



Transrectal ultrasound evaluation in tropical dairy goats: an indispensable tool for the diagnosis of reproductive disorders

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Abstract

In Brazil, great milk productivity was achieved after the implementation of a genetic improvement program. However, reproductive efficiency is still far from optimal, possibly due to the high number of undiagnosed disorders that may affect fertility. The aim of this study was to evaluate occurrences of the main reproductive disorders in dairy goats in southeastern Brazil. Data were collected between January 2015 and May 2017 from 23 commercial herds of different breeds, with goats ranging from 8 months to 12 years of age. Transrectal ultrasound exams were performed in 2680 goats. A total of 14.8% of the does showed a disorder in the reproductive tract: hydrometra (10.0%), ovarian follicular cysts (2.3%), gestational loss (1.5%), and hydrosalpinx (1.1%). This was the first study evaluating reproductive disorders in live animals that used a high number of Brazilian dairy goats. Considering that all these diseases affect fertility to different degrees, the performance of transrectal ultrasonography exams twice a year is strongly suggested, in order to guide precocious treatment or discard the animal as soon as possible, thus reducing economic losses in dairy goat farming.

Keywords Reproductive efficiency · Hydrometra · Hydrosalpinx · Ovarian follicular cysts · Gestational loss

Introduction

Brazilian goat herds are estimated to comprise more than 9 million animals, with 92.7% of goats located in the northeastern region (IBGE 2015). Although less than 1.9% of herds are in the southeastern region, it has the most advanced technical goat milking systems in the country. In this region, dairy goat herds are composed of specialized European breeds raised in a semi-intensive or intensive system (Lôbo et al. 2010). After the implementation of a Brazilian genetic improvement program (CapraGene®; Facó et al. 2011), many data

from goat farming have been reliably identified, such as the quantity and quality of milk production. Curiously, data of milk production in the southeastern region (Lôbo et al. 2017) are similar to data from France (Maigret 2016), which is the highest producer of goat milk in European Union (FAOSTAT 2014). Overall, in southeastern Brazil, goats are seasonal breeders and thus constantly require controlled reproductive management in order to produce a sufficient amount of milk throughout the year.

Although plentiful milk productivity has been reached, reproductive efficiency is still far from optimal, possibly due to the high number of undiagnosed disorders that may affect fertility. Ultrasonography has commonly been used as a diagnostic tool for the main reproductive disorders of the genital tract. Hydrometra, ovarian cysts, and hydrosalpinx are probably the most relevant disorders that can be diagnosed by transrectal ultrasonography (Gonzalez-Bulnes et al. 2010; Maia et al. 2017). Moreover, fetal loss and other minor disorders can also be diagnosed. Therefore, this study aimed to investigate occurrences of the main reproductive disorders in dairy goats kept under tropical conditions in southeastern Brazil by transrectal ultrasonography technique.

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Materials and methods

Location and study conditions

Data were collected between January 2015 and May 2017 from dairy goats of 23 commercial herds located in the south-eastern region of Brazil (States of São Paulo, Rio de Janeiro, Espírito Santo, and Minas Gerais). Locations of the farms ranged from 19° 18' 40" to 23° 32' 33" latitude S, 41° 06' 46" to 41° 06' 46" longitude W, 5 to 849 m sea level. On 20 farms, goats were raised in an intensive production system, confined in group pens, and fed with chopped *Pennisetum purpureum* forage or corn silage. On the three remaining farms, the production system was semi-intensive with access to pasture. A balanced concentrate supplement (National Research Council 2007) and mineralized salt and drinking water were available ad libitum.

Animals

Dairy breed female goats ($n = 2680$) ranging from 8 months to 12 years of age were subjected to transrectal ultrasonographic examination. The majority of these goats were Saanen (78.2%; $n = 2097$), but other breeds included Alpine (13.5%; $n = 361$), Toggenburg (6.4%; $n = 172$), Anglo-Nubian (0.3%; $n = 8$), and crossbreds (1.6%; $n = 42$).

