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SHORT NOTE [NOTA CORTA]

ARTIFICIAL LONG DAYS INDUCE AN INCREASE OF MILK YIELD IN ALPINE GOAT

[LOS DÍAS LARGOS ARTIFICIALES CONSTANTES INCREMENTAN LA PRODUCCIÓN LÁCTEA EN LAS CABRAS ALPINAS]

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RESUMEN

Para determinar si la aplicación de días largos artificiales durante el invierno y primavera aumenta la producción láctea de las cabras Alpinas del norte de México, un grupo testigo (GT; n=14), fue expuesto a las variaciones naturales del fotoperiodo de la región durante todo el estudio (10 h y 19 m en el solsticio de invierno y 13 h con 41 m durante el solsticio de verano), mientras otro grupo experimental (GE; n=15), se sujetó a un tratamiento de días largos constantes (16 h de luz/8 h de oscuridad) del 1 de diciembre al 19 de abril. La producción de leche al inicio del estudio (día 0 = 45 ± 0.6 días posparto) fue similar en los dos grupos (P>0.05), mientras que del día 14 hasta el día 112 del estudio, fue diferente entre los dos grupos (3.2 ± 0.07 *vs*. 2.7 ± 0.06 lts/día/animal GE vs. GT; P<0.05). Estos resultados demuestran que la exposición a días largos artificiales induce un incremento en la producción láctea de las cabras Alpinas del norte de México, solamente durante el invierno.

Palabras clave: rendimiento de leche; composición de la leche; cabras; fotoperiodo.

SUMMARY

The aim of this study was to determine if the use of artificial long days during winter and spring improve milk production in Alpine goat raised in Northern Mexico. Control Group (CG; n=14), was exposed to naturals photoperiod variations of the region during the whole experimental period (10 h and 19 min in the winter solstice), while the Experimental Group (EG; n=15), subject, from December 1st to April 19th, to a constant long day treatment (16 h light/8 h dark). At the onset of the trial (day 0 = 45 ± 0.6 postpartum days) milk yield was not different (P>0.05) between both groups. However, the EG group depicted an increase (15%) in milk yield from d-14 to d-112 with respect to the CG group (3.2 ± 0.07 *vs*. 2.7 ± 0.06 l/day/animal EG *vs.* CG; P<0.05). These results show that, during winter, exposition to long artificial days induces milk production increases in Alpine goat raised in Northern Mexico. Further studies are required to evaluate if long photoperiodic treatment affects the hormonal reproductive status of dairy goats.

Key words: Milk Yield; Milk Composition; Goats; Photoperiod.

INTRODUCTION

Goat milk production is gaining importance worldwide, a situation that has promoted an increase in the number of specialized dairy farms under intensive conditions in different Mediterranean regions (Mabjeesh *et al.* 2007). Because of that, new technological strategies to increase milk production have been the focus of recent studies. According to Bourdon, 25% of the variation in milk production is attributable to the genetic makeup of the animals , while the remaining 75% is due to environmental factors (Bourdon 1997).

Among the environmental factors affecting milk production, photoperiod has been defined as a very important one (Dahl *et al.* 2000); it can be defined as the recurring cycle of light and darkness within a period of 24 h. Under natural conditions, photoperiod is the most consistent environmental cue among years, for this reason, the immense majority of terrestrial species has adopted this environmental indicator to

setup in time long-term physiological processes, particularly reproduction. However, in ruminants, other variables that also affect this environmental cue include growth, lactation and immune function. In this way, manipulation of photoperiod during the life cycle of dairy animals is currently a very important strategy affecting the productive outcomes of the dairy industry, even under intensive management conditions (Collier *et al.* 2006).

Photoperiod is defined as the duration of light exposure within 24 hours. A long day or long day photoperiod (LDPP), consists of a period of 16-18 h of exposure to light. In contrast, a short day or short day photoperiod (SDPP) is characterized by 8 h of light followed by 16 h of darkness (Dahl 2008). Even the use of soft night lighting positively affects both lactation, with increases of milk yield in the early lactation period, as well as by increasing fertility of dairy cows when compared to those not exposed to a soft night lighting (Reksen *et al.* 1999). Certainly the use of LDPP increases milk production by 8 to 10% compared with cows under natural photoperiod (Miller *et al.* 1999).

It has been shown that artificial long days can increase milk production in several species such as sheep and cattle (Dahl *et al.* 2000, Morrissey *et al.* 2008). For example, there is evidence that exposure of cows to long days during lactation can improve milk production in the subsequent lactation, however, in some cases it has been observed a decline in the percentage of fat when compared with animals exposed to natural days (Phillips and Schofield 1985; Dahl *et al.* 2000). There is also evidence that the response to LDPP persist through an entire lactation (Dahl and Petitclerc 2003). Moreover, Bocquier *et al.* (1997) found a significant increase in milk production in sheep under constant artificial long days, compared with ewes exposed to short days. Indeed, Sarda ewes under long days (15 h 3 m light/day) from day 25 before lambing to 150 days of lactation produced 25% more milk (1.21 vs. 0.96 l/day) than ewes under short days (8 h light 30 m/day) during this same period. Mabjeesh *et al.* (2007) reported that in both sheep and goats, the response to LDPP was greater than that usually observed in cows (+20%).

