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Food supplementation with mesquite and orange in goats: effect on colostrum, milk and kids

Complementación alimenticia con mezquite y naranja en cabras: efecto sobre el calostro, leche y cabritos

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ABSTRACT

The aim of the present study was to evaluate the quality of colostrum, milk and offspring development in goats supplemented with mesquite pods (*Prosopis spp*.) and orange bagasse (*Citrus sinensis*). Twenty-six multiracial goats in the last third of gestation were divided into three homogeneous groups with respect to body weight and body condition. The mesquite group (MG; n=9) was supplemented with 250 g/animal/day of mesquite pods, the orange group (OG; n=11) was supplemented with 250 g/animal/day of orange bagasse meal and the control group (CG; n=10) was not supplemented. The body weight of the goats of the three groups was similar during the study (P>0.05). Likewise, no statistical difference was found (P>0.05) in any of the other variables analyzed: blood glucose and ketone bodies, colostrum quality at calving of the mother goats, milk quality and body weight of the offspring. The results allow us to conclude that supplementation before and during parturition with orange bagasse or mesquite pods does not influence the quality of colostrum and milk, nor the development of the offspring in goats from the semidesert of Mexico.

Keywords: Orange bagasse, mesquite pod, postpartum, prepartum, dietary supplementation.

RESUMEN

El objetivo del presente estudio fue evaluar la calidad de calostro, leche y desarrollo de las crías en cabras complementadas con mezquite y bagazo de naranja. Veintiséis cabras multirraciales en último tercio de gestación se dividieron en tres grupos homogéneos respecto al peso y condición corporal. El grupo mezquite (GM; n=9) fue complementado con 250 g/animal/día de vaina de mezquite, el grupo naranja (GN; n=11) fue complementado con 250 g/animal/día de harina de bagazo de naranja y el grupo control (GC; n=10) no fue complementado. El peso corporal de las cabras de los tres grupos fue similar durante el estudio (P>0.05). Igualmente, no se encontró diferencia estadística (P>0.05) en ninguna de las demás variables analizadas: glucosa sanguínea y cuerpos cetónicos, calidad del calostro al parto de las madres, calidad de la leche y peso corporal de las crías. Los resultados permiten concluir que la complementación antes y durante el parto con bagazo de naranja o vaina de mezquite no influye en la calidad del calostro y leche, ni en el desarrollo de las crías en cabras del semidesierto de México.

Palabras clave: Bagazo de naranja, vaina de mezquite, post-parto, pre-parto, complementación alimenticia.

INTRODUCTION

Goats (*Capra hircus* L.) are one of the most important domestic species for humans, since they can produce and reproduce in adverse environments such as arid and semi-arid zones of the world (Meza-Herrera *et al*., 2022). Goats have great versatility in the collection of native browse and herbaceous species, in addition to having a great capacity to walk long distances in these environments, which allows them to graze over a large area of land per day compared to other species (Armenta-Quintana *et al*., 2011).

In the extensive system where goats are raised, changes occur throughout the year, in the type, quantity and vegetation composition (Mellado, 2016; Arévalo *et al*., 2020). This causes great nutritional challenges for this species, mainly in pregnant or lactating females, since in these stages they require a significant increase in nutrients (Salinas-González *et al*., 2016). The variability in quantity and quality of vegetation can affect the development of the fetus in the last stage of gestation, composition, quantity of colostrum and milk, which can also affect the development of the offspring (Banchero *et al*., 2015; Keles *et al*., 2017). These animals should be provided with a feed supplement once the vegetation decreases or their nutritional quality decreases (Luna-Orozco *et al*., 2015). However, traditional feed supplements, such as forages, or grains such as corn or commercial concentrates are very expensive, so other supplements of nutritional quality, but low cost, must be sought. An alternative for feed supplementation (Mínguez & Calvo, 2018), can be the use of agro-industrial by-products such as orange bagasse (*Citrus sinensis*). It is considered as an energy source within ruminant diets (Sharif *et al*., 2018) due to its nutritional characteristics (digestible nutrients 63.78 (Mcal), crude protein (10%), crude fiber (30 to 80%) and micronutrients (magnesium, zinc, ascorbic acid and carotenoids) (Cypriano *et al*., 2018; Cabrera-Núñez *et al*., 2020; Rincón *et al*., 2005). Another alternative is the use of supplements such as mesquite (*Prosopis* sp) pods, which are high in protein, carbohydrates, minerals and vitamins (Armijo-Nájera *et al.,* 2019; Ruiz-Nieto *et al*., 2020). Mesquite are leguminous plant species widely distributed worldwide especially in arid and semi-arid areas such as those found in Lagunera of Coahuila town, Mexico. In the country, there are about 4 million hectares of mesquite with an estimated production of 4.5 ton/ha/year of pods (Rodríguez *et al*., 1996), which is harvested from July to September (Mayagoitia *et al*., 2020). The use of these products could reduce goat feed costs, take advantage of alternative local products for goat feed, and have an impact on goat colostrum and calf weight at birth. Based on the above, the objective of this study was to evaluate the quality of colostrum, milk and offspring development in goats supplemented with mesquite and orange bagasse.

