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Vaginal microbiota and antimicrobial susceptibility in creole goats

Microbiota vaginal y susceptibilidad quimioterapéutica en cabras criollas

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ABSTRACT

This work´s aim was the aerobic vaginal microbiota determination of creole goats and its antimicrobial susceptibility. Vaginal swabs were taken of 51 healthy female goats in reproductive age. Samples were processed under standard bacteriological conditions. Bacterial isolation was achieved in 41.2% of the samples. Gram-positive (GP) cocci were the most abundant bacteria recovered (65.6%), the principal genera detected were *Staphylococcus* spp. (31.2%) and *Aerococcus* spp. (21.9%). *Escherichia coli* was the only Gram-negative (GN) genus detected. In the antimicrobial susceptibility test *Aerococcus* and *Corynebacterium jeikeum* were the most susceptible GP bacteria. Dicloxacillin, cefotaxime, and ampicillin had the lowest resistance pattern on GP bacteria. On the other hand, *E. coli* isolates showed high resistance to all antibiotics (95%), except for ciprofloxacin (60%). This work findings exhibit the importance of vaginal microbiota of creole goats as potential pathogenic ecological agents, as well as it showed the high antimicrobial resistance pattern of this bacteria.
Keywords: goat production, vaginal microbiota, antimicrobial susceptibility.

RESUMEN

El objetivo de este trabajo fue determinar la microbiota vaginal aerobia de cabras criollas, así como el perfil de susceptibilidad a quimioterapéuticos. Se tomaron muestras de mucosa vaginal de 51 hembras caprinas sanas en edad reproductiva mediante hisopos estériles. Las muestras fueron procesadas bajo técnicas de identificación bacteriológica estándar. Se obtuvo aislamiento bacteriano en el 41.2% de las muestras. Las bacterias aisladas con mayor frecuencia fueron cocos Gram positivos (GP) (65.6%), los géneros principales identificados fueron *Staphylococcus* spp. (31.2%) y *Aerococcus* spp. (21.9%). En cuanto a bacterias Gram negativas (GN), los aislamientos correspondieron a *Escherichia coli* (15.6%). Del perfil de resistencia a antibióticos los aislamientos de *Aerococcus* y *Corynebacterium jeikeium,* en proporción, fueron los más susceptibles a los antibióticos analizados contra bacterias GP. Los antibióticos con menor perfil de resistencia ante aislamientos GP fueron dicloxacilina, cefotaxima y ampicilina. Los aislamientos de *E. coli* mostraron ser altamente resistentes a todos los antibióticos probados (95%), siendo ciprofloxacina el antibiótico con menor resistencia (60%). Los hallazgos de este trabajo ponen de manifiesto la importancia de la microbiota vaginal en cabras criollas como agentes ecológicos con potencial patogénico, además de demostrar la alta resistencia de estas bacterias a agentes quimioterapéuticos.
Palabras clave: producción caprina, microbiota vaginal, susceptibilidad antimicrobiana.

INTRODUCTION

The microbiota is the population, resident or transitory, of microorganisms and viruses that live in the epithelia of animals, creating an ecosystem (Pascale *et al*., 2018). In this ecosystem, prokaryotes (mainly bacteria, although there are also archaea) are the most abundant organisms. Generally, these microorganisms live in a state of symbiosis with the host. On the other hand, the imbalance of the environment and the immune system can trigger negative effects on the health of the hosts, and some microorganisms of the microbiota can become pathogenic (Maynard *et al*., 2012; Belkaid *et al*., 2013). In ruminants, the role of the ruminal microbiota in the digestion of cellulose is well known, which allows obtaining energy for these animals (Henderson *et al*. 2015).

