Effect of beet pulp silage on ewes' weight and lambs growth during lactation

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Abstract

The aim of this work is to evaluate the effect of incorporating beet pulp silage (BPS) in the diet of lactating ewes on weight variations and lamb growth during the first two months of lactation. Forty-five ewes of the Boujâad breed were randomly divided into three homogeneous groups according to weight and age. Three diets were tested: T_0 (barley, alfalfa hay, straw, wheat bran); T_1 (barley, alfalfa hay, straw, wheat bran and 15% BPS) and T_2 (barley, alfalfa hay, straw, wheat bran and 30% BPS). The experiment was lasted 60 days (from lambing to 60 days of lactation) preceded by a 6-day diet adaptation period. The ewes and their lambs were weighed at lambing, 10, 30 and at 60 days of lactation. Variations in ewes and their lambs' weight and average daily gain (ADG) during the experimental period (lambing; 60 days of lactation) are the main parameters measured. The results showed that the incorporation of BPS did not affect the weight of the ewes at 10, 30 and 60 days of lactation ($P>0.05$). However, lambs' weight at 10 days and ADG_{0-10} were significantly affected. While the lambs' weight at 30 and 60 days and the ADG_{10-30}, ADG_{30-60} and ADG_{0-60} were not affected by the diet.

Key words: Beet pulp silage, Boujâad breed, ewes, lambs, growth performances

Effet de la pulpe de betterave ensilée sur l'évolution du poids des brebis et la croissance des agneaux durant la lactation

Résumé

Le travail a pour objectif d'évaluer l'effet de l'incorporation de la pulpe de betterave ensilée (PBE) dans le régime alimentaire des brebis en lactation sur les variations de leurs poids et la croissance des agneaux durant les deux premiers mois de lactation. Quarante-cinq brebis de la race Boujâad ont été réparties en trois lots homogènes selon le poids et l'âge. Trois régimes alimentaires ont été testés : T_0 (orge, foin de luzerne, paille, son de blé); T_1 (orge, foin de luzerne, paille son de blé et 15% PBE) et T_2 (orge, foin de luzerne, paille, son de blé et 30% PBE). L'essai a duré 60 jours (de l'agnelage à 60 jours de lactation) et il a été précédé d'une période d'adaptation aux régimes alimentaires de 6 jours. Les brebis et leurs produits ont été pesés à l'agnelage, 10, 30 et à 60 jours de lactation. Les poids aux âges types (poids à la naissance, à 10j, à 30j et à 60j), les gains moyens quotidiens GMQ_{0-10}, GMQ_{10-30}, GMQ_{30-60} et GMQ_{0-60}, ainsi que les variations de poids des brebis durant la période de l'essai sont les principaux paramètres mesurés. Les résultats obtenus ont montré que l'incorporation de (PBE) dans la ration des brebis en début de lactation n'a affecté ni le poids ni les variations de poids des brebis (P>0,05). Toutefois, le poids des agneaux à 10 jours et le GMQ0-10 ont été significativement affectés. Les poids à 30 et 60 jours et les GMQ_{10-30}, GMQ_{30-60} et GMQ_{0-60} n'ont pas été affectés par le régime alimentaire.

Mots clés : Pulpe de betterave ensilée, race Boujâad, brebis, agneaux, performances de croissance

