

Body condition score at lambing did not affect the resumption of ovarian and estrous activity in lactating Pelibuey ewes

La condición corporal al parto no afecta el reinicio de la actividad ovárica y estral en ovejas Pelibuey lactantes

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Abstract

The aim of the study was to evaluate the effect of body condition score (BCS) at lambing over the resumption of ovarian and estrous postpartum activity in lactating Pelibuey ewes. Twenty ewes were assigned to two groups, according to the BCS at lambing: Low BCS (LBC, n = 10) and High BCS (HBC, n = 10). Ovarian and estrous activities were daily monitored from day 3 postpartum until the first estrous or 90 days postpartum. Continuous variables were analyzed using *Student's t* test and binary responses with the exact Fisher test. No significant effect of BCS at lambing on ewes in estrous, lambing to first estrous interval, estrous length, and estrous cycle length, preovulatory follicles at estrous, the maximum follicular diameter at estrous day or ovulation rate was observed. However, the lambing to first preovulatory follicle interval was shorter in the HBC group (HBC = 6.2 ± 2.6 vs LBC = 10.8 ± 4.5 d; P < 0.05). The lambing to first corpus luteum intervals were similar between groups, but without estrous expression. The function of the first corpus luteum postpartum was similar in both groups. BCS at lambing did not affect the resumption of ovarian and estrous activity postpartum in lactating Pelibuey ewes.

Keywords: sheep; follicular development; ovulation rate; live weight; sexual behavior; tropical; body condition; lambing; ovarian activity; estrous activity; estrous; corpus luteum; Pelibuey; lactating; animals

Resumen

El objetivo del estudio fue evaluar el efecto de la condición corporal (BCS) al momento del parto en la reanudación de la actividad ovárica y estral de las ovejas Pelibuey lactantes. De acuerdo con la condición corporal postparto, veinte ovejas fueron separadas en un grupo de baja BCS (LBC, n = 10) y alta BCS (HBC; n = 10). Las actividades ovárica y estral se observaron diariamente, desde el tercer día postparto hasta el primer estro o 90 días postparto. Las variables continuas se analizaron mediante la prueba *t de Student* y las respuestas binarias con la prueba exacta de Fisher. No se observó ningún efecto significativo de la BCS al parto, sobre la presencia de celo, intervalo parto-primer celo, duración del estro y duración del ciclo estral, presencia de folículos preovulatorios en el celo, diámetro folicular máximo en el día del celo o tasa de ovulación. Sin embargo, el intervalo entre el parto y el primer folículo preovulatorio fue más corto en el grupo HBC (HBC = 6.2 ± 2.6 vs. LBC = 10.8 ± 4.5 d; P < 0.05). El intervalo entre el parto y el primer cuerpo lúteo fueron similares entre los grupos, pero sin expresión de celo. La función del primer cuerpo lúteo postparto fue similar en ambos grupos. La BCS en el parto no afectó la reanudación de la actividad ovárica y estral postparto en ovejas Pelibuey lactantes.

Palabras clave: ovejas; desarrollo folicular; tasa de ovulación; peso vivo; comportamiento sexual; trópico; condición corporal; parto; actividad ovárica; actividad estral; celo; cuerpo lúteo; Pelibuey; lactancia; animales

1. Introduction

Nutritional status is a key aspect in breeding ewes to reach a higher reproductive performance in sheep production systems of tropical areas. And the nutritional requirements rises in critical periods such as in late gestation and during lactation (Dos Santos *et al.*, 2017).

The most accepted method to measure the nutritional status, is through body condition score (BCS); a practical and reliable indicator of corporal energy reserves in ewes; that includes the assessment of subcutaneous and muscle reserves along the backbone and which exerts important effects on reproductive activity (Kenion *et al.*, 2014).

Previous studies indicate that ewes with high BCS (> 3 points) have a positive effect over reproductive performance like better fertility rates, larger length, and estrous rate, as well as higher follicular activity, and ovulatory rate compared to ewes with low BCS (≤ 1.5 points) during breeding season (Vatankhah *et al.*, 2012; Cam *et al.*, 2018). In cattle, several studies showed the positive effect of BCS at calving (≥ 3.5 , in the 1 to 5 pounds scale) on the calving to first estrous interval, duration of the luteal phase and an increase of ovarian activity and fertility on the first postpartum service (Roche *et al.*, 2015).

