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in

López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.).

Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas

Zaragoza : CIHEAM

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125

2021

pages 499-502

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=00008052>

To cite this article / Pour citer cet article

Benbati M., El Hansali M., El Fazazi K., Chafki L., Haddioui A., Keli A. **Effect of use of olive mill wastewater for moistening of dry beet pulp in diets on fattening performance of lambs, carcass characteristics and meat quality.** In : López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.). *Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas.* Zaragoza : CIHEAM, 2021. p. 499-502 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125)



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Effect of use of olive mill wastewater for moistening of dry beet pulp in diets on fattening performance of lambs, carcass characteristics and meat quality

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Abstract. The objective of this study was to evaluate the effect of use of olive mill wastewater (OMW) for moistening dry beet pulp in lambs' diet on fattening performance, carcass characteristics and meat quality. OMW were used to replace partially or totally water used for moistening the dry beet pulp (DBP). Twenty four cross-breed lambs "D'man x Boujaad" were randomly assigned to 4 treatments: T1 containing 27% alfalfa, 11% barley straw and 62% barley grain; T2 containing 26% alfalfa, 10% straw, 32% barley grain and 32% PSB (humidified with 100% water); T3 containing 26% alfalfa, 10% straw, 32% barley and 32% PSB (humidified with 50% water and 50% OMW), T4 containing 26% alfalfa, 10% straw, 32% barley grain and 32% PSB (humidified with 100% OMW). The fattening trial was lasted 70 days after 7-days of adaptation period and lambs were weighed at the beginning and at the end of the trial, and fortnightly. At the end of the trial, lambs were slaughtered and the carcass dressing percentage (CDP), fatness (1-5 scale), conformation (SEUROP system), ruminal pH, pH of meat at 0 and 24h postmortem, fat deposition (mesenteric and pelvic fat) were determined. The use of OMW for moistening of dry beet pulp in the lamb diet did not affect the average daily gain, ruminal pH, cold CDP, fatness, conformation, pH of meat at 0 and 24h postmortem and fat deposition (mesenteric and pelvic fat). The average daily gain of lambs was 214.5, 236.8, 219.2 and 217.6 g/d for T1, T2, T3 and T4, respectively. The cold CDP was 47.7, 47.3, 47.3 and 47.7 for T1, T2, T3 and T4, respectively.

Keywords. Olive mill wastewater – Lamb – Fattening – Carcass – Meat.

Effet de l'utilisation des margines pour l'humidification de la pulpe sèche de betterave dans le régime alimentaire des agneaux sur les performances d'engraissement, les caractéristiques de la carcasse et la qualité de la viande

Résumé. L'objectif de cette étude était d'évaluer l'effet de l'utilisation des margines pour l'humidification de la pulpe sèche de betterave dans le régime alimentaire des agneaux sur les performances d'engraissement, les caractéristiques de la carcasse et la qualité de la viande. Les margines ont été utilisées pour remplacer partiellement ou totalement l'eau utilisée pour humidifier la pulpe de betterave sèche (PSB). Vingt-quatre agneaux croisés D'man*Boujaad ont été répartis au hasard en 4 traitements: T1 contenant 27% de luzerne, 11% de paille d'orge et 62% d'orge grain; T2 contenant 26% de luzerne, 10% de paille, 32% d'orge grain et 32% de PSB (humidifié avec 100% d'eau); T3 contenant 26% de luzerne, 10% de paille, 32% d'orge grain et 32% de PSB (humidifié à 50% eau et 50% margines), T4 contenant 26% de luzerne, 10% de paille, 32% d'orge grain et 32% de PSB (humidifié à 100 % margines). L'essai a duré 70 jours après une période d'adaptation de 7 jours. Les agneaux ont été pesés au début et à la fin de l'essai et tous les quinze jours. À la fin de l'essai, les agneaux ont été abattus et le rendement en carcasse (RC), l'état d'engraissement (échelle de 1 à 5), la conformation (système SEUROP), le pH du rumen, le pH de la viande à 0 et 24h post mortem, le dépôt adipeux (gras mésentériques et pelvien) ont été enregistrés. L'utilisation des margines pour l'humidification de la pulpe sèche de betterave n'a pas eu d'effet significatif sur le gain moyen quotidien (GMQ), le pH ruminal, le RC froide, l'état d'engraissement, la conformation, le pH de la viande à 0 et 24h post-mortem et le dépôt de gras (gras mésentérique et pelvien). Les GMQ enregistrés étaient de 214,5, 236,8, 219,2 et 217,6 g/j respectivement pour T1, T2, T3 et T4. Le RC froide était respectivement de 47,7, 47,3, 47,3 et 47,7% pour T1, T2, T3 et T4.