تأثير سيلاج لب الشمندر السكري على تطور وزن الأغنام ونمو الحملان أثناء الرضاعة

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ملخص

الهدف من هذا البحث هو إدخال سيلاج لب الشمندر السكري في تغذية النعاج و تقييم تأثير على وزنها ونمو الخرفان خلال الشهرين الأولين من الرضاعة. لذلك تم تقسيم 45 نعجة من سلالة بجعد إلى ثلاثة مجموعات متجانسة حسب الوزن والعمر . تم اختبار ثلاثة وجبات: T0 (الشعير، تبن الفصة ، تبن الشعير ، نخالة القمح)؛ T1 (الشعير، تبن الفصة ، تبن الشعير، نخالة القمح و 15٪ من سيلاج لب الشمندر) و T2 (الشعير ، تبن الفصة ، تبن الشعير ، نخالة القمح و 30٪ من سيلاج لب الشمندر) . استغرقت التجربة 60 يومًا (من الولادة إلى 60 يومًا من الرضاعة) مسبوقة بفترة 6 أيام للتكيف مع النظام الغذائي. تم وزن النعاج و الخرفان عند الولادة، في 10 أيام، و 30 يومًا، و 60 يومًا من الرضاعة. الأوزان عند الأعمار النموذجية (الوزن عند الولادة، 10 أيام، عند 30 و 60 يوما)، معدل النمو اليومي 0-10 و معدل النمو اليومي 10-30 و معدل النمو اليومي 30-60 و معدل النمو اليومي0-60 ، بالإضافة إلى تغيرات الوزن للنعاج خلال الفترة التجريبية هي المؤشرات الرئيسية التي تم قياسها خلال هذه التجربة . أظهرت النتائج أن إدخال دمج سيلاج لب البنجر في تغذية النعاج في بداية الرضاعة لم يؤثر على وزن النعاج أو تغيرات الاوزان (P> 0.05). بينما تأثر وزن الحملان عند 10 أيام و معدل النمو اليومي 0-10 معنوياً. لم تتأثر الأوزان عند 30 و 60 يومًا و معدل النمو اليومي 0-30 و معدل النمو اليومي 30-60 و معدل النمو اليومي 0-60 بالنظام الغذائي.

الكلمات المفتاحية: سيلاج، لب الشمندر، سلالة بجعد، النعاج، الخرفان، القدرات الإنتاجية

Introduction

The feeding of ewes during the last two months of pregnancy and during lactation is extremely important to achieve a good foetal development and a good milk production throughout the first month of lactation and consequently a correct lamb's growth. Indeed, at the end of gestation and during the first weeks of lactation, ewes tend to mobilize their body reserves to assure their own needs and those of their offspring (De Vries and Veerkamp, 2000). This phenomenon is much more marked in extensive breeding in most Moroccan regions which are characterized by long drought periods (Boudechiche et *al.*, 2010). To mitigate this energetic deficit, sheep breeders have often supplemented their animals with concentrated feeds. However, raw materials prices on the international market have increased the production cost, which has made livestock feeding a real constraint for the improvement of the livestock sector in Morocco. To deal these increases in raw material prices, the use of locally available food resources is becoming an important choice. Beet pulp is the most important by-product of the sugar industry about 428.9 Mt (COSUMAR, 2021). It represents about 5.5% of beet components (Pennington and Baker, 1990). It has very high nutritional qualities (22-25% dray matter, 1.01UFL, 0.99 UFV, 98 g crude protein, 482 g NDF per kg dray matter (Agabriel, 2007)) and can contribute, through its richness in highly digestible fibers, to promote optimal rumen conditions when used with appropriate supplements (Arzate, 2005). It is frequently stored in the pellet form. However, the increases in the cost of energy have made the drying of the pulp more expensive. Beet pulp silage (BPS) is the new conservation form of this by-product to reduce draying cost. It is characterized by high NDF content (hemicellulose + cellulose + lignin) and low lignin content, which confer a very good apparent digestibility (Araba, 2018). Their use in dairy cows and fattening bulls has been studied and incorporation levels have been identified to prevent digestive and physiological problems (Decruyenaere et *al*., 2017). In sheep, Benbati et al (2021) reported that incorporating this forage into fattening lambs' diets improved fattening performance However, to our knowledge; no previously research has been done to evaluate the incorporation of BPS into ewe diets.

The objective of this study was to evaluate the effects of incorporating beet pulp silage (BPS) in ewe lactating diet on the evolution of their body weight, on the lambs growth and feed cost

Materials and methods

Animals and diets used

The experiment was conducted at the Deroua experimental field of the National Institute of Agronomic Research (INRA) of Tadla. The experiment involved forty-five ewes of the Boujâad breed at the end of pregnancy. The ewes were divided into 3 homogeneous groups of 15 females each according to their age, weight and parity. Each group was assigned to a diet. Three diets were formulated according to the incorporation level of BPS: T_0 (control diet, 0% BPS), T_1 (15% BPS) and T_2 (30% BPS).The diets are formulated to satisfy the ewes requirements in the late pregnancy - early lactation period using the INRA 2007 feed tables (Agabriel, 2007). The composition of the three diets is presented in Table 1. The experimental lasted 60 days, this was preceded by a six-days adaptation period to the diet. The ewes were previously treated for internal parasites, vaccinated against enterotoxaemia and injected with a selenium injection against myopathy. The diet distribution method

adopted was a totally mixed ration (TMR). The diet is distributed every day in the morning (around 8:30 am) in a unique intake. Throughout the experiment, the animals were provided with fresh water and blocks of mineral and vitamin supplements. The boxes and troughs are cleaned daily.