It has been determined that the vaginal microbiota (VM) in ruminants varies according to the physiological/reproductive state, estrous cycle and to a lesser extent by breed (Giannattasio-Ferraz *et al*., 2019; Manes *et al*., 2018). In sheep and goats, the VM analysis has gained relevance in recent years, due to the use of reproductive technologies (use of progestogens, prostaglandins and gonadotropins), mainly in intensive livestock (Suárez *et al*., 2006; Martins *et al*., 2009; Penna *et al*., 2013; Oliveira *et al*., 2013; Manes *et al*., 2013; Manes *et al*., 2018). The composition of VM in goats is partially known. It has been reported that it is composed mainly of Gram positive bacteria (GP) and to a lesser extent Gram negative (GN) (Manes *et al*., 2013). In goats, the change in VM composition due to the use of vaginal devices containing progestogens has been associated with vaginitis and infertility (Penna *et al*., 2013).

In Mexico, goat production is linked to social classes with low economic income, following a primarily subsistence model (Pinos-Rodríguez *et al*., 2015). In Tamaulipas, Mexico, goat production is aimed at the production of 21-day-old weaned kid. The type of production characteristic of northeastern Mexico is an extensive system dependent on natural resources in the region (Alva-Pérez *et al*., 2019). Although goats are rustic animals, adaptable to different environmental conditions, fertility and conception problems in goats are common in production (Salinas-González *et al*., 2016). Knowledge of VM in Creole goats can reveal the opportunistic bacterial population, which could trigger clinical and subclinical vaginitis. This knowledge can provide the basis for determining the degree of involvement of reproductive system infections in production problems in goats. In addition to this, knowledge of the chemotherapeutic susceptibility profile of the bacteria that make up the VM contributes to improving the treatment of these infections.

MATERIAL AND MÉTODOS

Animal management and sampling site. The present work was carried out in Jaumave municipality, Tamaulipas located between the parallels 23º 53´ and 23º 04´ north latitude, and the meridians 99º 41´ and 99º 10´ west longitude, with an average height of 735 meters above sea level. The orography is mainly mountainous, with a semi-dry semi-warm climate with rains in summer (INEGI, 2010). The goat inventory in this municipality reported in 2018 was 3,931 heads (SIAP, 2019). Five production units (PU) were sampled during June 2019. In each PU, 10 samples were taken, except for the last one, where 11 samples were taken, for a total of 51 vaginal swab samples. The goat herds present a population that mixes several races (Creole population), with predominant encastes of Boer, Alpino, Nubia and Toggenbourgh (Alva-Pérez *et al*., 2019). The inclusion criteria were healthy females of reproductive age (2 to 4 years). The exclusion criterion was sick or pregnant females. The sampling was carried out under ethical standards of animal welfare, and was authorized by the Bioethics and Animal Welfare Committee of the Faculty of Veterinary Medicine and Zootechnics of the Autonomous University of Tamaulipas (official letter number CBBA_19_05).

Sample collection and processing. In the selected females, momentary physical restraint was carried out with the minimum possible stress, to insert a sterile swab in the vaginal vestibule. The swabs were gently rubbed on the walls of the vaginal mucosa to later be placed in a sterile transport medium (Dehydrated culture media: transport medium amies; BD Difco, Maryland EU). The swabs were kept refrigerated until processing in a period no longer than 12 hours. All the bacteriological processing of the samples was carried out in the Diagnostic Laboratory of the Faculty of Veterinary Medicine and Zootechnics of the Autonomous University of Tamaulipas. For the isolation and identification of the microorganisms, the swabs were sown on blood agar (Blood agar base; Becton Dickinson-Bioxon, Querétaro Mexico) and trypticasein soy agar (BD Difco, Maryland USA). The samples were incubated under aerobic conditions, 37º C for 24 to 48 hours.