Mots-clés. Margines d'olive – Agneaux – Engraissement – Carcasse – Viande.

I – Introduction

Morocco is considered as one of the world's largest olive producer with a production, of 2 millions tons in 2018 of which about 65% is used for the extraction of olive oils. This operation generates large amounts of olive mill wastewater which consists mainly of water used in washing and olives soluble substances. The treatment of one ton of olive produces between 0.5 and 3.25 m³ of olive mill wastewater (Paraskeva and Diamadopoulos, 2006). These by-products are very rich in mono-saccharide (Fezzani and Ben Cheikh, 2009) and mineral substances (Ranalli, 1991) mainly potassium (47%), carbonates (21%), phosphates (14%) and sodium (7%) (Fiestas and Padilla, 1992). The direct discharge of OMW into natural environment constitutes a serious problem of the olive industry due to its highly polluting potential, including soil contamination, water pollution and emission of greenhouse gases after fermentation (Rinaldi *et al.*, 2003). One of the most widely-used management options of these by-products, in Morocco, is natural evaporation in storage ponds. This method produces a solid phase which can be used mainly as amender of fertilizer. Other alternative of OMW revalorization is to use it in ruminant feeding. In this context, the objective of this work was to assess the effect of use of olive mill wastewater (OMW) for moistening dry beet pulp diet on in lambs' fattening performance, carcass characteristics and meat quality.

II – Material and methods

Twenty four synthetic breed lambs "Dman x Boujaad" with initial weight of 36 ± 4 kg and age 12 ± 1 month were randomly divided into four treatments of 6 animals: T1 (27% alfalfa hay, 11% barley straw and 62% barley grain); T2 (26% alfalfa hay, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 100% water)); T3 (26% alfalfa, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 50% water and 50% OMW)); T4 (26% alfalfa hay, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 100% OMW)). The trial lasted 70 days preceded by 7 days of adaptation. All used diets are iso-energetic and iso-nitrogenous. Free clean water and mineral block were available all the time. Lambs were weighed before morning feeding, at the beginning and at the end of the trial and each week during the first month and every two weeks for the rest of trial. The controlled parameters concerned the feed intake and the average daily gain (ADG). At the end of the trial, all lambs were sacrificed and carcass dressing percentage, fatness (1-5 scale), conformation (SEUROP system), ruminal pH, pH of meat at 0 and 24h postmortem and fat deposition (mesenteric and pelvic fat) were determined.

The data analysis was done using ANOVA according to the following statistical model: $Y_{ij} = \mu + \alpha_i + e_{ij}$, where Y_{ij} = performance of the animal (i) receiving diet (j); μ = general average; α_i = effect of diet; e_{ij} = the residual error. The PROC GLM procedure of the SAS statistical package was used for the analysis. Comparisons among mean values were tested using the LSD test.

III – Results and discussion

1. Fattening performances

Final live weight and average daily gain (ADG) as well as feed conversion ratio (FCR) and feeding cost are presented in Table 1. The ADG values recorded in lambs fed T2 were not significantly higher ($P=0.5841$) than those recorded in the treatments. The replacement of water by OMW for moistening dry beet pulp reduces feed conversion and feeding cost.