During the first month of age, the lambs were not receiving any supplementation. Feeding was based exclusively on suckling. At the 30 days of age, in addition to the milk diet, the lambs a creep-feeding consisting of starter concentrate, barley and alfalfa hay (progressive feeding). After adaptation, lambs received ad libitum creep-feeding.

It should be noted that lambing was grouped over a period of 20 days. Lambing occurred between the first and last week of April.

Table 1. Composition of three tested diets

Ingredients (%)	**T_0**	**T_1**	**T_2**
Alfalfa hay	42.5%	42.5%	40.5%
straw	11%	10.2%	10,5%
barley	39%	25.5%	13%
Wheat bran	7.5%	6.8%	6%
Beet pulp silage	0%	15%	30%
Crude protein %	16.5	15.8	15.3
Neutral detergent fiber	53.5	53.4	52.9

Analysis and controls applied

Ingestion control

The offered quantities and the refusals are controlled daily in order to determine the quantities of feed ingested. During the experiment, fresh water and mineral and vitamin supplement blocks were available to the animals on a free access.

Weight control and average daily gain (ADG) assessment

Throughout the experimental period, lambs were weighed at birth, 10, 30 and 60 days using a precision scale (120±0.01kg). Ewes were weighed at lambing (just after lambing), 10 days, 30 days and 60 days postpartum using a livestock scale (30±0.01kg). Weighing was done in the morning before distributing diets to the ewes. Average daily gains between birth and 10 days, 10 to 30 days, 30 to 60 days and birth to 60 days were calculated.

Data analysis

Data collected were analysed using SAS software (version 9.4). Diet and sex were both used to evaluate lambs growth performances using the formula 1. While, ewe's weight variation was evaluated based on diet effect using the formula 2.

$$(1)\ Yijk = \mu + ai + bj + (ab)ij + eijk$$

With:

- ✓ Yijk: performance of animal (k) of sex (j) and diet (i);
- ✓ μ: the population mean;
- ✓ ai: diet effect;
- ✓ bj: animal sex effect;
- ✓ (ab)ij: interaction diet*sex effect;
- ✓ eijk: residual error.

$$(2)\ Yij = \mu + ai + eij$$

With:

- ✓ Yij: performance of animal (j) and diet (i);
- ✓ μ: the population mean;
- ✓ ai: diet effect;
- ✓ eij: residual error.

Results and discussion

Dry matter intake and feed cost

Throughout the experiment, ewes were fed a diet based on alfalfa hay, straw and beet pulp silage as a rough feed and barley and wheat bran as a supplemental feed. The quantities of dry matter intake are presented in table 2. We have to note that the same amounts of dry matter were recorded in the ewes of the three groups, i.e. 1.92±0.16, 1.92±0.17 and 1.93±0.15 kg DM/ewe/day respectively for the T_0, T_1 and T_2 diets. However, Yang and Beauchemin (2006) and O'Doherty and Crosby (1997b) reported that beet pulp silage is a highly palatable feed and the amount of dry matter Intake increases as the BPS level in the ration increases. Also, Boguhn et al (2010) found that substituting a 20% DM of corn silage with beet pulp silage had a significant effect ($P<0.05$) on the digestibility of the organic matter of the diet. On the other hand, Münnich et *al.* (2017) showed that incorporation of beet pulp silage in dairy cattle did not significantly affect the amount of dry matter intake, but it negatively affected the energy intake due to increased fibre consumption.