The different isolates were identified both macroscopically (colonial morphology, pigment production, and hemolysis) and microscopically (Gram stain). Final bacterial identification was achieved through the following biochemical tests: catalase (Hydrogen peroxide; Merck, Darmstadt Germany), oxidase (n, n, n´, n´-tetramethyl-1,4-phenylenediamine, Biomerieux México, Estado de México), methyl red-Voges Proskauer (Becton Dickinson Bioxon, Querétaro México), nitrate reduction (BD Difco, Maryland EU), urease (Caldo urea; Becton Dickinson-Bioxon, Querétaro México), indole, hydrogen sulfide and motility (SIM medium; Dibico, Estado de México México), growth on McConkey agar (BD Difco,

Maryland EU), triple sugar iron (Iron and triple sugar agar, Becton Dickinson-Bioxon, Querétaro México), citrate (BBL Simmons Citrate Agar ; Becton Dickinson, Le Point de Claix France) and use of the following carbohydrates: maltose, mannitol, xylose, lactose and sorbitol (all from Becton Dickinson Bioxon, Querétaro México, prepared with phenol red, phenol red base broth BD Difco, Maryland EU). Identification was carried out following the standards of the Cowan and Steel bacterial identification manual (Barrow and Feltman, 2004).

Susceptibility to chemotherapeutics. The isolates were evaluated in different antibiotics, through the disk diffusion method (Humphries *et al*. 2018). It is briefly described below. 3 CFUs were selected from each isolation in pure culture, which were seeded in trypticasein soy broth (BD Difco, Maryland EU) and incubated at 37 ºC with shaking (200 rpm). The incubation time varied for each isolate, until obtaining an inoculum equivalent to the 0.5 McFarland standard (0.05 ml of 1% $BaCl_2$ [Sigma-Aldrich, St. Louis, Missouri United States] and 9.95 ml of 1% H_2SO_4 [Sigma- Aldrich, St. Louis, Missouri United States]) of turbidity, corresponding to 1 to 2×10^6 CFU/ml in GP bacteria and 5×10^8 CFU/ml in GN bacteria. 1ml of each isolate was seeded on Müller-Hinton agar (MH, BD Difco, Marylando EU). The following sensidisks (Diagnostic Research; Mexico City, Mexico) were used: ampicillin (10 µg, *Staphylococcus* spp.: resistant phenotype (RF): <28 mm; susceptible phenotype (FS):> 29 mm; other bacterial genera: FR: <21 mm; FS:> 22 mm), Cephalothin (30 µg, FR: <14 mm, FS:> 15 mm), Cefotaxime (30 µg, FR: <14 mm, FS:> 15 mm) , ciprofloxacin (5 µg, RF: <15 mm, FS:> 16 mm), clindamycin (30 µg, RF: <14 mm, FS:> 15 mm), dicloxacillin (1 µg, RF: <10 mm) , FS:> 11 mm), erythromycin (15 µg, RF: <13 mm, FS:> 14 mm), gentamicin (10 µg, FR: <12 mm, FS:> 13 mm), penicillin (10 U , Staphylococcus spp .: FR: <28 mm, FS:> 29 mm, other genera GP: FR: <14 mm; FS:> 15 mm), sulfamethoxazole-trimethoprim (25 µg, FR: <10 mm, FS: > 11 mm), tetracycline (30 µg, FR: <14 mm, FS:> 15 mm), vancomycin (30 µg, FR: <14 mm, FS:> 15 mm), chloramphenicol (30 µg, FR : <12 mm, FS:> 13 mm), Carbenicillin (100 µg, FR: <18 mm, FS:> 19 mm), Netilmicin (30 µg, FR: <12 mm, FS: > 13 mm), nitrofurantoin (300 µg, FR: <14 mm, FS:> 15 mm), norfloxacin (100 µg, FR: <18 mm, FS:> 19 mm) and amikacin (30 µg, FR : <14 mm, FS:> 15 mm). The chemotherapeutics clindamycin, dicloxacillin, erythromycin, penicillin, tetracycline, and vancomycin were tested only in GP isolates; whereas chloramphenicol, carbenicillin, netilmicin, nitrofurantoin, norfloxacin, and amikacin were tested only in GN isolates. The zones of inhibition in each sensidisc were measured with a ruler after 16 to 18 h of incubation at 37 ºC. Isolates with intermediate susceptibility were considered resistant, since these bacterial populations present subpopulations of resistant bacteria that will transmit this phenotype to susceptible bacteria (Hombach *et al*. 2013; Maurer *et al.* 2014).