The use of OMW for moistening of dry beet pulp did not affect the studied parameters (Table 1). Similar results were obtained by Christodoulou *et al.* (2008) who reported that the incorporation of fermented OMW in fattening lambs diet (alfalfa hay and soybean) did not affect growth parameters or carcass characteristics compared to a control diet based on barley grain, dry beet pulp and alfalfa hay.

Table 1. Final body weight, average daily gain, feed conversion and feeding cost of different used diets

Parameters	Treatments				SEM	P
	T1	T2	T3	T4		
Final body weight (kg)	50.6	52.8	51.2	52.8	1.99	0.8128
Average daily gain (ADG, g/d)	214.5	236.8	219.3	217.6	12.33	0.5841
Feed conversion (Kg DMI/ Kg ADG)	6.7	7.4	7.1	6.7	–	–
Feeding cost (MAD/kg ADG)	18	20.6	20	18.6	–	–

T1: diet containing 27% alfalfa hay, 11% barley straw and 62% barley grain; T2: diet containing 26% alfalfa hay, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 100% water); T3: diet containing 26% alfalfa, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 50% water and 50% OMW); T4: diet containing 26% alfalfa hay, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 100% OMW). SEM: standard error of the mean; P: probability of the differences; MAD: Moroccan dirham (1 MAD= 0.09 €).

2. Carcass characteristics and meat quality

Table 2 shows the obtained results related to carcass characteristics and meat quality. No significant effect is recorded on the studied parameters ($P>0.05$). However, we noted a slight, but not significant, superiority of the full rumen weight recorded in lambs of T4 in which dry beet pulp was moistened by 100% of OMW and the ruminal pH is more acid. This lower value of pH can be explained by the high acidity of OMW (about 4.55) (Achak *et al.*, 2008) which may affect the ruminal pH. The addition of OMW (rich in anti-nutritional substances) may lead to the disturbance of the ruminal fermentation mainly that of fibers and consequently to a slow transit time of the diet through the reticulum-rumen (Theriez and Boule, 1970).

Our results are consistent with those of Christodoulou *et al.* (2008) who reported that the incorporation of fermented OMW in the fattening lambs' diet affected neither fattening performance nor carcass characteristics.

Table 2. Carcass characteristics and meat quality of lambs fed different diets (n=6)

Parameters	Treatments				SEM	P
	T1	T2	T3	T4		
Full rumen weight (kg)	5.53	5.17	4.86	5.99	0.512	0.5269
Empty rumen weight (kg)	0.91	0.82	0.82	0.86	0.067	0.7087
Ruminal pH	6.93	6.97	6.90	6.86	0.106	0.9018
Mesenteric fat (kg)	1.02	1.13	1.31	1.22	0.107	0.3442
Warm carcass dressing percentage (%)	49.2	48.9	49.2	49.3	0.82	0.9852
Cold carcass dressing percentage (%)	47.7	47.3	47.3	47.7	0.75	0.9611
Meat pH at slaughtering (pH0)	6.50	6.39	6.47	6.46	0.086	0.8368
Meat pH 24 h postmortem (pH24)	5.71	5.69	5.72	5.79	0.035	0.2783
Pelvic fat (kg)	0.62	0.64	0.75	0.59	0.078	0.5791
Conformation	3.50	3.50	3.50	3.80	0.129	0.3526
Fatness	2.67	2.67	2.80	2.70	0.145	0.9176

T1: diet containing 27% alfalfa hay, 11% barley straw and 62% barley grain; T2: diet containing 26% alfalfa hay, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 100% water); T3: diet containing 26% alfalfa, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 50% water and 50% OMW); T4: diet containing 26% alfalfa hay, 10% barley straw, 32% barley grain and 32% dry beet pulp (moistened with 100% OMW). SEM: standard error of the mean; P: probability of the differences.

IV – Conclusions

Olive mill wastewater can be used for moistening the dry beet pulp used in the fattening lamb diet without affecting the fattening performance, the characteristics of the carcass and the meat quality. The addition of these compounds to fattening lambs' diets reduces the feed conversion and consequently the feeding cost and preserves the environment.

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