MATERIAL AND METHODS

The methods and procedures used in the present study for the use and care of experimental animals were in accordance with national (NAM, 2002) and international (FASS, 2010) guidelines approved by the Autonomous Agrarian University "Antonio Narro" with number: 38111-425503002-2702.

Location of the study area

The present research was conducted in a goat production unit in the municipality of Matamoros, Coahuila de Zaragoza, Mexico (25°31'41'' LN, 103°13'42'' LO). The region has an average annual rainfall of 230 mm, average maximum temperature (41 ºC) during the months of May and June, and minimum (-3 ºC) in December and January.

Animals and treatments

Twenty-six multiparous multiracial goats, 2 to 2.5 years of age, were used in the experiment, which were divided into three homogeneous groups in weight (48.7± 8.3 kg) and body condition between 2 and 3 on the scale of 1 to 4 (Figure 1). All goats were fed with extensive grazing carried out in two schedules (morning and afternoon): 10:00 to 13:00 h and 15:00 to 18:00 h, then enclosed in open corrals (5 m x 12 m), with access to water, mineral salts *ad libitum* (afternoons-nights). The control group (CG; n=6) did not receive food supplementation, the mesquite pod group (MG; n=9) was supplemented with 250 g/animal/day, the orange bagasse group (OG; n=11) was supplemented with 250 g/animal/day. Prior to the start of the experiment, the female goats were adapted to the diet (-28d prepartum), subsequently, the feed was offered on average 3 weeks prepartum and 7 days postpartum. To ensure the g/day consumption of supplemented groups (MG and OG), the supplement was offered in individual trays identified by experimental unit and the rejection was weighed.

Pre- and experimental management

Five months prior to the start of the experiment goats were synchronized with injectable progesterone, (Progesterona®, Zoetis, Mexico, 20 mg per animal) plus 100 IU of eCG (Serigan® Sheep laboratory, Mexico) (Zuñiga-Garcia *et al*., 2020). After mating, two transrectal ultrasonographies were performed to diagnose ovulatory rate and pregnancy in goats (7.5 MHz, Aloka, Japan). Additionally, females were vaccinated (Brucellosis, Melirev-R) and dewormed internally and externally (Dectomax, Zoetis, Mexico).

Sample collection

Mesquite pods and orange bagasse were collected in June-July months, then exposed to room temperature for 3 days. Afterwards, mesquite pods and orange bagasse were ground with a hammer mill, which was stored in hermetically sealed bags in a dry and cool environment until the beginning of the experiment (Table 1).

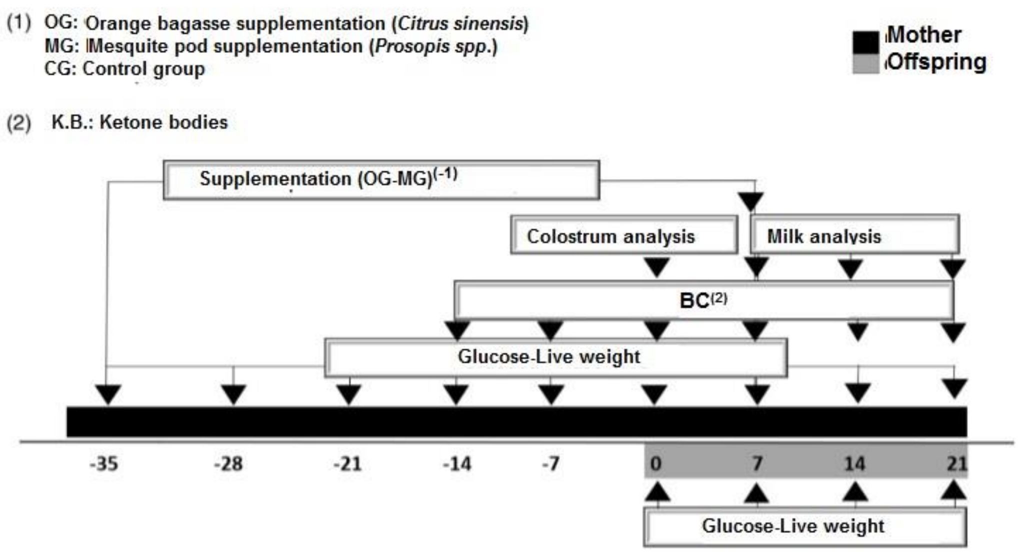

Figure 1. Experimental design. The experimental period, experimental groups and sampling in females and offspring are shown

Variables evaluated: females

Weight and body condition

The weight of the goats was recorded every week from the beginning of the adaptation period until the end of supplementation (-28 to +21 days post parturition), using a Torrey® industrial scale with digital base EQM 400-800 platform, with a capacity of 400 kg.

