# Use of kaolinite clay to promote productivity of Ouled-Djellal ewes in periparturient period

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## Abstract

In order to promote animal performance in difficult areas, and to find an alternative to antibiotics for ruminants, twelve adult ewes of the Ouled-Djellal breed in 5th mo of gestation were alloted equally in two experimental boxes to quantify the effect of kaolinite clay on the dynamics of the body condition of ewes, lamb growth and milk production up to 70 days post-parturition. The experiment was conducted at the demonstration farm of the Technical Institute of Breedings of Ain M'lila Algeria. Oat hay dominated the basic ration with a limited distribution of barley straw. The control group ($C_0$) received a complement with a control concentrate (without kaolinite), however, the other group (CL) received the same concentrate added with 5% of kaolinite. The data collected were subjected to statistical treatment based on the T test of Student and U test of Mann Whitney to visualize the differences existing between the variables studied using the STATISTICA V.6 program. The statistical analysis showed that the sheep of both groups had similar curve of body weight and body reserves dynamics from the 5th mo of pregnancy until 1st mo of suckling. Regarding milk production, milk quality was detected unchangeable in the presence of kaolinite clay, moreover, ewes of CL groupe produced significantly more of milk (+29.4% ; $p<0.05$) than those of control. Besides, the lambs mothered with kaolinite had faster growth with significant highest average daily gain compared to those of the control (+74% ; $p<0.05$), consequently, they were significantly heavier (+41% ; $p<0.05$) at 4 wk and at 70 days post-lambing (+57% ; $p<0.05$) compared to those of control. Our results showed that the kaolinite clay can effectively have a role of additive growth promoter, however, to draw the maximum benefis from it, it is preferable to lead other in-vivo studies, preceeded by other in-vitro studies to characterize its effect on the dynamics of the ruminal ecosystem and animal performance with increasing doses.

**Keywords :** Additives, clay, ewe, nutrition, performance, periparturient.

## Introduction

The main limiting factor for the expression of animal genetic potential is the nutrition state, moreover, in arid regions, food resources are limited on natural pastures and the residues of lignified and nutritionally poor crops (Teferedegne, 2000; AFSSA, 2007). This situation is usually corrected by a perpetual supplementation with concentrate to compensate the deficit, and the incorporation of nutritional additives (antibiotics, coccidiostats, conservators). This is especially the case of intensification of farming that places animals in stressful conditions in order to promote the digestive efficiency of animals, improve animal welfare and reduce the environmental impact of livestock. Although, these additives had adverse reputation because of the emergence of antimicrobial resistance and the chemical residues that persist in meat products (Claude, 2002; Alloui, 2011; Peterson, 2012; Ouachem, 2017).

Currently, with the increasing awareness campaigns, orientation to "Bio" and "Eco- friendly" farms is increasingly required, inciting scientists to find alternatives to antibiotics and synthetic drugs. In this regards, one of the promising solutions that have been suggested to improve animal productivity is clay with its different types. In addition to its availability in nature and its reduced cost, the consumption of clay has been recorded for millennia for therapeutic and spiritual reasons in humans (Ferrell, 2008; Bonglaisin *et al.* 2011), besides that, it is considered as a natural phenomenon in animals according to Duval (1993) and Bonglaisin *et al*. (2011). Therefore, the incorporation of clay in animal feed has proven its usefulness as a potential growth promoter additive, especially in ruminants (Ouachem *et al.*, 2005; Norouzian *et al.*, 2010; Stojković *et al.*, 2012).

For this study, we evaluated the response of ewes to incorporation 5% of kaolinite at the last month of pregnancy and during nursing by quantifying the effect on their productivity and growth of their lambs.

## Materials and Methods

The experiment was conducted in the demonstration Farm of the Technical Institute of Breeding of Ain M'lila in Oum-El-Bouaghi province, Algeria, during the autumn period of 2019.

*Clay*

This additive of natural origin, it is classified in the category of zootechnical additives since it aims to improve animal performance (CIV, 2008; Delteil *et al.*, 2012) and it is kaolinite already used in the work of Ouachem *et al.* (2012).

*Animals and Diets*

Twelve adult ewes of the Ouled-Djellale breed, clinically healthy, in last month of pregnancy, with an average weight of 72.08 kg (±10.57 kg) and average body condition score (BCS) of 2.75 (±0.6) were allotted in a breeding hangar and distributed equally into two experimental lots. The sheep of the two groups were given the same ration dominated by hay oat with limited distribution of barley straw. They also received 500g/day supplementation of granular concentrate based on corn, barn and supplemented with soya, mineral-vitamin supplement, phosphate and limestone. A transition period of 10 d was practiced to accustome the sheep to the different diets. The control group ($C_0$) recieved control concentrate (without kaolinite), and the other group (CL) received the same concentrate supplemented with 5% of kaolinite powder.