Unlike other species, there are few studies in goats carried out to evaluate the effect of photoperiod on milk production (Garcia-Hernandez *et al.* 2007, Véliz *et al.* 2009). Recently, Véliz *et al.* (2009) showed that in Saanen goats maintained in northern Mexico in an intensive system, exposure to 70 artificial long days (16 h light / day) from 16 December (day 8 of lactation), increased production levels of milk after weaning (at 30 days postpartum) compared with goats kept in natural short days. However, it is important to determine whether continuous artificial long days can increase milk production over a longer period of time and if the increase in milk production can be faster in those females without offspring. . Therefore, the hypothesis of this study was that constant long-day photoperiods during winter and spring can increase milk production in Alpine goats in northern Mexico.

MATERIAL AND METHODS

The study was conducted from December 1st, 2007 to April 19th in the arid north of Mexico (26° 23' N, 104° 47' W). A total of 29 adults Alpine goats were divided into two homogeneous groups according to their date of birth, litter size, body weight, body condition and milk production (44 ± 0.6 days postpartum, Table 1). In addition, kids were weaned before starting the study (approximately 30 days postpartum). Each group of females was placed in an open corral (15 X 15 m), 30 m away from each other. Pens were equipped with shades, feeders and automatic water-supply devices. A group of females (control group, CG, n = 14) was exposed, throughout the study, to natural daylight in the region (10 h 19 m in the winter solstice and 13 h with 41 m during the summer solstice .) The other group (experimental group, EG, n = 15) was subjected to a constant long-day treatment (16 h light / 8 h dark) from 1st December to 19th April. To this end, the pen in the experimental group was equipped with nine fluorescent lamps with a minimum luminous intensity of 413 ± 48 Lx at eye level of the animals. Goats remained housed throughout the study and were fed on alfalfa hay *ad libitum* (17% crude protein) which was provided three times daily (7:00, 13:00 and 20:00 h), each goat received 300 g of commercial concentrate (14% crude protein, 1.7 Mca / kg DM). While 50% of concentrate was provided during the morning milking (6:00 h), the other 50% was offered during the evening milking (18:00 h). Water and minerals were provided *ad libitum*.

Measurements

Over a period of 24 hours (two milkings, morning and evening) milk production was measured every two weeks throughout the study. To measure milk production, dairy milk weighers were used. Body condition was measured every two weeks throughout the study, according with the technique described by Walkden-Brown *et al.* (1997), which consists of measuring muscle mass in the lumbar region of the animal; so the value was given on a scale of 1-4 with intermediate points, where 1 was to extremely thin animals, and 4 = to animals with a very good muscle mass and a thick layer of subcutaneous fat.

Statistical Analysis

Milk production and body condition were compared by ANOVA with two factors (time and treatment). Then, independent student t tests were performed to evaluate difference among means. Statistical analyses were performed using the statistical package SYSTAT 10 (Evanston, ILL, USA, 2000).

RESULTS AND DISCUSSION

Milk production in goats of both groups during the study is shown in Figure 1. The ANOVA revealed a significant effect of group ($P<0.05$), an effect of time ($P<0.001$), as well as an effect of the treatment by time interaction ($P<0.001$). Milk production at the onset (day 0 = 45 ± 0.6 days postpartum) of the study was similar between groups ($P>0.05$), whereas from day 14 to day 112 of the study there were observed differences between experimental groups (3.2 ± 0.07 *vs.* 2.7 ± 0.06 liters/day /animal, EG *vs.* CG; $P<0.05$). In addition, body condition was similar in both groups (1.9 ± 0.05, $P>0.05$).

Our results demonstrate that exposure to artificial long days photoperiods continued during the winter in Alpine goats under an intensive production system, increases milk yield after 14 days of exposure to long days, compared to goats maintained on natural photoperiod. In fact, in this study, the long days treatment group achieved a 15% increase in milk production than controls. It should be noted that while milk production in the control group remained constant, the treated group milk production increased, observing the milk-peak on day 42. Thereafter, both groups depicted a decrease in milk yield up to day 126, where no differences were observed between experimental groups ($P>0.05$).

Table 1. Alpine goats in Northern Mexico divided into two homogeneous groups (control and experimental) according to their date of birth, litter size, body weight, body condition and milk production.