For its part, body condition (BC) was determined at the beginning and end of the study by visual and tactile assessment of muscle mass in the lumbar vertebrae, considering a scale from 1 to 4, where 1 was a very lean animal and 4 was a very fat animal (Ghosh *et al*., 2019).

Table 1. Nutritional composition of mesquite (*Prosopis* spp.) pods and orange (*Citrus* sinensis) bagasse

Component (%)	Mesquite pod	Orange bagasse
Protein	13.90	6.40
Ash	6.41	3.00
NDF	42.50	46.10
NAF	21.00	37.20
DM	12.29	5.35
Fat	3.90	1.95

Colostrum and milk analysis

All females were sampled for colostrum and milk by hand milking prior to grazing. Colostrum was obtained at 0, 12 and 24 h and milk at 7, 14 and 21 days post parturition. Colostrum and milk samples were deposited in individual 40 mL bottles with hermetic seal and stored at 4 ºC until analysis; percentages of fat, protein, density, non-fat solids, lactose and temperature in degrees Celsius (°C) were determined (Mikotester® milk analyzer).

Glucose and ketone bodies levels

Glucose and ketone levels were determined in all females from day 14 prepartum to day 21 postpartum using a blood monitoring system. Samples were obtained by puncture of the jugular vein every 7 days, using the FreeStyle Optium Neo Glucometer® indicator with specific test strips.

Variables evaluated: calves

Weight and glucose

These were recorded every week from birth until weaning (21 days post-birth), using the scale described in the variables of the mothers.

Statistical analysis

For the analysis of the data of the present study (colostrum/milk quality in hours/days, goat/calf weight expressed in days, as well as glucose and ketone levels), an analysis of variance (ANOVA) was used, then the means were compared with the Tukey test with a 95% confidence interval. All analyses were performed with SPSS 10 software for Windows.

RESULTS

Weight and body condition of the goat mothers

The live weight of the three groups of goats was similar during the study (P>0.05) (Figure 2). However, there were changes during the study (49 ± 1.2 kg, prepartum, 45 ± 1.3 kg, parturition and 43 ± 1.5 kg at the end of the study) (Figure 2). The body condition of the three groups of goats was similar in the study (2.5 ± 0.68 kg and 2.2 ± 0.6 kg) (P>0.05).