*Forage Analysis*

Forage analysis was applied following the European directive for the determination of the chemical composition of plants (French Association for Standardization ‘AFNOR’, 1982). For minerals, the analysis was made by the calcination method. The forage and the concentrate used had the chemical composition shown in Table 1.

Table 1 : Nutritional values of feed distributed to ewes

| Aliments | DM[1] (%FM) | OM (%DM) | MM (%DM) | CP (%DM) | CF (%DM) | Ca (%DM) | P (%DM) |
|---|---|---|---|---|---|---|---|
| Oat hay | 91.62 | 91.73 | 8.27 | 3.85 | 17.97 | 0.13 | 0.28 |
| Barley straw | 90.28 | 92.04 | 7.96 | 2.55 | 31.60 | 0.11 | 0.27 |
| Concentrate | 90.50 | 94.83 | 5.17 | 15.53 | 3.04 | 0.07 | 0.55 |

[1]DM : dry matter ; FM : fresh matter ; OM : organic matter ; MM : mineral matter ; CP : crude protein ; CF : crude fiber ; Ca : calcium ; P : phosphorus.

*Weight and BCS*

In this experiment, ewes were monitored for weight dynamics and body condition score (BCS). The two parameters were evaluated in the same day, ewes were weighed at prefeeding time with a weighing scale (MARECHALLE-pesage PM 150. France) with a maximum weight of 200kg and a standard deviation of 500g. BCS was evaluated by lumbar palpation according to the recommendations of Russel *et al.* (1969) cited by Russel (1984).

Besides, the lambs were also the subject of a study of the kinetics of the weight, and were weighed at birth, then every week until the age of 70 d using a precision balance (Dahongying, China) with a maximum capacity of 30kg and a margin error of ±5g. The average daily gain (ADG) of lambs was estimated as follows:

ADG (g) = Weight (g) in t (days)/t (days)

*Milk Production*

The quantity of milk produced by ewes was estimated at 1st and 8th week of lactation using the equations (Table 2) proposed by Torres-Hernandez and Hohenboken (1980).

Table 2 : Prediction equation for milk yield of ewes (Torres-Hernandez and Hohenboken, 1980)

| Âge of lambs (wk) | Single birth | | Twin birth | |
|---|---|---|---|---|
| | Équation[1] | $R^2$ | Équation | $R^2$ |
| 1 | MY(L) = 0.17+5.06×ADG | 0.65** | MY(L) = 0.03+4.98×ADG | 0.69** |
| 8 | MY(L) = 0.42+3.45×ADG | 0.33* | MY(L) = 0.63+1.89×ADG | 0.20* |

[1]MY: milk yield, ADG : Average daily gain
** $p < 0.01$, * $p < 0.05$

*Milk Sampling and Analysis*

Sampling was done in early lactation (the first 10 d), mid lactation (5th wk) and during the 10th wk of suckling. The milk was collected by manual milking in glass tubes and then transported cold in a cooler to the laboratory for physico-chemical analysis. The analysis of the milk was carried out using LACTOSCAN apparatus (Ultrasonic Milk Analyser, BQC®) for the fat content (FR), the protein rate (PR) and the lactose rate (LR).

*Statistical Analysis*

The data collected were subjected to statistical treatment using STATISTICA V.6 program. The exploration was carried out by a comparison of variables using the T test of Student for the variables with normal distribution and its counterpart U of Mann-Whitney for the variables having non-normal distribution.

## Results and Discussion

*Ewe Weight and BCS Monitoring*

The impact of energy balance on animal productive capacities is implicitly recognized, however, the body reserves serve to control it (Purroy *et al*., 1991; Bouvier-Muller, 2017). Weight and BCS, two quantitative parameters having a primordial role in the assessment of animal body condition and their level of energy reserves, their importance in the management of female's productivity in particular pregnant ones makes their monitoring compulsory in order to improve animal performance.

