fatty acids (MUFA) in meat, but reduces that of polyunsaturated fatty acids (PUFA) (Hernández-Matamoros et al., 2011). Joven et al. (2014) reported that PUFA content is not changed ($p>0.05$), saturated fatty acid (SFA) content decreases ($p=0.01$) and MUFA concentration increases ($p=0.02$) in the subcutaneous fat of saws receiving increasing levels of CO.

Concerning individual fatty acids, the results of our study are in agreement with those of Vera et al. (2009) who found that a diet consisting of 32% OC increases ($p<0.05$) the level of oleic (C18:1) and stearic (C18:0) acids in the subcutaneous fat of lambs. Ozdogan et al.(2017) noted an increase in the level of arachidonic acid (C20:4) in Longissimus dorsal muscle following the inclusion of 25% OC in mixed feed offered to lambs. The level of C20:4 in the meat produced by the lambs fed OC-FBs in this experiment is slightly higher ($p>0.05$) than in the meat of control lambs.

In addition, intramuscular fat from lambs fed silage formulated with olive meal and cactus cladodes has a higher linoleic acid content (C18:2) but a lower amount of linolenic acid (C18:3) than fat from lambs fed only oat hay (Vasta et al., 2008). Finally, Marcos et al. (2020) noted that the concentration of PUFAs increases, but that of SFAs decreases in the milk of goats consuming concentrates made from agro-industrial by-products including meal.

CONCLUSION

The lowest feed conversion ratio was found in lambs supplemented with olive oil cake (32% OC). The consumption of feed blocks modifies the composition of intramuscular fat towards a healthier profile by reducing the concentration of lauric and myristic acids (SFA). Additionally, the supplementation of olive oilcake and feed blocks increases the content of oleic acid (MUFA) in lamb meat.

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