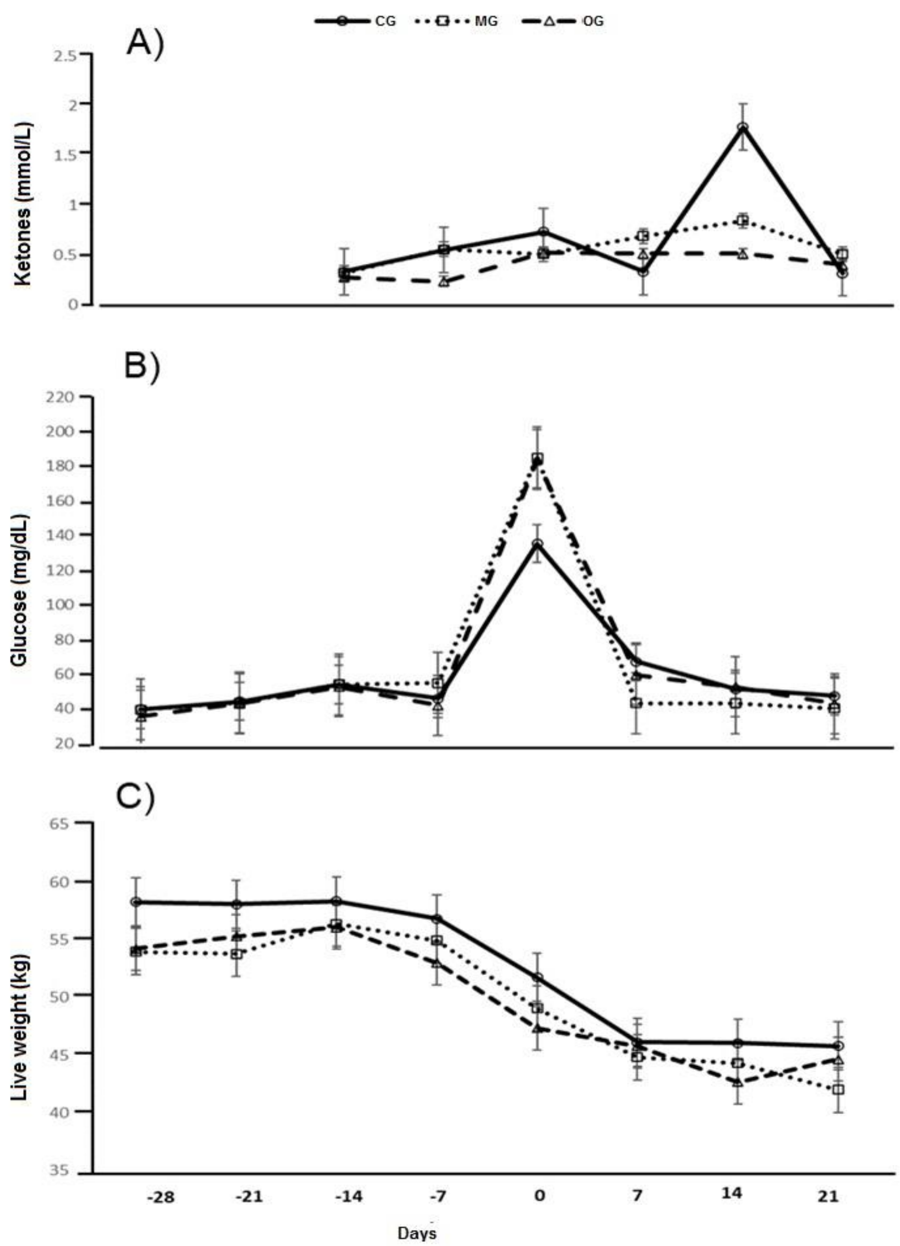

Figure 2. Blood levels of ketones (A) (mmol/L), glucose (B) (mg/dl) and body weight (C) (kg) of goats in the control group (CG), supplemented with mesquite (MG) and orange (OG)

Table 2. Colostrum and milk quality (0, 12, 24 h and 7, 14, 21 days post parturition, respectively) of goats in the control group (CG), supplemented with mesquite (MG) and orange (OG)

	Colostrum			Milk		
Variables/groups	0 h	12 h	24 h	7 d	14 d	21 d
Fat (%)						
CG	7.1 ± 1.5^{a1}	8.4 ± 1.2^{a1}	8.1 ± 2.9^{a1}	6.1 ± 0.3^{bc1}	6.2 ± 0.5^{a1}	5.6 ± 0.3^{a1}
MG	7.9 ± 0.8^{a1}	7.7 ± 0.5^{a1}	7.3 ± 0.5^{a1}	7.1 ± 0.3^{a1}	6.4 ± 0.4^{a1}	6.6 ± 0.2^{a1}
OG	10.3 ± 1.0^{a}	8.1 ± 1.1^{a}	8.1 ± 1.1^{a}	9.3 ± 1.2^{a1}	7.8 ± 0.8^{a1}	7.2 ± 1.1^{a1}
Protein (%)						
CG	6.6 ± 1.1^{a1}	4.4 ± 0.4^{a1}	4.9 ± 1.3^{a1}	2.7 ± 0.5^{a1}	3.0 ± 0.06^{a1}	2.6 ± 0.2^{a1}
MG	6.8 ± 0.6^{a1}	4.4 ± 0.3^{a2}	3.7 ± 0.2^{a2}	3.1 ± 0.05^{a1}	3.0 ± 0.2^{a1}	2.9 ± 0.08^{a1}
OG	8.2 ± 0.6^{a1}	4.5 ± 0.4^{a2}	5.1 ± 1.1^{a2}	2.5 ± 0.3^{a1}	3.0 ± 0.5^{a1}	3.0 ± 0.2^{a1}
Lactose (%)						
CG	9.8 ± 1.7^{a1}	6.5 ± 0.6^{a1}	5.1 ± 0.3^{a2}	4.5 ± 0.2^{a1}	4.4 ± 0.1^{a1}	4.3 ± 0.1^{a1}
MG	10.2 ± 0.8^{a1}	6.6 ± 0.5^{a2}	5.6 ± 0.3^{a2}	4.4 ± 0.08^{a1}	4.5 ± 0.2^{a1}	4.3 ± 0.2^{a1}
OG	12.2 ± 0.9^{a1}	6.0± 0.4^{a2}	6.0 ± 0.6^{a2}	4.3 ± 0.08^{a1}	4.7 ± 0.5^{a1}	4.1 ± 0.5^{a1}
Density (%)						
CG	51.5 ± 8.8^{a1}	32.7 ± 3.2^{a1}	33.2 ± 4.8^{a1}	25.6 ± 0.6^{a1}	23.1 ± 0.5^{a1}	23.0 ± 0.4^{a1}
MG	53.7 ± 4.4^{a1}	34.0 ± 2.6^{a2}	28.3 ± 1.4^{a2}	24.8 ± 1.1^{a1}	23.7 ± 0.3^{a1}	23.0 ± 0.6^{a1}
OG	64.5 ± 4.6^{a1}	33.1 ± 2.1^{a2}	40.9 ± 3.5^{a2}	23.7 ± 1.2^{a1}	25.7 ± 2.3^{a1}	22.0 ± 0.7^{a1}