Statistical analysis. The bacterial identification results of the different samples are presented through descriptive statistics and frequency tables. For the results of the chemotherapeutic susceptibility test, contingency tables were constructed with the chi-square test with a significance level of P <0.05 using the PROC FREQ procedure of the SAS program (2002, v9.0. SAS Institute Inc., Cary, NC., USA) to know the resistance percentages. Furthermore, an analysis of variance was performed in a generalized linear model using the PROC GLM and the least significant difference test (LSD, Fisher's exact test) for the comparison of the resistance profile between antibiotics with a P <0.05. For this analysis, the percentage values were converted into values in a range from 0 to 1.

RESULTS

Bacterial isolation and identification. From the 51 samples, only 21 (41.2%) were positive to bacteriological isolation. From these 21 samples, 32 bacteria were isolated and identified (Table 1).

Table 1. Identification and frequency of bacteriological isolates from vaginal samples of goats.

	Frequency
Gram-positive bacteria	
Staphylococcus spp.	31.2% (10/32)
Aerococcus spp.	21.9% (7/32)
Corynebacterium jeikeium	15.6% (5/32)
Staphylococcus chromogenes	6.3% (2/32)
Corynebacterium renale	3.1% (1/32)
Staphylococcus xylosus	3.1% (1/32)
Streptococcus spp.	3.1% (1/32)
Gram-negative bacteria	
Escherichia coli	15.6% (5/32)

Susceptibility to chemotherapeutics. In the analysis of the antimicrobial resistance profile for GP bacteria, it is noteworthy that all isolates were resistant to erythromycin and tetracycline (Table 2). Isolates of Staphylococcus spp. had a general percentage of resistance of 87.5% (χ^2= 18.51, p = 0.0704), with penicillin being the antibiotic with the lowest resistance (70%). The two isolates of *S*. *chromogenes* had the lowest resistance among the tested antibiotics (70.8%), with no difference between them (χ^2=16.73, p=0.1158). The isolates of *C*. *renale*, *S*. *xylosus* and *Streptococcus* spp., had resistance percentages of 83.3% (χ^2= 12.0, p = 0.3636), 91.7% (χ^2= 12.0, p = 0.3636) and 83.3% (χ^2= 12.0, p = 0.3636), respectively. On the other hand, isolates of the genus *Aerococcus* spp. (resistance 80.9%) showed a lower resistance against dicloxacillin (28.6%, χ^2= 22.85, p=0.0185), compared to the other antibiotics. Likewise, isolates of *C*. *jeikeium*

showed a lower percentage of resistance to cefotaxime and ampicillin (20% and 40%, respectively χ^2= 34.9, p <0.001) in contrast to the other antibiotics. For these bacteria the resistance was 85%. Under the conditions of this work, the GP isolates had a resistance profile of 83.2%.

For Enterobacteriaceae (GN isolates) the general percentage of resistance was 95%, most of the antibiotics tested had a resistance of 100%, with the exception of ciprofloxacin (60%) and nitrofurantoin (80%), whose resistance was less than rest of antibiotics (p <0.05, Table 3).

The comparison between the resistance profiles shows that dicloxacillin was more effective among GP bacteria (0.59, Table 3), similar to the resistance profile of ampicillin (0.63) and cefotaxime (0.77). The overall average resistance for antibiotics tested against GP bacteria was 0.84, while the overall average resistance for antibiotics tested against GN bacteria was 0.95.