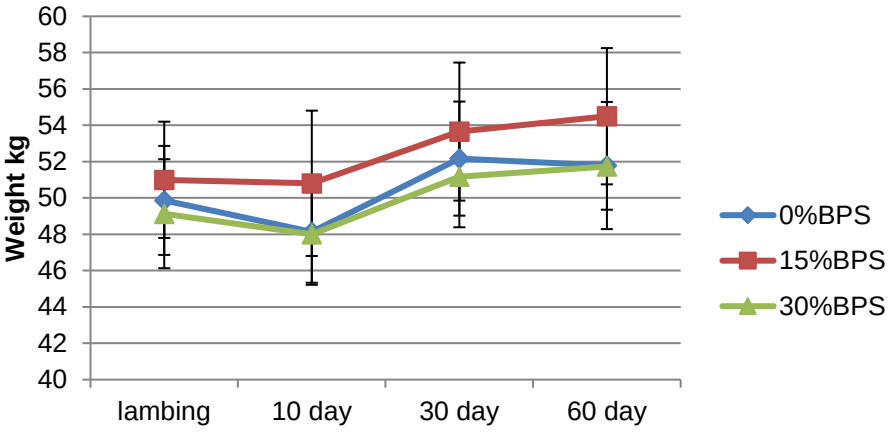
Regarding the feed cost, it was estimated using the prices of raw materials during the experiment. The results presented in Table 2 show that incorporation of BPS contributed to reducing feed costs. The reduction is estimated at 17.5% for an incorporation level of 30%.

Table 2. Dry matter intake according to the level of beet pulp silage in the diet

	T_0	T_1	T_2
DMI Total (kg)	7288.3	7300.1	7311.2
DMI/group/d (kg)	28.8±2.39	28.9±2.49	28.9±2.31
DMI/animal/d (kg)	1.92±0.16	1.92±0.17	1.93±0.15
FC (MAD/kg DM)	2.47	2.34	2.09
DMI: Dry matter intake, **FC**: feed cost			

Ewes weight evolution

The evolution of the ewe average weights 60 days of lactation is shown in figure 1. The results show that for all diets, ewes had a weight loss after lambing. This decrease in weight that continues until 10 days postpartum, is certainly due to the mobilization of the corporal reserves in order to provide the necessary nutrients to the mammary for milk synthesis (Meredef and Madani, 2015). Indeed, the requirements of the ewe during the first two weeks of lactation are maximal and the ingestion capacity is limited due to the appetite limitation as well as the rumen volume restriction by the foetus during the pregnancy period (Agabriel, 2007). Bocquier et *al.* (1988) reported that the requirements of the ewe during the first two weeks of lactation are rarely covered by feed intake and the deficit can be up to 0.85 of maintenance requirement. The weight loss of control group between lambing and 10 days postpartum was greater (1.64 kg), whereas the loss was smaller for ewes receiving the 15% BPS diet and for those consuming the 30% BPS diet (1.23 kg and 0.31 kg respectively). These results can be explained by the high content of highly digestible fibre in BPS, which leads to an improvement in digestibility and utilization efficiency of the diet (Kelly, 1983, Arrigo et *al.*, 2016). This improvement of feed conversion has limited the mobilization of body reserves and therefore a slighter weight loss. Deraz et *al.* (2016) reported that incorporating beet pulp silage into fattening lambs' rations improved diet digestibility. Similarly, Benbati et *al.* (2021) reported that incorporating ensiled beet pulp into the lamb fattening diet improved conversion ratio. In addition, Araba (2018) reported that high digestibility of beet pulp confers high energy, reduces rumination time and enhances microbial protein synthesis



Figur 1. The ewes weight evolution during the experiment in function of the BPS incorporation level

Statistical analysis of data (Table 3) showed that diet did not significantly affect the evolution of ewe weights during the trial period (P>0.05). In addition, after 10 days of lactation the ewes start to regain weight by re-establishing their corporal reserves. Additionally, Benbati et *al.* (2016) reported that ewes started gaining weight 30 days after lambing.

Table 3. Ewes weights at lambing, 10, 30 , and 60 days post-partum according to the BPS incorporation level

	Diet			SEM	P
	T_0	T_1	T_2		
Lambing weight (kg)	49.87	51.00	49.13	-	-
Weight at 10th day (kg)	48.23	49.77	48.82	0.629	0.2399
Weight at 30th day (kg)	52.25	52.65	51.96	0.731	0.8065
Weight at 60th day (kg)	52.30	53.31	52.32	0.897	0.6776

SEM: Standard error mean; **BPS :** Beet pulp silage

Lamb performance

The mean values of weights at typical ages (birth, 10, 30 and 60 days of lactation) depending on BPS incorporation levels of BPS and sex are presented in table 4.

Lambing weight

Regarding the effect of diet, the mean value was 3.88kg, 3.91kg and 3.89kg respectively for T_0, T_1 and T_2. These results are higher than those reported by Benjelloun et *al.*, (2016) for the same breed. On the other hand, these results are approximately to those reported by Belacel (1991) in the Algerian Ouled Djellal breed with a birth weight of 3.5 kg.