Results of ewe's weight and BCS monitoring from the last month of pregnancy until achievement of the first month of suckling are shown in Table 3. This monitoring showed that ewes followed the same pattern of weight and BCS through these different physiological stages, knowing that they had similar weight and BCS at the start of the experiment, during last month of pregnancy, although the ewes of CL group had a numerically less intense lipomobilization compared to the control ones. With the lack of references and studies conducted in this context on ewes, especially those of the Ouled-Djellal breed, it should be noted that our result is opposed to the findings of Karatzia *et al.* (2013), Parmigiani *et al.* (2013) and those of Garzón Prado *et al.* (2017) indicating that a supplementation of dairy cows with clay in periparturient period improved significantly their body state which was related to the improvement of the energy balance in this physiological circumstance as explained by Karatzia *et al.* (2013).

Table 3 : Weight[1] and BCS[1] monitoring in periparturient period as affected by kaolinite addition

| Physiological stage | Parameter[2] | Control ($C_0$) | Clay (CL) | *p*-value |
|---|---|---|---|---|
| Last month of pregnancy | LW (kg) | 72.0±11.74 | 64.33± 9.71 | 0.4023 |
| | BCS | 2.5±0.70 | 2.33± 0.29 | 1.0000 |
| At lambing | LW | 59.88±8.82 | 54.5± 2.18 | 0.5959 |
| | BCS | 2.25±0.50 | 2.5± 0.00 | 0.4366 |
| 1st month post-lambing | LW | 54.5±11.74 | 49.5± 3.77 | 1.0000 |
| | BCS | 1.63±0.25 | 2.0± 0.00 | 0.1116 |

[ab]In the same row, means with different subscripts are significantly different at $p<0.05$
[1]Mean and standard deviation
[2]LW : Live weight in kg ; BSC : Body condition score.

*Milk Production*

Milk production depends 25% on animal genetics, and 75% on environmental factors, in which food is the dominant component (Ilić *et al* 2005 ; 2011). In other words, according to Đoković *et al.* (2011), yield and chemical composition of milk are dependent on the influence of breed, food, hygiene, lactation stage and housing.

The milk yield as well as the chemical composition of the milk emerging from our experiment are shown in Table 4. Statistical analysis showed that ewes receiving kaolinite had significantly the highest (+29.4% ; p <0.05) cumulative milk yield during the first 8 wk of suckling compared to those of the control group. This finding supports those of Katsoulos *et al.* (2006), Micic *et al.* (2017), Uyarlar *et al.* (2018) and Khachlouf *etal.* (2019) relating that the improvement in milk yield of dairy cows due to the clay incorporated in their diets, although, it contradicts with the other findings (Migliorati *et al.*, 2007 ; Agus *et al.*, 2014; Sulzberger, 2016). Otherwise, according to Khachlouf *et al.* (2019), it was assumed that increased milk production could result from an increase in ruminal propionate concentration, due to increased postruminal digestion of starch, increased protein synthesis, increased bypass protein or from a combination of these factors. It is noted that these phenomena may have been associated with the presence of clay in the ration, as mentioned in several studies carried out in this direction in ruminants (Murray, 1990; Wallace and Newbold, 1991; Ouachem and Nouicer, 2006; Laibi *et al.*, 2015; Goodarzi and Nanekarani, 2012; Ibrahim, 2012) where the authors reported the stabilizing effect of clay on rumen ecosystem by enriching it with minerals essential to protein synthesis and fibrolytic digestion and allowing the saving of a part of the ammonia and improving the protein flow towards the intestine, besides, redirecting the bioprocess of fermentation towards the production of advantageous propionate, which was also assumed by Ivan *et al* (1992) that clay could increase protein flow to the intestine by protecting protein and amino acids against microbial attacks.

Regarding the milk quality, the results are presented in Table 4. Statistically speaking, the various quality parameters appearred to approach each other between the two groups. Our results are consistent with the findings of Lemerle *et al.* (1984), Migliorati *et al.* (2007) and Sulzberger (2016) reporting that clay had no significant effect on the quality of cows'milk when it was incorporated whith diet. However, this contrasts with what has been discussed by Duval (1993), Katsoulos *et al.* (2006), Ilić *et al.* (2011) and Alic-Ural(2014) in cows and by Ouachem *et al.* (2012) in the Arabia goats in Algeria. These authors mentioned that the chemical composition of milk was vulnerable in the presence of clay, and had been recognized as an effective additive to improve food efficiency, by improving the protein and fatty acid supply in conditioning the quality of milk.