$^{a-c}$Different superscript within the same column indicates significant difference between groups for each variable evaluated (p <0.05). $^{1-2}$Different superscript within the same row indicates significant difference (p <0.05). NS = Not Significant

Glucose and ketone bodies of mothers

Blood glucose levels during the experimental period showed no significant difference between treatments (P>0.05) (Figure 2). However, there were changes during the study time (38.23 ± 1.22 mmol/L, prepartum, 173.19 ± 18.40 mmol/L, at parturition and 42.84 ± 2.16 mmol/L, at the end of the study). The plasma concentration of ketone bodies was similar in the three experimental groups (P>0.05). However, at day 14 after calving, the MG group was superior to the other two groups (1.5 vs. 0.7, P>0.05, respectively), while at the end of the study (d21), ketone levels were similar in the three groups (0.42 ± 0.05; P>0.05) (Figure 2).

Colostrum and milk quality

Colostrum quality at calving (Table 2) was similar in all three groups of females for all characteristics (5.40 ± 0.2% protein, 40.03 ±1.8 % density, 8.13 ± 0.35% fat and 1.47 ± 0.28% OG solids; P>0.05). In contrast, the percentage of colostrum components (protein, fat, OG solids, density and lactose) decreased in all three groups at 24 h postpartum (P<0.05) (Table 2). On the other hand, milk quality of the three groups was similar in all variables during the study (2.88 ± 0.8%, protein; 7.0 ± 0.25%, fat; and 0.77 ± 0.08%, OG solids; density, 24 ± 0.70%; P>0.05). Only fat was higher in MG (7.81 ± 0.76%) than in OG and CG (6.48± 0.43; 6.2± 0.46%) on postpartum day 14 (P<0.05).

Body weight and glucose of the offspring

Body weight and glucose of the offspring of the three groups were similar during the study (3.2 ±0.11 kg, weight at birth and 6.9 ± 0.17 kg, weight at the end of the study) (P<0.05). (Table 3).

DISCUSSION

Feeding supplementation of goats with orange bagasse or mesquite pods pre and post parturition did not influence milk quality, weight and development of the offspring. Similarly, supplementation did not influence the weight or body condition of mothers, similar to what has been reported in previous studies (Liñán-González, 2015; Garza-Brenner, 2014). In addition, it was also not reflected in plasma blood glucose levels or ketone body concentration. Some blood nutrients such as glucose and ketone body levels can be very sensitive to feeding (Posada *et al*., 2012). Indeed, when an animal consumes a feed, it can immediately be reflected in an increase in blood glucose, since feed is digested and sugars are converted to glucose in order to be absorbed, while ketone bodies are a reflection of the reserve energy utilization in muscle (Hocquette *et al.*, 1998).

Table 3. Body weight (kg) and glucose level (mg/dL) of kids born to goats in the control group (CG), supplemented with mesquite (MG) and orange (OG)

Variables/groups	Days of birth				*P* Value
Glucose (mg/dL)	0	7	14	21	
CG	45.5 ± 4.05^{a2}	125.1 ± 14.0^{a1}	113.1 ± 4.3^{a1}	120.8 ±5.1^{a1}	**
MG	81.8 ± 14.0^{a2}	146.0 ± 6.6^{a1}	113.4 ± 2.9^{a2}	114.8 ± 4.8^{a2}	*
OG	51.07 ± 7.2^{a2}	130.0 ± 5.5^{a1}	121.4 ± 10.8^{a1}	107 ± 4.9^{a2}	*
Body weight (kg)					
CG	3.2 ± 0.2^{a2,4}	4.3 ± 4.0^{a2,3}	5.6 ± 0.5^{a1,3}	7.0 ± 0.5 ^{a1}	*
MG	3.5 ± 0.2^{a2,3}	5.0 ± 0.2^{a2}	6.2 ± 0.2^{a2}	7.1 ± 0.1^{a1}	*
OG	3.0 ± 0.2^{a2}	4.4 ± 0.3^{a2}	5.5 ± 0.3^{a1}	6.2 ± 0.4^{a1}	*

$^{a-b}$Different superscript within the same column indicates significant difference (p <0.05),
$^{1-3}$Different superscript within the same row indicates significant difference (p <0.05).
* p < 0.05. ** p < 0.001

On the other hand, the lack of response in body weight and body condition is normal, since it is common to find no differences when a short period of feed supplementation is given (Meza-Herrera *et al*., 2013). Another possibility, why there was no effect of dietary supplementation, could be due to the fact that the amount of supplementation (250 g) was not sufficient to increase blood levels of carbohydrates. Indeed, in other studies in which an increase in milk quality was observed, the supplementation was higher (2500g;