Concerning the effect of sex, the lambing weights of males were 4.17 kg while those of females were about 3.61 kg. A significant difference ($P<0.05$) is recorded between the birth weights of the two sexes (Table 4). This result is in agreement with those reported by Benjelloun et *al.*, (2016) on the Boujaad breed. Similarly, Chikhi and Boujenane (2003) reported that male lambs are heavier than females at lambing.

Weight at 10, 30 and 60 days of lambs age

The effect of diet, at the 10th day of age, showed that males recorded a small superiority, 150g, compared to the males. This difference is statistically insignificant ($P>0.05$) (Table 4). The same results were obtained by Kerfal and Boujenane (1990) on local breeds.

Concerning the lambs' weight at 30 days of age, the difference between the both sexes is feeble (0.09 kg) and is not statistically significant ($P>0.05$) (Table 4). The same results were obtained by Djellal et *al.*, (2016) who found that sex did not have a significant effect on lamb weight between 20 and 30 days. Nevertheless, our results are in contrast with the results reported by Dekhili (2004) in Algeria, Boujenane et *al.* (2001) and Chikhi and Boujenane (2003) in Morocco who found that the sex factor is highly significant on lamb weight.

Table 4. Weight at typical ages according to diet and sex

	Diet			**SEM_1**	**Sex**		**SEM_2**	**P value**		
	T_0	T_1	T_2		M (n=19)	F (n=30)		T	S	T*S
Lambing weight	3.88	3.91	3.89	0.25	4.17	3.61	0.18	0.8695	0.0254	0.2346
Weight at 10 days	6.78	7.89	6.87	0.32	7.25	7.10	0.27	0.0387	0.6922	0.2976
Weight at 30 days	9.85	9.60	9.87	0.42	9.82	9.73	0.35	0.8825	0.8515	0.9720
Weight at 60 days	15.51	15.71	15.48	0.61	15.33	15.80	0.51	0.4763	0.7881	0.4618

SEM1 : Standard error of the mean of the 3 ewe diets; SEM2 : Standard error of the mean of the two sexes
M : Male lambs; F : Female lambs; S : Sex of lambs; T: diet; T*S : Interaction between ewe diet and sex of lambs

Average daily gain (ADG) of lambs

The results of the ADG evolution calculated for the periods 0-10days, 10-30days, 30-60days and 0-60days are presented in table 5. We observe that during the period (0-10 days), the ADGs recorded in lambs from ewes fed with a diet containing BPS were very slightly higher than those recorded in lambs from ewes fed a non-BPS diet. The best ADGs were recorded by lambs from T_1 ewe's lot. The superiority of ADGs between 0-10 days in favour of T_1 lambs may be is related to an improvement in milk production, as it is the exclusive feed source during this age period, following the addition of PBS (feed rich in digestible fibre). Additionally, this superiority of T1 lambs compared to T2 lambs may be explained by the fact that the adequate level of BPS incorporation for the most efficient use of diet is 15%.The statistical analysis showed no significant effect (P>0.05) of lamb sex on ADG during this period (0-10 days). However, O'Doherty and Crosby, (1997a) showed that substituting 40% corn silage by beet pulp silage in the ewe's diet had a significant effect on lamb performance before one month of age.

Concerning the period 10 to 30 days, we note that the ADG recorded in lambs from ewes of T_1 are low compared to the ADGs of lambs from other lots. This difference is explained by the cases of diarrhea registered in the T_1 lambs group during this period. The analysis of the variance showed no significant effects of both diet and sex. The results recorded in this work are in accordance with those reported by Benjelloun et *al.* (2016) in the Boujaâd breed. However, Chikhi and Boujenane (2003) have founded higher ADGs in the same breed.

About the period between 30 and 60 days of age, ADGs registered in lambs of the three diets are similar. Statistical analysis did not reveal any significant dietary or sex effects. The ADGs recorded in this period are similar to those reported by Chikhi and Boujenane (2003) in the same breed. However, they are higher than those reported by Benjelloun et *al*., (2016). O'Doherty and Crosby (1997a) have founded a significant effect (P<0.05) of ewe diet on lambs ADGs between 4 and 14 weeks of age.