Ultrasonographic examination

The reproductive tract of each goat was examined by a single operator using a B-mode, transrectal ultrasonographic scanner (US) (Mindray®, M5Vet, Shenzhen, China), equipped with a linear 5.0 MHz transducer taped to a PVC tube to facilitate its use in small ruminants (Souza et al. 2013). During the examination, goats remained standing, restrained by an assistant. To prevent the spread of pathogens among the female goats, plastic sanitary sleeves developed to fit the US rectal transducer (Camisinha para probe retal; NTB Indústria e Comércio de Produtos para Pecuária LTDA, São Paulo, Brazil) were used, with a new sleeve being applied to the US rectal transducer after each examination. A syringe containing 10 mL of carboxymethyl cellulose gel (Carbogel® UTL; Carbogel Indústria e Comércio LTDA, São Paulo, Brazil) was used to deposit lubricant into the goat's rectum and to increase the contact surface between the transducer and the rectal wall.

After visualization of the urinary bladder, imaging of the uterus and ovaries was performed to evaluate reproductive soundness. Once any abnormality was observed in the reproductive organs, sonographic representative images were saved for subsequent analysis. Goats were ranked according to detected reproductive disorders detected.

Statistical analysis

Data were analyzed using a statistical program (SAEG®, 9.0; Universidade Federal de Viçosa, Minas Gerais, Brazil). Frequency data for reproductive disorders were assessed by Fisher's exact test, considering breed and age effect, at a 5% significance level.

Results

Ultrasonographic examination

Ultrasound images of the main reproductive disorders found in goats (including viable fetuses for comparison) are shown in Fig. 1.

Occurrence of reproductive disorders

A total of 14.8% (398/2680) of the goats showed a disorder in the reproductive tract. These findings were classified as follows: hydrometra (10.0%; 268/2680), ovarian follicular cysts (2.3%; 62/2680), gestational loss (1.5%; 39/2680), and hydrosalpinx (1.1%; 29/2680). Individual data of goats affected by each reproductive disorder were divided according to breed and age (< 3 and ≥ 3 years old) (Table 1).

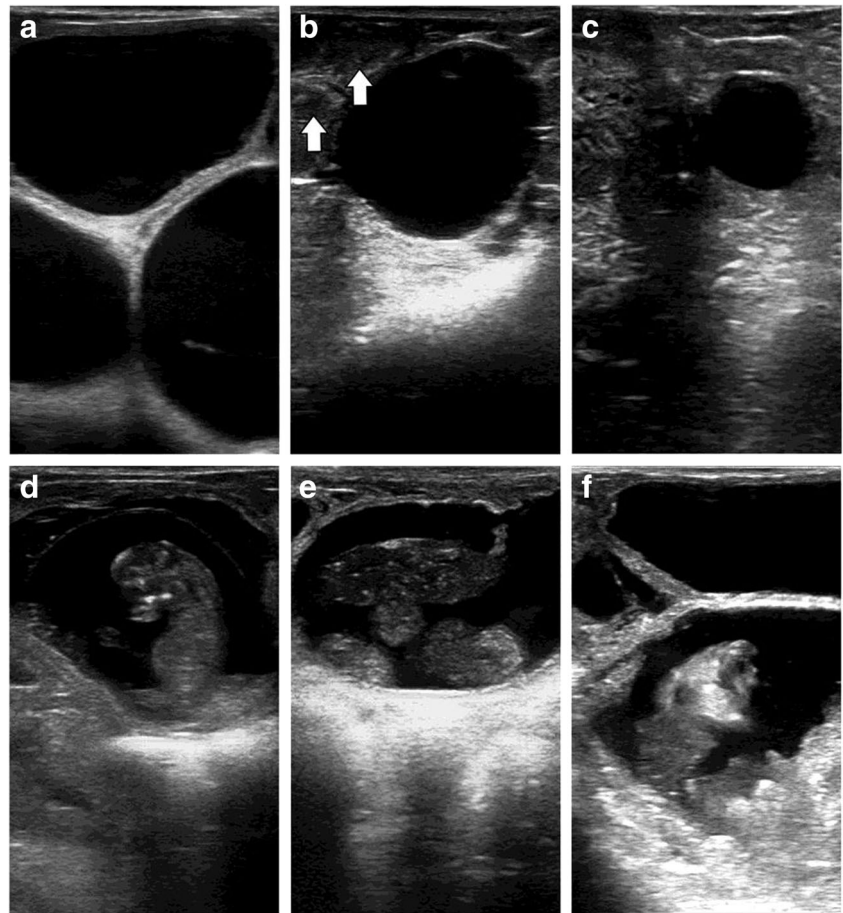
Among the 23 herds evaluated, occurrences of hydrometra ranged from 0 to 29.8%. It is worth mentioning that the owner of the only herd which did not present any cases of hydrometra reported having administered PGF2 α to two goats prior to our visit, due to suspected hydrometra. One of these goats had hydrometra and expelled the liquid, but the other was actually pregnant, and administration of PGF2 α led to the abortion of the fetus.