Table 4 : Ewe's milk yield[1] and milk composition[1] during the suckling period as affected by kaolinite addition

| Parameters[2] | | Wk post-lambing | $C_0$ | CL | *p*-value |
|---|---|---|---|---|---|
| Quantity (L) | | 1st wk | 1.0± 0.21 | 1.36± 0.35 | 0.1145 |
| | | 8th wk | $0.9^a$± 0.04 | $1.1^b$± 0.18 | 0.0418* |
| Quality | FR (%) | 1st wk | 9.17± 1.38 | 8.8± 1.35 | 0.7016 |
| | | 8th wk | 8.6± 1.63 | 8.2± 2.82 | 0.7862 |
| | PR (%) | 1st wk | 4.1± 0.26 | 3.8± 0.30 | 0.2682 |
| | | 8th wk | 3.6± 0.26 | 3.6± 0.19 | 0.9235 |
| | LR (%) | 1st wk | 3.5± 0.14 | 3.5± 0.19 | 0.8406 |
| | | 8th wk | 3.6± 0.50 | 3.8± 0.58 | 1.0000 |

[ab]In the same row, Means with different subscripts are significantly different (*: $p<0.05$)
[1]Mean and standard deviation
[2]FR : fat rate; PR : protein rate; LR : lactose rate.

*Maternized Lambs*

Lamb birth weight of the two experimental groups as well as the monitoring of their growth are shown in Table 5. Indeed, the comparison of the data revealed that birth weight in the group of lambs mothered with kaolinite was numerically higher ($p>0.05$) than that of lambs in the control maternity with a remarkable 17% difference. This consolidates the finding of Ouachem and Soltan (2009) who repoted a positive effect of the supplementation of goats with the clay in periparturient period which had a positive effect on fetal growth which generated good birth weight, and this explains the result of this experiment by better food availability during the last month of gestation, consequantly to the combined effects of the increase in dry matter intake and a better digestive yield in the presence of clay.

In contrast, highly significant superiority ($p<0.005$) of lamb weight mothered with clay at 4 wk of age, at 70 d of age and in average daily gain was observed compared with those of the control, showing differences of +41%, +57% and+74%, respectively. In fact, according to Ouachem *et al.*(2012), the growth of new born lambs was directly linked to the quantity and quality of milk available. In this case, the high milk yield of ewes receiving the clay explained the fastest growth of their progeny compared with those of control having low milk yield and their slower offspring growth. On the otherside, according to Benyounes *et al.* (2013), birth weight is a key element for the survival of lambs, in this context, Dekhili (2003) indicated that the weaning rate of Ouled-

Djellal lambs increased by 15% when their weight at birth went from 2 to 5kg. In other words, lambs of normal birth weight had the capacity to increase their heat production to ensure thermoregulation, although, lambs with low birth weights would have higher calorific loss, and reduced body reserves (Benyounes *et al.,* 2013). This is also able to explain, the lesser importance of, the rapid growth of lambs mothered with clay representing high birth weight compared to those of control in our study.

Table 5 : Birth weight[1] and lamb growth[1] of Ouled-Djellale lambs with or without kaolinite

| Parameters[2] | $C_0$ | CL | *p*-value |
|---|---|---|---|
| BW (kg) | 3.8± 0.69 | 4.5± 0.34 | 0.1104 |
| W4w (kg) | $7.6^a$± 1.36 | $10.7^b$± 1.70 | 0.0056* |
| W70d (kg) | $12.0^a$±2.04 | $18.8^b$± 3.38 | 0.0014** |
| ADG (g/d) | $116.9^a$±0.02 | $203.9^b$± 0.04 | 0.0010** |

[ab]In the same row, means with different subscripts are significantly different (*p< 0.05 ; **p<0.01)
[1]Mean and standard deviation
[2]BW : Birth weight; W4w : Weight at 4 wk after birth; W70d : Weight at 70 d of age; ADG : Average Daily Gain from birth to 70 d of age.

## Conclusion

The results of this study are proof of the usefulness of clay especially the kaolinite type as a growth promoter additive. Its contribution in improving the productivity of ewes in the transition period through the promotion of milk production and lambs growth which can inhence their survival, and even, will effectively attract the attention of farmers, livestock feed manufacturers and even decision-makers wishing to improve the profitability of farms, especially in difficult areas with an accessible, available, effective and especially a safety product for human consumers as tested in this study. In this regard, and to externalize the most visible responses and so as to get the maximum profit possible, it is better to follow our study with in vitro studies, by testing increasing doses of clay in order to characterize its effect on the dynamics of the ruminal ecosystem, followed by in-vivo studies in order to find the optimal dose positively affecting the metabolism of the animal.

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