Table 5. Average daily gain (g/day) of lambs by the sex and ewes diet

	Diet			**SEM_1**	**Sexe**		**SEM_2**	**P value**		
	T_0	T_1	T_2		Female (n=30)	Male (n=18)		T	S	T*S
0-10 day	294.08[b]	405.03[a]	303.00[b]	32.26	326.21	341.86	26.93	0.0387	0.6922	0.2976
10-30 days	165.43	106.49	156.36	15.23	141.64	143.88	12.75	0.0532	0.9047	0.4930
30-60 day	187.26	212.81	186.09	11.32	200.58	190.20	9.46	0.2008	0.4567	0.2424
0-60 day	194.26	197.58	193.85	10.10	199.15	191.32	8.43	0.9612	0.5266	0.3411

SEM1 : Standard error of the mean of the 3 ewe diets; SEM2 : Standard error of the mean of the two sexes M : Male lambs; F : Female lambs; S : Sex of lambs; T: diet; T*S : Interaction between ewe diet and sex of lambs;

Conclusion

The results of this study showed that beet pulp silage can be incorporated in lactating ewes' diet to minimise ewe weight loss and improve lamb growth. These results demonstrate that 15 % is the most adequate level of incorporation of this feed resource in lactating ewes' diets.

Acknowledgments

The authors extend their appreciation to the technical staff of the Regional Center for Agricultural Research in Tadla for their assistance during the development of this research.

References

Agabriel, j. (2007). Alimentation des bovins, ovins et caprins. Besoins des animaux - Valeurs des aliments. 310 pages.

Arrigo, Y., Metthez, C., Wyss, U. (2015). Digestibilité des ensilages de pulpes de betteraves avec ajout de mélasse. Recherche Agronomique Suisse. Vol.6 (10). p. 454–461.

Arzate Petit, M. D., & Pinilla, J. M. (1995). Production and purification of a sugar syrup fromcarob pods. In LWT - Food Science and Technology. Vol. 28(1). https://doi.org/10.1016/S0023-6438(95)80027-1.

Belacel, M. 1991. La production de petit ruminant en Algérie. In. Small Ruminant Reaserch and Developement in Africa. Cairo Egypt. p. 3-7.

Benbati, M., El Hansali, M., El Azhari, E., Mounsif, M., Haddioui, A., Benjelloun, B. and Keli, A. (2021). Effects of the incorporation of ensiled sugar beet pulp in the diet on lambs fattening performance. In Options Méditerranéennes: Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas. Zaragoza: CIHEAM/ENA. Vol 125. p. 413-416.

Benjelloun, B., Benbati, M., Chikhi, A., Boulanouar, B. (2016). Performances de croissance et de viabilité pré-sevrage des races parentales et des moutons croisés « D'man x Boujaâd » de générations F1, F2 et F3. In : Options Méditerranéennes. The value chains of Mediterranean sheep and goat products. Organisation of the industry, marketing strategies, feeding and production systems Zaragoza : CIHEAM. Vol. 115. p. 407-411.

Bocquier, F., Theriez, Z.M., Prache, S., Brelurut, A. (1988). Alimentation des ovins. In: Alimentation des bovins, ovins et caprins. INRA, Versailles, France Edition. p.249-281.

Boguhn, J., Kluth, H., Bulang, M., Engelhard, T., & Rodehutscord, M. (2010). Effects of pressed beet pulp silage inclusion in maize-based rations on performance of high-yielding dairy cows and parameters of rumen fermentation. Animal, 4(1). p. 30-39

Boudechiche, L., Araba, A. et Ouzrout, R. (2010). Influence d'une complémentation de brebis en fin de gestation par des rebuts de dattes sur les performances d'allaitement. Livestock Research for Rural Development. Volume 22. http://www.lrrd.org/lrrd22/3/boud22051.htm.

Boujenane, I., Roudies, N., Benmira, A., El Idrissi, Z., & El Aouni, M. (2003). On-station assessment of performance of the DS synthetic and parental sheep breeds, D'man and Sardi. Small Ruminant Research.Vol.49(2). p.125-133

Boujenane, I., Zian, S. M., & Sadik, M. (2001). : Estimation des paramètres génétiques et phénotypiques de la croissance des ovins de race Sardi. Actes. Inst. Agron. Vet. (Maroc). Vol. 2(3). p.177-183

Chikhi, A., & Boujenane, I. (2003). Caractérisation zootechnique des ovins de race Sardi au Maroc. Revue d'élevage et de Médecine Vétérinaire Des Pays Tropicaux. Vol. 56(3–4). p. 187-192.