Table 2. Percentage of resistance in vaginal isolates of Creole goats

Bacteria	**(n)%**	**Quimioterapéutico Chemotherapeutic**											
Gram +		**AMP**	**CEF**	**CFT**	**CIP**	**CLI**	**DIC**	**ERI**	**GEN**	**PEN**	**STM**	**TET**	**VAN**
Staphylococcus spp.	(10) 37	80	90	100	80	90	80	100	80	70	100	100	100
Aerococcus spp.	(7) 25.9	57.2	71.4	85.7	85.7	100	28.6	100	85.7	85.7	71.4	100	100
C. jeikeium	(5) 18.5	40	100	20	100	100	100	100	100	100	100	100	60
S. chromogenes	(2) 7.4	50	0	0	100	100	0	100	100	50	100	100	100
C. renale	(1) 3.7	0	100	100	100	100	100	100	0	100	100	100	100
S. xylosus	(1) 3.7	100	100	100	100	0	100	100	100	100	100	100	100
Streptococcus spp.	(1) 3.7	100	100	100	100	0	100	100	0	100	100	100	100
Gram -		**AMP**	**CEF**	**CFT**	**CIP**	**CLO**	**CAR**	**NET**	**GEN**	**NIT**	**NOT**	**STM**	**AMI**
Escherichia coli	(5) 100	100	100	100	60	100	100	100	100	80	100	100	100

AMP: ampicillin, CEF: cephalothin, CFT: cefotaxime, CIP: ciprofloxacin, CLI: clindamycin, DIC: dicloxacillin, ERI: erythromycin, GENE: gentamicin, PEN: penicillin, STM: sulfamethoxazole-trimethroprim, TET: tetracycline, VAN: vancomycin, CLO: chloramphenicol, CAR: carbenicillin, NET: netilmicin, NIT: nitrofurantoin, NOT: norfloxacin and AMI: amikacin.

DISCUSSION

Bacterial isolation and identification.

The environmental conditions of the VM of ruminants favor the development of a microbiota in accordance with the physiological development. This population does not allow, in general, the development of pathogenic or saprophytic microorganisms (Otero *et al*., 2000). The compromise of the integrity of the vaginal mucosa, as well as the alterations of the microbiota, can trigger ascending infections of the urogenital tract, putting at risk the reproductive health of goats (Ababneh and Degefa, 2006), cows (Otero *et al*., 2000) and sheep (Sargison *et al*., 2007).

Table 3. Comparison of the resistance pattern between antibiotics

Bacteria	Chemotherapeutic												
	AMP	**CEF**	**CFT**	**CIP**	**CLI**	**DIC**	**ERI**	**GEN**	**PEN**	**STM**	**TET**	**VAN**	**SEM (*P*)**
Gram +	0.63^{cd}	0.81^{abc}	0.77^{cd}	0.85^{ab}	0.93^{ab}	0.59^{d}	1.0^{a}	0.81^{abc}	0.81^{abc}	0.93^{ab}	1.0^{a}	0.93^{ab}	0.124 (0.0001)
	AMI	**AMP**	**CAR**	**CEF**	**CFT**	**CIP**	**CLO**	**GEN**	**NET**	**NIT**	**NOT**	**STM**	**SEM (*P*)**
Gram -	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	0.6^{b}	1.0^{a}	1.0^{a}	1.0^{a}	0.8^{b}	1.0^{a}	1.0^{a}	0.002 (0.05)

AMP: ampicillin, CEF: cephalothin, CFT: cefotaxime, CIP: ciprofloxacin, CLI: clindamycin, DIC: dicloxacillin, ERI: erythromycin, GENE: gentamicin, PEN: penicillin, STM: sulfamethoxazole-trimethroprim, TET: tetracycline, VAN: vancomycin, CLO: chloramphenicol, CAR: carbenicillin, NET: netilmicin, NIT: nitrofurantoin, NOT: norfloxacin and AMI: amikacin. SEM: standard error of the mean. Mean values with the same superscript are not significantly different. The percentage data were transformed to be analyzed through Fisher's exact test.