Salvador *et al.,* 2014). Similarly, in the case of dehydrated orange pulp, administration ranges from 0 to 30% of the supplement, obtaining an increase in fat percentage from 4.4 to 4.5% (Hernández-Meléndez *et al*., 2015). Supplementation with orange bagasse, coupled with grass forage and complementary feed, on average 250-500 g, showed an increase in this same percentage of milk fat with the administration of 250g in lactation phase (5.2575 ± 0.97) (Flores *et al*., 2018). Feed supplementation should be 35 to 65% concentrate for the concentrate to have an effect on both milk production and milk composition (Goetsch *et al*., 2011). Another possibility is that the supplementation time was short; as in another study we supplemented for at least 30 days (Luna-Orozco *et al*., 2015) showing higher milk production and fat and protein levels in the treated group. Another factor was that our supplements were energy and not protein. Indeed, it has been reported that, under parched conditions in semi-arid and arid zones, females find sufficient energetic nutrients in the flora of these ecosystems (Mellado *et al*., 2004; Nagel *et al*., 2011), however, a more important problem is protein nutrients, which are not available in seasons of feed shortage and drought (Nagel *et al*., 2011).

The absence of our supplementation effect could also be because the goat mothers had a regular body condition (2.4±0.92). It suggests that they obtained in the pasture the nutrients they needed (Mellado, 2016), since these animals are able to adapt to these adverse conditions even in the dry season, by adapting their diet and selecting other flora to compensate their nutritional needs even in the last third of gestation. In fact, it is likely that the females that did not receive supplementation adapted their selection of flora and consumed more than those that received it, or selected higher quality (more protein, etc.) and thus were able to compensate their nutritional needs.

On the other hand, both colostrum and milk quality did not differ and both were of good quality (Romero *et al.,* 2013*)*. In addition, the weight of the calves at birth suggests that, in effect, the calves obtained the necessary nutrients from the mothers, which caused their good development, and from the immunological point of view, it is likely that the colostrum of all groups was similar and of good quality, which caused these calves a good transfer of immunoglobulins that gave them immunity against diseases. Finally, the statistical similarity between the groups, with respect to blood glucose levels of the calves, suggests that the calves consumed sufficient milk, both in quantity and quality for good body development.

CONCLUSION

Feeding supplementation with orange bagasse or mesquite pods to pre and postpartum goats did not influence the quality of colostrum and milk, nor the development of the offspring. More studies are needed to increase the time of supplementation or increase the amount of feed in the goats.

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CITED LITERATURE

ARÉVALO JR, García JE, Mellado M, Encina-Domínguez JA, Dueñez J, Suárez-Hernández E. 2020. Impact of 25 years of grazing exclusion and shrub removal on plant community structure and soil characteristics in a xerophytic rangeland. *Spanish Journal of Agricultural Research*. 18(1): e0302. ISSN: 1695-971X. https://doi.org/10.5424/sjar/2020181-15934

ARMENTA-QUINTANA JA, Ramírez-Orduña R, Ramírez-Lozano RG. 2011. Forage utilization and diet selection by grazing goats on a sarcocaulescent scrubland in northwest Mexico. *Revista Chapingo Serie Ciencias Forestales y del Ambiente.17*:163-171. ISSN e: 2007-4018. https://doi.org/10.5154/r.rchscfa.2010.11.110

ARMIJO-NÁJERA MG, Moreno-Reséndez A, Blanco-Contreras E, Borroel-García VJ, Reyes-Carrillo JL. 2019. Vaina de mezquite (*Prosopis* spp.) alimento para el ganado caprino en el semidesierto. *Revista Mexicana de Ciencias Agrícolas.* 10(1):113-122. ISSN 2007-0934. https://doi.org/10.29312/remexca.v10i1.1728

BANCHERO GE, Milton JTB, Lindsay DR, Martin GB, Quintans, G. 2015. Colostrum production in ewes: a review of regulation mechanisms and of energy supply. *Animal. 9*(5):831-837. ISSN: 1751-7311. https://doi.org/10.1017/S1751731114003243

CABRERA-NÚÑEZ A, Lammoglia-Villagómez M, Martínez-Sánchez C, Rojas-Ronquillo R, Montero-Solís F. 2020. Utilización de subproductos de naranja (*Citrus sinensis* var.

valencia) en la alimentación para rumiantes. *Abanico Veterinario.* 10. e2020.4. ISSN 2448-6132. https://doi.org/10.21929/abavet2020.6

CYPRIANO DZ, da Silva LL, Tasic L. 2018. High value-added products from the orange juice industry waste. *Waste Management. 79:*71-78. ISSN: 0956-053X. https://doi.org/10.1016/j.wasman.2018.07.028

FASS (Federation Animal Science Society). 2010. Guide for the care and use of agricultural animals in agricultural research and teaching. FASS, Savoy, IL. https://www.fass.org/images/science-policy/Ag_Guide_3rd_ed.pdf