COSUMAR. (2021). Rapport finacier annuel (2020). 57 apges.

Dekhili, M. (2004). Etude de la productivité d'un troupeau de brebis de race Ouled-Djellal. Rencontre recherches ruminants. 11, 234. http://www.journees3r.fr.

Deraz, T. & Khir, A. & Suliman, A. & Abdel-Salam, O. & Elashhab, Ahmed. (2016). Feeding sugar beet tops silage: in Summer. Egyptian Journal of Nutrition and Feeds. Vol 19. p. 47-54.

Djellal, F., Kadi, S. A., Mouhous, A., Berchiche, M., Djellal, F., Kadi, S. A., Mouhous, A., & Effet, M. B. (2016). Effet de la saison de naissance et du sexe sur la croissance avant sevrage des agneaux de la race Ouled Djellal (Algérie). In : Options Méditerranéennes. The value chains of Mediterranean sheep and goat products. Organisation of the industry, marketing strategies, feeding and production systems Zaragoza : CIHEAM. Vol. 115. p. 441-445.

Ertl, P., Zebeli, Q., Zollitsch, W., & Knaus, W. (2017). Effects of supplementation of a forage-only diet with wheat bran and sugar beet pulp in organic dairy cows. Renewable Agriculture and Food Systems. Vol. 32(5). p. 446-453.

Heydari, M., Ghorbani, G. R., Sadeghi-Sefidmazgi, A., Rafiee, H., Ahamdi, F., & Saeidy, H. (2021). Beet pulp substituted for corn silage and barley grain in diets fed to dairy cows in the summer months: feed intake, total-tract digestibility, and milk production. Animal. Vol. 15(1). Articl 10068.

Kelly, P. (1983). Sugar beet pulp - A review. Animal Feed Science and Technology. Vol. 8(1).p. 1–18.

Kerfal, M., & Boujenane, I. (1990). Estimation de la production laitière des brebis D'man. Alawamia. Vol (78). p. 145–155.

De Vries, M. J. and Veerkamp, R. F. (2000). Energy Balance of Dairy Cattle in Relation to Milk Production Variables and Fertility. Journal of Dairy Science. Vol.83. p. 62–69.

Meredef, A. et Madani, T. (2015). Dynamique des réserves corporelles de la brebis Ouled Djellal en zone semi-aride. Livestock Research for Rural Development. Vol. 27(4). Article 69.

Münnich, M., Khiaosa-ard, R., Klevenhusen, F., Hilpold, A., Khol-Parisini, A., & Zebeli, Q. (2017). A meta-analysis of feeding sugar beet pulp in dairy cows: Effects on feed intake, ruminal fermentation, performance, and net food production. Animal Feed Science and Technology.Vol. 224. p. 78-89.

O'Doherty, J. V., & Crosby, T. F. (1997a). Effects of molassed sugar-beet pulp and formic acid on silage fermentation, intake and digestion, and rumen fermentation of sheep. Irish Journal of Agricultural and Food Research, 36(1). p. 11-22.

O'Doherty, J. V., & Crosby, T. F. (1997b). The effect of diet in late pregnancy on colostrum production and immunoglobulin absorption in sheep. Animal Science, 64(1). p. 87-96.

Pennington, Neil L.,Baker, Charles W.,(1990). Sugar: User's Guide To Sucrose. Van Nostrand Reinhold Inc., U.S.; 1990e edition. 332 pages.

Yang, W. Z., & Beauchemin, K. A. (2006). Physically effective fiber: Method of determination and effects on chewing, ruminal acidosis, and digestion by dairy cows. Journal of Dairy Science, 89(7). p. 2618-2633.

Decruyenaere, V., Agneessen R., et, Vancutsem, F. (2017). Des pulpes de betteraves surpressées dans la ration des ruminants. https://www.irbab-kbivb.be/wp-content/uploads/2017/09/pulpes-betteravier-septembre-2017.pdf.

Araba, A. (2018). L'alimentation de la vache laitière pour une meilleure qualité du lait: Comment augmenter le taux butyreux et protéique du lait. https://www.agrimaroc.net/2018/05/22/lalimentation-de-la-vache-laitiere-pour-une-meilleure-qualite-du-lait-comment-augmenter-le-taux-butyreux-et-proteique-du-lait/3/