Discussion

This is the first study comparing occurrences of reproductive disorders in a high number of live dairy goats by transrectal ultrasonography. The methodology used and results presented in the current study can be very useful for both scientific and practical conditions.

In the present study, hydrometra was the highest prevalent disorder found in the reproductive tract, occurring in herds on an average of 10.0% (ranging from 0 to 29.8%) of the goats. This disease occurred in dairy herds on an average of 9.0% (ranging from 3.0 to 20.8%) and 7.7%, as reported by Hesselink (1993) from farms in the Netherlands and Moraes et al. (2007) from the northeastern region of Brazil, respectively. Because of the fact that hydrometra is mainly characterized by anestrus behavior, it is considered a silent disturbance in regions where there is marked reproductive seasonality (as is the case in the southeast

Fig. 1 Ultrasound images of the reproductive tract of dairy goats showing **a** hydrometra characterized by segments filled with liquid (anechoic), divided by the uterine wall (hyperechoic line); **b** hydrosalpinx characterized by the presence of rounded structure filled with liquid (anechoic) adjacent to transversal cuts of the uterus featuring normal aspect (white arrows, hypoechoic); **c** ovarian follicular cyst, identified as a cystic structure (> 10 mm) filled with liquid (anechoic); **d** healthy fetus in the embryonic vesicle (filled with anechoic liquid), surrounded by amniotic membrane (thin hyperechoic line); **e** recent gestational loss characterized by the misshapen conceptus with a compact appearance; and **f** advanced gestational loss developing hydrometra, with the presence of heterogenic content dispersed in liquid-filled segments (anechoic) separated by a thin uterine wall (hyperechoic line)



region of Brazil). Depending on the amount of fluid that has accumulated into the uterus, goats exhibit a pregnancy-like distended abdomen (Souza et al. 2013) and may have enlarge udders and present with lactogenesis at the end of the presumed pregnancy, easily confusing the farmer (Pietersen and Taverne 1986; Taverne et al. 1995). Considering that most farmers do not

have a veterinarian performing US evaluation on a consistent basis, some goats identified in the present study as having hydrometra had already undergone the “drying off” procedure for the prepartum period and had received the same nutritional management as females at the end of pregnancy, which resulted in a greater supply of concentrate and unnecessary expenses.

Table 1 Main reproductive disorders according to breed and age (< 3 and ≥ 3 years) of dairy goats ($n = 2680$) evaluated by transrectal ultrasound in the southeastern region of Brazil