FLORES D, Capacho M, Quintero M, Gamboa V. 2018. Efecto de la suplementación con ensilaje de naranja sobre la calidad de leche caprina. *Revista U.D.C.A Actualidad & Divulgación Cientifica.* 21(2):501-506. https://doi.org/10.31910/rudca.v21.n2.2018.982

GARZA-BRENNER E. 2014. Efecto de la suplementación con dos subproductos agroindustriales y reinserción de CIDR sobre el comportamiento productivo y reproductivo en vacas charoláis*. Tesis Maestría. UANL, Gral. Escobedo.* Pp. 63*.* http://eprints.uanl.mx/4105/1/1080253682.pdf

GOETSCH AL, Zeng SS, Gipson TA. 2011. Factors affecting goat milk production and quality. *Small Ruminant Research.* 101(1-3):55-63. ISSN: 0921-4488. https://doi.org/10.1016/j.smallrumres.2011.09.025

HERNÁNDEZ-MELÉNDEZ J, González-Reyna A, Rojo R, Sánchez-Dávila F, Salvador A, Vázquez-Armijo JF. 2015. Producción y composición de la leche de cabras alimentadas con diferentes inclusiones de cáscara de naranja deshidratada. *Revista Científica.* 25(4):324-329. ISSN: 0798-2259.
http://www.redalyc.org/articulo.oa?id=95941173008

HOCQUETTE JF, Ortigues-Marty I, Pethick D, Herpin P, Fernandez X. 1998. Nutritional and hormonal regulation of energy metabolism in skeletal muscles of meat-producing animals. *Livestock Production Science.* 56(2):115-143. ISSN: 0301-6226 https://doi.org/10.1016/S0301-6226(98)00187-0

KELES G, Yildiz-Akgul F, Kocaman V. 2017. Performance and milk composition of dairy goats as affected by the dietary level of stoned olive cake silages. *Asian-Australasian Journal of Animal Sciences*, 30(3), 363. ISSN:2765-0235.
https://doi.org/10.5713/ajas.16.0482

LIÑÁN GONZÁLEZ MA. 2015. *Respuesta fisiológica de cabras reproductoras a la suplementación con subproductos agroindustriales cáscara de naranja, DDGS y urea* (*Doctoral dissertation, Universidad Autónoma de Nuevo León).* 82 pp http://eprints.uanl.mx/id/eprint/13667

LUNA-OROZCO JR, Meza-Herrera CA, Contreras-Villareal V, Hernández-Macías N, Angel-Garcia O, Carrillo E, Mellado M, Veliz-Deras FG. 2015. Effects of supplementation during late gestation on goat performance and behavior under rangeland conditions. *Journal of Animal Science*. 93:1-8. ISSN:1525-3163. https://doi.org/10.2527/jas.2014-8609

MAYAGOITIA P, Bailey DW, Estell RE. 2020. Phenological changes in the nutritive value of honey mesquite leaves, pods, and flowers in the Chihuahuan Desert. *Agrosystems, Geosciences & Environment*. *3*(1):e20026. ISSN:2639-6696.
https://doi.org/10.1002/agg2.20026

MELLADO M. 2016. Dietary selection by goats and the implications for range management in the Chihuahuan Desert: a review. *The Rangeland Journal.* 38(4):331-341. ISSN:1834-7541. https://doi.org/10.1071/RJ16002

MELLADO M, Valdez R, Lara LM, García JE. 2004. Risk factors involved in conception, abortion, and kidding rates of goats under extensive conditions. *Small Ruminant Research*. 55(1-3):191–198. ISSN: 0921-4488.
https://doi.org/10.1016/j.smallrumres.2003.10.016

MELLADO-BOSQUE M, González-Rodríguez H, García-Martínez JE. 2001. Características corporales, número de partos y de fetos como factores de riesgo del aborto de cabras en agostadero. *Agrociencia.* 35(3):355-361.ISSN: 1405-3195. http://www.redalyc.org/articulo.oa?id=30200310

MEZA-HERRERA CA, Navarrete-Molina C, Luna-García LA, Pérez-Marín C, Altamirano-Cárdenas JR, Macías-Cruz U, García de la Peña C, Abad-Zavaleta J. 2022. Small ruminants and sustainability in Latin America & the Caribbean: Regionalization, main production systems, and a combined productive, socio-economic & ecological footprint quantification. *Small Ruminant Research*. 211: 106676.
https://doi.org/10.1016/j.smallrumres.2022.106676

MEZA-HERRERA CA, Vargas-Beltran F, Tena-Sempere M, González-Bulnes A, Macias-Cruz U, Veliz-Deras FG. 2013. Short-term beta-carotene-supplementation positively affects ovarian activity and serum insulin concentrations in a goat model. *Journal of Endocrinological Investigation*. *36*(3):185-189. ISSN: 1720-8386.
https://doi.org/10.3275/8410