In the Mexican tropics Pelibuey sheep is the main breed, used either as purebred or crossbred, playing a maternal role for lamb production (Tec *et al.*, 2016). Some studies in Mexico over BCS with tropical hair sheep given hormonal treatments have shown varied results on estrous activity, ovarian follicular growth, and ovulatory rate (De la Isla *et al.*, 2010).

Nevertheless, there is minimal information that discuss the effect or relation between live weight and BCS to the interval from lambing to estrus and ovulation on ewes in tropical systems (Santos *et al.*, 2009; Chay-Canul *et al.*, 2019).

This highlights the need of further research to know the real effect of BCS at lambing on the ovarian activity resumption, and if applicable, the use of this information to establish nutritional and reproductive strategies aimed to improve herd productivity. The objective of this study was to determine the effect of BCS at lambing on the ovarian postpartum resumption and estrous activity in lactating Pelibuey ewes

2. Methods, techniques, and instruments

Site of study

This study was carried out from September to December of 2009 in the Faculty of Veterinary and Animal Science of the Universidad de Yucatán in Yucatan, México. Yucatan is located between $21^{\circ} 06'$ north latitude and $89^{\circ} 27'$ west longitude. The climate of the region is tropical sub-humid with an average temperature of 25.8°C , annual rain falls of 983.8 mm and relative humidity between 75 and 80 % (INAFED, 2016).

Animals

Twenty multiparous Pelibuey ewes (2 to 4 lambing) from a commercial flock were used in this study. Females lambed during the first two weeks of September and were randomly divided in accordance to their BCS into two groups: high body condition (HBC; $n = 10$; BCS: 3.0 to 4.0 points) and low body condition score (LBC; $n = 10$; BCS: 2.0 to 2.5 points). Body condition was performed by lumbar palpation performed by a single trained person (Russel *et al.*, 1969). Body weight and BCS of ewes of both groups were recorded at the start and at the end of this study. Ewes of both groups were in good health and stayed with their lambs under continuous suckling, until day 60 postpartum.

Treatments

Animals grazed during 8 hours per day Star grass paddocks (*Cynodon plectostachyus*) under irrigation. In addition, they were supplemented with 400-600 g/d of a commercial concentrate (16 % CP and 10.1 MJ/kg of dry matter), to cover the maintenance and lactation requirements of ewes in relation to live weight. Ewes had permanently access to fresh water, shadow area and mineral supplementation.

From day 3 postpartum, estrus and ovarian activity were recorded daily until the first estrus occurred or 90 days postpartum. Estrus expression was detected, throughout the experiment twice a day (07:00 and 18:00 h) by the

introduction of two teaser rams with a marker for 30-40 minutes. Estrus duration was estimated based on the time elapsed (h) between the first and last observation of estrous signs, estrus cycle length was defined as the time, in days (d), between two consecutive estrous (d). Follicular development was evaluated through transrectal real-time ultrasonography, with a linear transducer of 7.5 MHz (Aloka-500. Aloka Co, Ltd. Tokio, Japan). In each exploration the scanning of both ovaries was evaluated, recording the number, diameter, and relative position of all the follicles. Preovulatory follicles were defined as those who had ≥ 4 mm of diameter (Ravindra *et al.*, 1994). The number of corpora lutea (CL) was determined by ultrasonography and confirmed nine days after estrus using laparoscopy (Karl Storz de 0.5 mm. Germany). The ovulatory rate was calculated dividing the number of observed CL between the total numbers of ewes that ovulated (De la Isla *et al.*, 2010).

Ewes that were detected in estrous were subjected to blood sampling every three-day interval, starting the day that the ovulation was identified by ultrasound until four samples were obtained for each female. Blood samples were obtained by jugular venipuncture, collected in tubes with EDTA 10 %, and then centrifuged at 1500 g for 15 minutes. Plasma was stored at -20°C, until the determination of progesterone (P4) concentration using an enzyme immunoassay (ELISA, DRG Instruments GmbH, Germany). The CL function was considered normal when P4 concentrations were ≥ 1 ng/ml in at least two consecutive samplings (Hunter, 1991).