	Experimental Group	Control Group
Date of birth (days)	October 10^{th} ± 11^{a}	October 15^{th} ± 10^{a}
Litter size/female	1.3 ± 0.1[a]	1.4 ± 0.2[a]
Body weight (kg)	57.3 ± 1.4[a]	57.0 ±1.3[a]
Corporal Condition (1-4 scale)	2.0 ± 0.1[a]	2.0 ± 0.1[a]
Milk production (l)	2.7 ± 0.1[a]	2.6 ± 0.2[a]

Different literal denote statistical difference, $P<0.05$

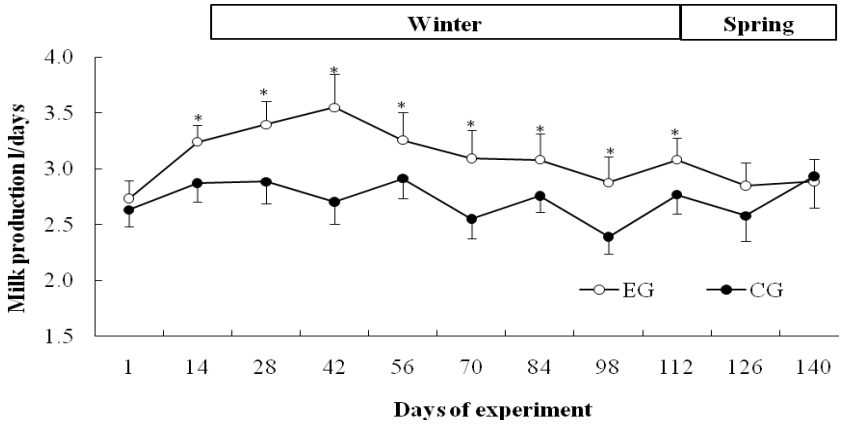

Figure 1. Evolution of milk production (mean ± SEM) of two groups of Alpine goats in northern Mexico (26° N). One group (black circles) was subjected from the 44 ± 0.6 days of lactation (day 0) to 140 constant long days from December 1^{st} (16 h light/day), while another group (white circles) was subjected to natural daylight in the region during the winter and spring.

The increase in milk production in the treated group was most likely due to a galactopoietic effect generated because of the exposure to the LDPP in the treated goats (Dahl *et al.* 1997). Indeed, recent studies have shown that long day photoperiods increase the serum concentration of IGF-I both in heifers and cows in production, so this may mediate the galactopoietic response to photoperiod (Dahl *et al.* 1997). At the onset of the study, a homogenous milk yield increase between experimental groups was observed, in disagreement to that observed by Veliz *et al.* (2009), who reported that females under 70 days long artificial depicted increases in milk yield after weaning after 42 days of treatment during winter, when compared to goats maintained in natural short days. However, in the present study, increases in milk production were immediate, and a possible explanation is that these females never directly provided milk to their kids, a situation that may have influenced milk production (Veliz *et al.* 2009). Indeed, in the present study, long days stimulated milk production from the beginning of the experimental period as observed in other species (Dahl *et al.* 1997).

Moreover, the lack of response to artificial long days after 112 days of experimental period, probably occurred because the treated animals began to be insensitive to the artificial long day photoperiod, as mentioned in sheep where after be subjected to more than 100 days of LDPP, ewes depicted the same performance than those ewes exposed to SDPP (Bocquier *et al.* 1997). Another possibility is that the control group did not decrease milk production in the spring as the treated group, because it was in natural long days. Indeed, it has been reported that goats' milk production varies during the year, observing increases just at the middle of the year (Linzell 1973). Another factor that may have influenced production of milk is the quality value of diet (Sharma 1982), however, both groups were subjected to the same nutritional regime throughout the study. In addition, body condition was not different between groups. Nonetheless, it is likely that an increased feed intake (*ad libitum* alfalfa) could be exerted by the treated group. Indeed, in cows has been reported an increased feed intake in animals subjected to long days (Miller *et al.* 2000).

One likely explanation for this difference in milk production between both experimental groups may be associated to increased levels of prolactin, since according to Aharoni *et al.* (2000), the difference in the response of milk and its components by the photoperiod, should be considered by factors affected by this hormone, although this aspect was not analyzed in this study. In dairy cows, it has also been reported (Aharoni *et al.* 2000, Auchtung *et al.* 2005) that both increases on both milk production and milk composition be achieved by decreasing the length of the days during the postpartum period, thus affecting the production of subsequent lactation. Because of this, further studies on the effect of long-day photoperiod in dairy goats under the conditions of the region, should consider the effect on the postpartum period and measurement of hormone levels, mainly of PRL and IGF-I.

CONCLUSION

The use of artificial long-day photoperiods in Alpine goats under intensive production system, increases their milk production during the winter, in contrast with females exposed to natural photoperiod.

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