Reproductive disorders (%)	Range (%)	Age	Alpine ($n = 361$)	Sannen ($n = 2097$)	Toggenburg ($n = 172$)	Others* ($n = 50$)	Total ($n = 2680$)
Hydrometra	0–29.8	< 3	3.1 ^{B,a}	6.8 ^{B,a}	2.6 ^{A,a}	4.5 ^{A,a}	5.9 ^B
		≥ 3	10.2 ^{A,b}	22.1 ^{A,a}	3.3 ^{A,b}	0.0 ^{A,b}	18.4 ^A
Ovarian follicular cysts	0–6.8	< 3	0.9 ^{B,b}	1.8 ^{A,ab}	5.3 ^{A,a}	0.0 ^{A,ab}	1.8 ^B
		≥ 3	7.4 ^{A,a}	2.5 ^{A,b}	4.5 ^{A,ab}	0.0 ^{A,ab}	3.1 ^A
Gestational loss	0–4.6	< 3	2.2 ^{A,a}	1.1 ^{A,a}	3.9 ^{A,a}	0.0 ^{A,a}	1.4 ^A
		≥ 3	0.0 ^{A,b}	1.4 ^{A,b}	5.7 ^{A,a}	0.0 ^{A,ab}	1.5 ^A
Hydrosalpinx	0–3.4	< 3	0.0 ^{A,b}	1.8 ^{A,a}	0.0 ^{A,b}	0.0 ^{A,ab}	1.4 ^A
		≥ 3	0.4 ^A	0.9 ^A	0.0 ^A	0.0 ^{A,a}	0.8 ^A
Total			9.9 ^{bc}	16.2 ^a	12.3 ^{ab}	2.0 ^c	14.8

*Anglo-Nubian and crossbreds

^{A,B} Percentages with different superscript letters within columns differed (Fisher's exact test; $P < 0.05$)

^{a,b} Percentages with different superscript letters within rows differed (Fisher's exact test; $P < 0.05$)

Thus, hydrometra can cause enormous economic loss in dairy goat breeding, since the expected kids will not be born and the milk production will be reduced (Hesselink 1993). Interestingly, goats that are more than 3 years old showed a higher occurrence of the disease ($P < 0.05$). The mean age of the affected goats was 3.8 ± 1.8 years old, which is similar to other studies, such as 2.8 ± 1.5 (Mialot et al. 1991) and 3.6 ± 1.0 (Salles and Araújo 2008). The effect of age on the occurrence of the disease was previously reported: 32.4% in goats from 6 to 11 years old vs. 10.4% in goats between 1 and 5 years old (Hesselink 1993). Moreover, the rates were superior in older Saanen goats. As the majority of the farmers of the southeastern region of Brazil have opted to use the Saanen breed, few bucks ended up being heavily used (Paiva 2016). Evaluated by Capragene®, the Saanen flocks feature an average inbreeding rate of 1.48%, which is acceptable, but it can be speculated that the presence of more cases of hydrometra in Saanen goats can be connected to genetic influences already verified in previous studies (Hesselink and Elving 1996).

Ovarian follicular cysts, which occur less frequently than hydrometra, represented 2.3% of reproductive disorders, with a significant difference regarding age, with older goats being more affected (3.1 and 1.8%—Table 1). Santa Rosa and Simplicio (1988) and Sattar (1988) reported, respectively, 3.2 and 0.2% of ovarian follicular cysts in the genital tracts of goats recovered from slaughterhouses. In live goats (1 to 9 years old), ovarian cysts were identified by transrectal US exams in 21.1% (4/19) of the females (Souza et al. 2013), demonstrating that the disease can be extremely variable in occurrence and age. Kawate (2000) reported that reproductive aging may be related initially to irregular cycling and anovulation, followed by a persistent estrus and later an anestrus period. Goats affected by ovarian follicular cysts usually present short estrous cycles and come into estrus every 3 to 7 days, or even are permanently in estrus (nymphomania). Thus, they can be mated successively during the breeding season without ovulation and fertilization occurring. With the end of the breeding season, they become anestrus due to the seasonal and remain unproductive, until the induction of estrus during the anestrus season or the return of the natural breeding season. In addition, Souza et al. (2013) identified ovarian follicular cysts in goats with hydrometra, highlighting a concomitant occurrence of both diseases. Similarly, Regassa et al. (2009) observed a higher prevalence of uterine diseases in sheep that had ovarian abnormalities. It is important to highlight that the negative impact of this disorder on production system efficiency can be minimized when diagnosed as early as possible.