Statistical analysis

The evaluated variables were: BCS, live weight, lambing to first estrus interval, lambing to first CL interval, lambing to first preovulatory follicle interval, maximum follicular diameter, number of preovulatory follicles and ovulatory rate were compared between groups using *t Student* tests. The variables: ewes in estrus (yes, no), estrous length, estrous cycle length, ovulatory rate at estrus and functionality of the first CL (yes, no). Number of ewes in estrus were analyzed by Fisher exact test. All statistical analyses were conducted using SAS (SAS Institute Inc, Cary, NC, USA).

3. Results and discussion

3.1 Body condition and live weight

BCS in both groups did not show significance differences ($P > 0.05$) at the end of the study compared with the initial score (averages of 3.3 and 3.2 respectively for HBC; 2.25 for LBC). Live weight showed a similar pattern, HBC group had similar body weight at the start (39.0 ± 6.0 kg) and at the end (37.7 ± 5.42 kg) of the study, while in LBC group at the end of the study the live weight had no significant change (initial weight 34.2 ± 3.27 kg and final weight 33.5 ± 2.5 kg).

3.2 Ovarian activity (follicular development-ovulation)

Table 1 show the interval from lambing to the presence of first preovulatory follicle, being 4 days lower in the HBC group in comparison with LBC group ($P < 0.05$). BCS at lambing had no effect over the number of preovulatory follicles, or by the maximum follicular diameter registered at estrous day ($P > 0.05$). Average number of follicles for both groups were 2.5 and the average for the maximum follicular diameter was 7.0 mm (table 1).

Also, no significant effect of the BCS over the ovulatory rate was founded ($P > 0.05$). HBC group had a lower first preovulatory follicle interval after lambing and a higher ovulatory rate than LBC, although this last was not statically significant. On the other hand, 100 % of the ewes in both groups presented their first CL without estrous signs, lambing-first CL interval was similar between HBC and LBC groups, this structure was present around 18.5 days (table 1).

Table 1. Results of ovarian activity resumption traits in lactating Pelibuey ewes with different body condition at lambing.

Tabla 1. Resultados del reinicio de la actividad ovárica en ovejas lactantes de la raza Pelibuey con diferente condición corporal al parto.

Variable	Body condition	
	HBC (n = 10)	LBC (n = 10)
Lambing- first preovulatory follicle interval (days)*	6.2 ± 2.6 ^a	10.8 ± 4.5 ^b
Lambing-first <i>corpus luteum</i> interval (days)	18.2 ± 8.4 ^a	19.3 ± 11.3 ^a
Maximum follicular diameter in estrous (mm)	7.4 ± 0.1 ^a	6.9 ± 0.1 ^a
Number of preovulatory follicles	2.4 ± 1.0 ^a	2.3 ± 1.1 ^a
Ovulatory rate**	1.6 ± 0.69 ^a	1.4 ± 0.72 ^a

Note: *d: Postpartum days. ^{a,b} Mean values with different letter are significantly different (P < 0.05). HBC: High body condition score (3 to 4); LBC: Low body condition score (2 to 2.5). **Number of CL observed divided by the number of ewes that ovulated.

Nota: *d: Días postparto. ^{a,b} Valor de la media con diferentes letras presentan diferencias estadísticas significativas (P < 0.05). HBC: Condición corporal Alta (3 a 4); LBC: Baja condición corporal (2 a 2.5). **Número de CL observados divididos por el número de hembras que ovularon.

With respect to the function of this first CL, progesterone concentration was maintained in > 1ng/ml for more than 9 days in all the ewes, therefore it had a normal duration in both groups (P > 0.05).

3.3 Estrus activity (estrous and estrous cycle)

BCS at lambing did not have effect on the postpartum estrous activity (table 2), encountering that the interval lambing-first estrous and the percentage of ewes in estrous, did not differ in both groups (P > 0.05), although it is observed a longer interval in the group of LBC. Estrous cycle length and estrous length were slightly lower in LBC group than in the HBC group (table 2); however, no significant difference was founded (P > 0.05).