From the vaginal swabs, 41.2% of the samples showed bacteriological growth. Manes *et al*., 2013 reported 52% of positive samples to isolation in Saanen goats in reproductive stage, while Penna *et al*., 2013 reported 77% of positive samples in Saanen goats in conditions of gestational anestrus. On the other hand, Oliveira *et al*., 2013 reported 100% bacterial isolation in anéstric Toggenbourgh goats, while Ababneh and Degfa 2006 reported 75% isolation in postpartum Baladi goats. These different results indicate the high variability of the bacterial isolation that can be due to race, reproductive status and physiological status. This research shows that, in creole goats, without an apparent definition of reproductive seasonality, the isolation of the aerobic bacterial microbiota is not greater than 50%. More studies are required to link physiological status and racial profiling with bacteriological isolation.

In this study it is shown that the predominant aerobic bacterial population in healthy creole goats was GP bacteria (84.4%) and to a lesser extent GN bacteria (15.6%). Various studies agree with our results. Manes *et al*., 2013 isolated 77% of GP bacteria in Saanen goats before vaginal sponge insertion with 60 mg of medroxyprogesterone acetate for oestrus synchronization; while Penna *et al*., 2013 isolated 71.3% of GP bacteria, being coagulase negative *Staphylococcus* (CoNS) the main bacteria isolated. This finding coincides with our work, since the largest number of isolated bacteria belonged to the genus *Staphylococcus* spp. (31.2%), coupled with the isolation of *S. chromogenes* (6.3%) and *S. xylosus* (3.1%). Oliveira *et al*., 2013 also isolated Staphylococcus spp. in 63.6% of vaginal swabs in anestric goats. These findings may indicate that the genus *Staphylococcus* is a primary inhabitant of VM in goats. The presence of vaginitis has not been reported in these animals associated with this bacterial genus (Oliveira *et al*. 2013),

as occurs in other species (Deng *et al*., 2019; Shea *et al*., 2019), indicating that in these hosts can be opportunistic pathogens.

The second bacterial group isolated from vaginal swabs was *Aerococcus* spp. with a percentage of 21.9%. This GP bacterium has been associated with opportunistic urinary infections in cattle (Liu *et al*., 2019). Its presence has previously been reported in the vaginal mucosa of goats, without signs of infection (Meekins *et al*., 2017). This could indicate that, like *Staphyloccocus* spp, the *Aerococcus* genus is a normal inhabitant of the vaginal mucosa in goats.

In proportion, the isolates of *C*. *jeikeium* and *E*. *coli* were similar (15.6%). *C*. *jeikeium*, bacillus GP, has been related to subclinical mastitis in sheep (Queiroga, 2017). There are no reports of the presence of this bacillus in goats, and based on the frequency of isolations of this bacterium in this study, it is likely that it is part of the native VM of Creole goats in northeastern Mexico. In contrast, *E*. *coli* is a widely distributed enterobacterium, it is the main bacterium that is part of the intestinal microbiota in domestic animals (except birds). The isolation of this *Enterobacteriaceae* from anatomical regions outside the intestine is related to pathogenic and opportunistic infections (Gyles and Fairbrother, 2010). In ruminants it has been linked as a cause of abortion and urogenital infections (Sargison *et al*., 2007). In goats this enterobacterium has been reported both in the absence of vaginitis and in inflammatory processes (Martins *et al*., 2009; Oliveira *et al*., 2013). The presence of *E*. *coli* in this work may therefore suggest opportunistic colonization.

Isolation of *C*. *renale* may represent an incidental finding, since it has not been previously reported as part of VM in goats. However, this organism can cause various urinary infections in goats and sheep, although it is rare (Moore *et al*., 2010). Additionally, it has been isolated in clinically healthy cows, behaving as an opportunistic pathogen, producing cystitis, urethritis and pyelonephritis (Yeruham *et al*., 2006), due to its environmental adaptability (Moore *et al*., 2010). The isolation of *C*. *renale* in the vaginal mucosa of Creole goats can, like *E*. *coli*, represent the colonization of an opportunistic bacterium.