MÍNGUEZ C, Calvo A. 2018. Effect of supplementation with fresh orange pulp (Citrus sinensis) on mortality, growth performance, slaughter traits and sensory characteristics in meat guinea pigs. *Meat science.* 145:51-54. ISSN:0309-1740 https://doi.org/10.1016/j.meatsci.2018.06.003

NAGEL P, Maria W, Iñiguez L, Echavarría Chairez FG, Flores Nájera MDJ, Pinos Rodríguez JM, Gómez Ruiz WJ, Zollitsch W. 2011. Sistemas de alimentación para las cabras y evaluación cualitativa de los piensos a los que se tienen acceso durante la temporada de seca: dos estudios de caso del altiplano mexicano. *Revista Chapingo Serie Ciencias Forestales y del Ambiente.* 17(SPE):247-258. ISSN:2007-4018 https://doi.org/10.5154/r.rchscfa.2010.09.089

NAM (National Academy of Medicine). 2002. Guide for the care and use of laboratory animals. Co-produced by the National Academy of Medicine-Mexico and the Association for Assessment and Accreditation of Laboratory Animal Care International. 1st ed. Harlan, México, DF, México. https://www.nationalacademies.org/our-work/update-of-the-guide-for-the-care-and-use-of-laboratory-animals

POSADA SL, Noguera RR, Bedoya O. 2012. Perfil metabólico de cabras lactantes de las razas Saanen y Alpina. *Livestock Research for Rural Development*. *24*(10). ISSN:0121-3784 http://www.lrrd.org/lrrd24/10/posa24182.htm

RINCÓN AM, Vásquez A, Padilla M. 2005. Composición química y compuestos bioactivos de las harinas de cáscaras de naranja (*Citrus sinensis*), mandarina (*Citrus reticulata*) y toronja (*Citrus paradisi*) cultivadas en Venezuela. *Archivos Latinoamericanos de Nutrición. 55*(3):305-310. ISSN:0004-0622.
http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0004-06222005000300013

RODRÍGUEZ FC, Maldonado ALJ. 1996. Overview of past, current and potential uses of mesquite in Mexico. *Prosopis;* Semiarid Fuel Wood and Forage Tree Building Consensus for the Disemfranchised. *Center from Semi-arid Forest Resources.* 6-41. http://www.bashanfoundation.org/contributions/Felker-P/1996.-Felker-USNAS.pdf#page=293

ROMERO T, Beltrán MC, Rodríguez M, De Olives AM, Molina MP. 2013. Goat colostrum quality: Litter size and lactation number effects. *Journal of Dairy Science. 96*(12):7526-7531. ISSN:0022-0302 https://doi.org/10.3168/jds.2013-6900

RUIZ-NIETO JE, Hernández-Ruiz J, Hernández-Marín J, Mendoza-Carrillo J, Abraham-Juárez M, Isiordia-Lachica PM, Mireles-Arriaga AI. 2020. Mesquite (*Prosopis* spp.) tree as a feed resource for animal growth. *Agroforestry Systems.* 1-11. ISSN: 1572-9680 https://doi.org/10.1007/s10457-020-00481-x(0123456789().,-volV() 0123458697().,-volV)

SALINAS-GONZÁLEZ H, Moysen EDV, de Santiago MDLA, Deras FGV, Jáquez JAM, Monroy LIV, Viramontes UF. 2016. Análisis descriptivo de unidades caprinas en el suroeste de la región lagunera, Coahuila, México. *Interciencia,* 41(11):763-768. ISSN: 0378-1844. http://www.redalyc.org/articulo.oa?id=33948191006

SALVADOR A, Igual M, Contreras C, Martínez-Navarrete N, del Mar Camacho M. 2014. Effect of the inclusion of citrus pulp in the diet of goats on cheeses characteristics. *Small Ruminant Research.* 121(2-3):361-367. ISSN:0921-4488. https://doi.org/10.1016/j.smallrumres.2014.06.012

SHARIF M, Ashraf MS, Mushtaq N, Nawaz H, Mustafa MI, Ahmad F, Younas M, Javaid A. 2018. Influence of varying levels of dried citrus pulp on nutrient intake, growth performance and economic efficiency in lambs. *Journal of Applied Animal Research. 46*(1):264-268. ISSN:0974-1844. https://doi.org/10.1080/09712119.2017.1294540

ZÚÑIGA-GARCÍA S, Calderón-Leyva G, Otal-Salaverri J, Moreno-Avalos S, Arellano-Rodríguez F, Véliz-Deras FG. 2020. Evaluation of Different eCG Doses+ Progesterone to Induce Reproductive Activity During the Transitional Reproductive Season in Anestrous Creole Goats. *Indian Journal of Animal Research.* B-1251. https://doi.org/10.18805/ijar.B-1251

Errata Erratum

https://abanicoacademico.mx/revistasabanico-version-nueva/index.php/abanico-veterinario/errata