Table 2. Results of estrus postpartum activity traits in two lactating Pelibuey ewes groups with different body condition at lambing.

Tabla 2. Resultados de la actividad estral postparto en dos grupos de ovejas lactantes de la raza Pelibuey con diferente condición corporal.

Variable	Body Condition	
	HBC (n = 10)	LBC (n = 10)
Lambing –first estrous interval (days)	49.7 ± 13.5 a	56.6 ± 17.3 a
Females in estrous (%)	100.0 a	90.0 a
Estrous length (h)	30.0 ± 14.1 a	25.3 ± 12.6 a
Estrous cycle (days)	17.4 ± 0.69 a	16.4 ± 2.45 a

Note: HBC: High body condition score (3 to 4); LBC: Low body condition score (2 to 2.5).

Nota: HBC: Condición Corporal Alta (3 a 4); LBC: Baja condición corporal (2 a 2.5).

3.4 Discussion

Body condition and live weight. This study aimed to measure the effect of BCS over estral and ovarian activity of ewe after lambing. Is known that several factors influence the return to postpartum ovarian cyclicity in ewes, playing the nutrition an important role in follicular development, through a variety of endocrine, neural, and metabolic mechanisms and consequently influences the period from lambing until the first estrus and ovulation (Ascani *et al.*, 2013), being the live weight and BCS a way for determine the nutritional status of sheep at different nutrition phases (Maurya *et al.*, 2017).

In the case of BC and live weight, not having found changes both at the beginning and at the end of the study could suggest that the nutritional plan that was followed during the postpartum period was adequate, similar

results were shown by Arroyo *et al.* (2011) founding no difference in the weights and BCS of Pelibuey ewes under continued or controlled nursing and with an adequate nutrition plan.

Ovarian activity. The period between lambing and the appearance of the first ovulatory follicle, resulted shorter in the HBC ewes (Milosevic-Stankovic *et al.*, 2020) found, in early postpartum goats, that blood levels of non-esterified fatty acids (NEFAs) and β -hydroxybutyrate (BHBA) depend on body condition, having an inversely proportional relationship. In vitro cultures, it could conclude that the presence of NEFAs and BHBA, have a negative effect on follicular growth and estrogen secretion (Nandi *et al.*, 2017) the latter necessary for pre-ovulatory follicle growth (Cárdenas y Pope, 2012).

This allows us to infer that the ewes that started with a low BCS saw follicular development affected by high concentration of NEFAs and BHBA, which was reflected in a greater interval between lambing to first preovulatory follicle.

Respect to the number of preovulatory follicles at estrous day, there were no significant difference between BC groups. It could be due in part to forage availability, adequate amount of food could counter the negative energetic balance postpartum, reflecting off a slightly decrease for live weight and for BC of the HBC group at the end of the study, independently of the nutritional supplementation which was managed based in ewes live weights. This could happen because there was no intake control during grazing.

Lambing BC did not affect the maximum follicular diameter founded during estrous day, similar results to those recorded by other authors as Viñoles *et al.* (2002) who worked with ewes in different BC scores, although with a minor diameter that founded in this study (5.5 and 5.3 mm in HBC and LBC respectively), apparently follicular size is modified when exists a higher energy input into the diet independently of BC score (Mosaad y Derar, 2009).

Neither the ovulatory rate was modified by the effect of BC in the present research, these results differ from the afore mentioned for BlackBelly breed, where it was found that ewes with a 3 points BC score presented a higher ovulatory rate (2.6), compared with ewes of 1 and 2 points of BC (1.6), furthermore in the same work reported that ewes with 4 BC points exceeds even up in 2 egg cells compared to females with 3 BC points (Rojas-Rodríguez y Rodríguez-Rivera, 1997).

The season of the year that the study was conducted (September-December), could be a determinant factor for the ewes to not express reproductive differences between BC groups, because fall-winter season in the northern hemisphere is considered a reproductive season for this specie, independently of the breed (Arroyo *et al.*, 2007).