Finally, *Streptococcus* spp. it was found in a low proportion (3.1%), compared to the other GP cocci. Penna *et al*., 2013 reported the isolation of these agents in 51.1% in vaginal swabs, before inserting the vaginal sponge, indicating that these bacteria are part of the VM. On the other hand, this bacterial genus has been widely related as a goat pathogen producing mastitis (Steward *et al*., 2017). The presence of vaginitis or urinary tract infections due to *Streptococcus* spp. species has not been reported. It is likely that the finding in this work evidently corresponds to VM, as suggested by Penna *et al*., 2013.

Susceptibility to chemotherapy

In this work, different antibiotic susceptibility profiles were shown, both for GP and GN bacteria. The difference in susceptibility between these two bacterial groups (83.2% of GP versus 95% of GN) must be taken with reserve, since in the GN bacteria they were isolated in lesser quantity from the swabs. However, it is worth noting the high resistance of the isolates to the action of antibiotics, considering that these are part of the VM, and that therefore, they have not been extensively subjected to antibiotic therapy.

From the antibiotics tested, erythromycin and tetracycline were shown to be completely ineffective against the GP isolates, whereas all the antibiotics tested against GN were ineffective, except for ciprofloxacin and nitrofurantoin. In this regard, Oliveira *et al*., 2013 and Penna *et al*., 2013 consider that the unrestricted use of antibiotics in the promotion of growth, as well as in the treatment of young animals for diarrheal and respiratory diseases, can predispose to the spread of resistance, as has been evidenced for GN bacilli (Moghaddam *et al*., 2015).

From the resistance profile in GP, *S*. *chromogenes*, *S*. *xylosus*, *C*. *renale* and *Streptococcus* spp., were shown to be completely susceptible to at least one antibiotic. Additionally, the isolates of the genus *Aerococcus* and *C*. *jeikum* showed the highest susceptibility tested to dicloxacillin and to cefotaxime and ampicillin, respectively. From these drugs, only ampicillin has been reported to be highly effective against bacterial isolates (mainly against *Staphylococcus* spp) from the vaginal mucosa, with percentages of 50 to 100% (Suárez *et al*., 2006; Martins *et al*., 2009; Oliveira *et al*., 2013; Manes *et al*., 2013) which highlights the effectiveness of this antibiotic for the treatment of vaginitis whose etiology is GP bacteria. On the other hand, the main etiology of bacterial vaginitis in small ruminants are coliform bacteria (Ababneh and Degefa, 2006; Martins *et al*., 2009; Oliveira *et al*., 2013). In relation to this, in the *E*. *coli* isolates, only ciprofloxacin showed the lowest percentage of resistance (60%). In this regard, Oliveira *et al*., 2013 showed that ciprofloxacin was 100% effective in the control of *E*. *coli* isolates, from vaginal isolates of goats. In the same way that Martins *et al*., 2009 showed 100% effectiveness in coliform bacteria from vaginal isolates of sheep. This can demonstrate the speed with which *E*. *coli* can develop resistance to ciprofloxacin, so it is very important to raise awareness among both producers and veterinary clinicians in the responsible use of antibiotics.

CONCLUSION

The aerobic VM of the Creole goats of Jaumave municipality, Tamaulipas is composed mainly of GP bacteria (population represented mainly by the genus *Staphylococcus* spp) and to a lesser extent by GN bacteria (*Escherichia coli*). The bacteriological isolation of the vaginal swabs represented 41.2% of the samples, indicating that other types of bacteria (nutritionally demanding) could be part of the VM. The aerobic VM GP found proved to be highly resistant to erythromycin, tetracycline and vancomycin, while the GN isolates were resistant to most of the chemotherapeutics evaluated, except for cryprofloxacin and nitrofurantoin (with a resistance profile of 60% and 80%, respectively). The high percentage of resistance found in this work highlights the importance of a responsible use of antibiotics in extensive goat production.

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