Although most gestational losses occur in the embryonic stage, there are indications that about 5% of pregnancies diagnosed are lost later, during fetal development (Jonker 2004; Fonseca et al. 2005). In the present study, US evaluations were held after 30 days of gestation, allowing the visualization of important US parameters such as conceptus appearance and movement, heart rate, amount of fluid present in the uterus and

its echogenic characteristic (“dirty uterus”), and presence of placentomas (Martinez et al. 1998; Gonzalez-Bulnes et al. 2010; Fonseca et al. 2012). Gestational losses totaled 1.5% with slightly higher, and the rates were slightly superior in older Toggenburg goats. This difference was possibly more associated with local conditions, especially nutrition plans. According to Bolet (1986), the mortality rate from conception to the 30th day of gestation in goats ranges from 6 to 24%. Engeland et al. (1998), studying 22 herds in Norway where fetal loss is a serious problem in goat breeding, found a variation in incidence between 3 and 38%. It is noteworthy that if gestational loss occurs after maternal recognition of pregnancy, it results in an increase of the interval to estrus, leading to an unproductive period and financial losses. In dairy herds, economic losses arising from the death of the fetus are very significant, since they include not only the absence of the calf that is necessary for the replacement and genetic improvement of the herd but also the prolongation of the unproductive period of the female (Jonker 2004). In addition, in goats, the development of hydrometra can occur due to the presence of the dead fetus in the uterus, which is associated with the persistent presence of the corpus luteum (Humbolt et al. 1995).

Hydrosalpinx has been associated to subfertility or infertility, whether it occurs uni- or bilaterally (cattle, Noakes et al. (2001); buffaloes, Purohit (2014)). Due to the scarce material found in the specialized literature, and the impossibility of identifying the disease by rectal palpation (as it is identified in cattle and buffaloes), hydrosalpinx does not appear as an important reproductive disorder in goats. However, considering the US approach defined in the present study (uterine horn followed by an anechoic round structure; Fig. 1b), hydrosalpinx can be clearly diagnosed and differentiated from hydrometra. Differently from hydrometra, goats that present hydrosalpinx show estrus and are mated with fertile males, but usually do not have the capacity for conception and/or maintenance of pregnancy. In the present study, hydrosalpinx was noted in 1.1% of goats, exceeding 0.02% (Sattar et al. 1988) and 0.3% (Beena et al. 2015), which were previously reported from slaughterhouse data. The majority of goats were younger than 3 years old (69.0%). Normally, these goats appear healthy, with good body condition scores and shining skin. These features resulted from impaired fertility and body mass accumulation without any production (fetuses or milk). Thus, if not adequately diagnosed, these “healthy” goats are not usually discarded.

Although dairy goat production in the southeastern region of Brazil is reaching a high level of productivity (Lobo et al. 2017), disorders in the reproductive system prevent the maximization of the females’ potential. The lack of ultrasonographic assessments for evaluating goats before and after mating seasons ends up generating unnecessary costs associated with females that could have been treated or discarded but remain unproductive in the herd. The time spent on resources to maintain goats that present the disorders reported in this study may exceed 1 year if

an accurate ultrasonographic identification is not performed, since there is a reproductive seasonality and many breeders do not make use of estrus induction in the off-season.

Conclusion

This was the first study using a high number of Brazilian dairy goats in 23 herds that evaluated reproductive disorders by transrectal ultrasound exam in live animals. Hydrometra was the most frequent disorder found, followed by ovarian follicular cysts, gestation loss, and hydrosalpinx. Thus, diagnoses and possible treatments for these disorders should be emphasized, and predisposing factors should be further investigated. Considering that all these disorders affect fertility in different degrees, it is transrectal ultrasonography exams are strongly suggested twice a year, to guide early animal treatment and/or discarding as soon as possible, thus reducing economic losses in dairy goat farming.

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Compliance with ethical standards

Statement of animal rights The Animal Care Committee of the Universidade Federal Fluminense approved the study design (protocol number #678/2015), and it was conducted under the principles of the Sociedade Brasileira de Ciência em Animais de Laboratório (SBCAL), which regulates conditions for experiments involving animals.

Conflict of interest The authors declare that they have no conflict of interest.

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