First corpus luteum postpartum was produced by silenced ovulations in all the females of both groups and presented between 18 and 20 postpartum days, this situation was previously documented in Pelibuey ewes, but with values of 40.6 to 77.3 days (Morales *et al.*, 2004; Pérez *et al.*, 2009). Thus, is also related to first average ovulation, occurred around day 20. On the matter, Ciccioli *et al.* (2003) founded a higher proportion of half-life CL, after day 20, compared to those formed during first postpartum days.

About the BC influence over postpartum luteal function, some studies indicate that there was no effect of body condition over first CL half-life, finding that the progesterone levels are maintained for more than 10 days, regardless of BC changes (Looper *et al.*, 2003)

Estrus response. Estrus activity results showed that BC at lambing had no effect over the proportion of females that went in estrous. This situation has been registered in Pelibuey breed with similar environmental conditions, but with non-lactating females, founding a 90 % of estrous activity in animals with a LBC and a 95 % in females with a HBC (Arroyo *et al.*, 2011). In another study in goats crossbreed goats, Ahmad *et al.* (2018) reported that there was no significant effect of BCS (2.5 to 4) on onset of estrus. The percentage of showed estrus suggested that the BCS managed in this study (2.25-3.3) is suitable for breeding multiparous Pelibuey ewes under tropical conditions.

Concerning to the period between lambing and first estrus presentation, this trait was not influenced by the BC effect. These results are partly similar from the observed by Dapoza *et al.* (1995) in Aragonesa ewes, which also found no effect of BC over the first postpartum estrous, recording weaning-estrous intervals in ewes with HBC of 32.09 ± 9.0 d and of 30.2 ± 4.0 d for LBC ewes (weaning was between 45 to 50 days), whereby the interval registered by these author's is around 80 days, average higher in about to 30 days compared for Pelibuey sheep in this study.

The lambing-first estrous average observed in this experiment is similar to the reported by different researchers in Pelibuey ewes of Mexican tropics (Peron *et al.*, 1990; Contreras *et al.*, 2003), who mentioned that this indicator is between 40 and 63 days.

Estrous length was either not affected by BC at lambing, this variable differs from results showing that a low BC reduces between 6 and 9 h the estrous length (De la Isla *et al.*, 2010; Aké-López *et al.*, 2013). Fitz-Rodríguez y Santiago Miramonte (2009) working with goats indicating that females with body condition between 2 y 4 points presented estrous of normal length, coinciding with averages founded in this study were within time range considered as normal for ewes (24-48 h) and registered by other authors in tropics for Pelibuey breed (Peron *et al.*, 1990).

As regards to estrus cycle length, BC had no significant effect. The length average for estrous cycle in this experiment (16.9 d), is consistent with the normal parameter described before in the ovine specie (16-17 days; (Lozano *et al.*, 2012) and in breed (Macías-Cruz *et al.*, 2017).

Probably the similar scores in estrous activity variables, can be attributed to that BC and other nutritional factors do not affect sexual behavior significantly, as suggested by Abecia *et al.* (1995), and Dapoza *et al.* (1995), who experimented with alimentary restriction and various levels of BC and found no differences in estrous presentation, with different nutritional management.

On the other hand, Vatankhah *et al.* (2012) report that BC equal to or greater than 2.5 are ideal for adequate estrous function, because the hormones involved in this event are maintained at adequate levels. In addition, De la Isla *et al.* (2010), and Herrera-Corredor *et al.* (2010) argue that ewes and specially the Pelibuey breed possess the capacity to express estrous throughout the season with major reproductive activity (fall-winter), independently to their BC score or level alimentation, thus can be related with the time that this research was conducted (September to December).

Moreover, the alimentation offered in the present investigation could be determinant in the presence of a similarly estrous behavior of the LBC to the HBC group, because such animals could consume enough energy with grazing and cover their maintaining and postpartum production requirements. This situation could trigger an «immediate» nutritional effect over the sexual activity of ewes (Dowing y Scaramuzzi, 1991; Scaramuzzi *et al.*, 2006).

4. Conclusions

The conclusion is that at the BCS at lambing did not have effect over the ovarian and estrous activity resumption in lactating Pelibuey ewes maintained over tropical conditions.

5. Supplementary information

No.

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Contribution of the authors in the development of the Work

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Interest conflict

The authors declare that there is no conflict of interest.

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