*J Bangladesh Agril Univ 22(3): **396-403**, 2024* https://doi.org/10.3329/jbau.v22i3.76413

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau

Research Article

Ultrasonographic Udder Monitoring and Diseases Diagnosis in She-goat

Mst Sanjida Safawat, Samsun Naher, Mahmudul Hasan Sakib, Nahid Hassan, Md Abdur Rahim and Nasrin Sultana Juyena✉

Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

ARTICLE INFO

Article history
Received: 09 May 2024
Accepted: 22 September 2024
Published: 30 September 2024

Keywords
She-goat,
Ultrasonography,
Udder parenchyma,
Udder diseases

Correspondence
Nasrin Sultana Juyena
✉: nsjuyena@bau.edu.bd

ABSTRACT

Ultrasonography is an effective, non-invasive technique for regular monitoring of udder health to ensure the best quality of milk. The study was conducted to measure the diameter of gland cistern before and after milking and evaluate the effect of breeds, age, and seasons on udder diseases in she-goats. The diameter was measured through ultrasonography before and after milking and retrospective data (breed, age, season) were collected from the Veterinary Teaching Hospital, Mymensingh. Variation in gland cistern diameter (mm) was significant ($p<0.05$), meaning that the gland cistern's diameter changed more before and after milking. Results also revealed an insignificant ($p>0.05$) difference between the left and right quarter gland cistern's diameter independent of time. This study showed that the occurrence of udder diseases was higher in the Black Bengal breed (82%) compared to Jamuna Pari (18%). Mastitis mostly occurred at the age of between 2 to 3 years old (25.7%) and at the winter season (39.8%). All age groups had an affected incidence of 1.8% for udder wounds and showed higher occurrence during the summer season (5.3%). Furthermore, this study indicated that udder edema affection is more common in the group of goats younger than two years old and during the winter season (3.5%) This study concludes that normal physiological structures i.e. udder parenchyma, gland cistern and different pathological conditions such as mastitis, fibrosis can be easily monitored through transcutaneous ultrasonography.

Introduction

The goat is second in importance among Bangladeshi farmers' livestock and has been domesticated by humans for a longer period than cattle and sheep. The estimated number of goats in Bangladesh is 269.45 lakh (BBS, 2023). The cost-effective and hygienic milk production of healthy animals is influenced by their udder (Twardon et al., 2001). Arcos-Álvarez et al. (2020) reported that the volume of the udder, udder measures, and the daily milk production of Pelibuey ewes are correlated. Mammary gland disorders can impact milk production in terms of both volume and quality, which can have an impact on the economy. For the treatment of udder diseases evidence-based treatments are required and it is possible only by diagnostic imaging (Martin *et al*., 2018). For these reasons, accurate, fast, and effective measuring and diagnostic techniques were developed and one of the most effective and widely used methods worldwide is ultrasonography (Ragab et al., 2016). Nowadays, ultrasonography is a safe and non-invasive diagnostic tool and is used to a great extent in veterinary practice (Neijenhuis *et al*., 2001; Fricke, 2002).

Mammography is a contemporary, precise, and fast method (Mourya et al., 2020) for visualizing the normal texture of the mammary gland (Ayadi et al., 2003; Szencziová and Strapák, 2012). It can also be used to measure the diameter of the gland cistern as well as diagnose various surgical alterations of the udder, including inflammation, mucosal lesions, tissue proliferation, foreign bodies, milk stones, hematoma, and abscess, among other things (Franz et al., 2009). Measurements of gland cistern and udder size are required to ensure complete milking and enhance milk output. The measures of an animal's udder are also significant to farmers since they can be utilized for feeding, giving medication, selecting animals for breeding, and farm management (Makamu et al., 2023). The gland cistern measurement also aids in the prediction of milk yield (Wojtowski et al., 2006). Lactation number is also related to milk productivity as well as gland cistern size. The diameter of the gland

Cite This Article
Safawat, M.S., Naher, S., Sakib, M.H., Hassan, N., Rahim, M.A. and Juyena, N.S. 2024. Ultrasonographic Udder Monitoring and Diseases Diagnosis in She-goat. *Journal of Bangladesh Agricultural University,* 22(3): 396-403. https://doi.org/10.3329/jbau.v22i3.76413

cistern is decreased after milking which indicates complete milking (Makamu et al., 2023) and complete milking prevents mastitis. Therefore, the gland cistern measurement is necessary before and after milking. measuring of the gland cistern is greatly assisted by mammary gland ultrasonography.

Bangladesh's native black Bengal breed (BB) is the most common breed of goat due to its high prolificacy, soft skin, and tender flesh. On the other hand, Jamunapari goats are multi-purpose animals, producing meat, milk, skin, and hair (Amin et al., 2001). These goats especially the dairy goats have udder problems that are comparable to those of dairy cows (Smith and Roguinsky,1977). Age, breed, lactation stage, parity, environmental factors, damage to the udder or teat, teat sores, and management practices are some of the risk factors that have an impact on the development of the udder disease (Kumar et al., 2016). Goats may suffer from udder problems such as mastitis, udder abscess, udder wounds, udder edema, etc. Mastitis, the most prevalent disease, is a multifactorial and complex disease that is characterized by inflammation of the mammary gland parenchyma, pathological alterations in the glandular udder tissues, and alterations in milk composition (Islam et al., 2011). Various forms of mastitis result in decreased milk yield, higher expenses, and animal culling (Khan and Khan, 2006; Blowey and Edmondson, 2010). Poor farmers suffer huge losses as a result of the teat and udder affections and there are some significant contributing factors to teat and udder affections (Chakrabarti et al., 2014). So it should be diagnosed as early as possible. Under such circumstances, ultrasonography is an essential diagnostic method.

Ultrasonographic monitoring and measurement of the udder are scanty in Bangladesh. So, the present study was conducted to measure the diameter and difference of the gland cistern through ultrasonographic examination before and after milking and to track the impact of lactation number on the gland cistern diameters. It also includes observation of the effects of breed, age, and season on the occurrence of udder diseases and examination of normal physiological and pathological conditions of goats through ultrasonography.

Materials and methods

Study area and period

The experiment was conducted at the Research Animal Farm, Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh, 2202; Veterinary Teaching Hospital and Dairy Goat farm, Bangladesh Agricultural University during the period of September 2023 to February 2024. Animals were divided into two groups; based on lactation number. Ten Black Bengal she goats having lactation number one were selected randomly from Research Animal Farm, Department of Surgery and Obstetrics, Bangladesh Agricultural University. Ten Black Bengal she goats having lactation of more than one from VTH and Dairy Goat farm were selected. A complete history of age and lactation number were recorded.

Collection of data

Data collection was conducted at the Veterinary Teaching Hospital, Bangladesh Agricultural University, Mymensingh. Data were collected from the register book based on goats' age, breed, season & udder diseases (93 Black Bengal and 20 Jamuna Pari goats), and 113 cases were recorded (97 Mastitis, 6 udder edema, and 10 uddder wound cases).

Clinical examination of the udder

Clinical assessment includes observation and palpation to look for abnormal findings as well as the most common indications of inflammation (redness, heat, pain, and swelling). The udder's position, form, and shape were also examined.

Fig. 1. Inflamed udder of goat affected with acute mastitis

Confirmatory test of Mastitis

Milk sample was taken from each quarter of 15 mastitis-affected goats. Mastitis was identified using a mastitis kit test following laboratory testing. The BAU mastitis kit and milk sample were fully mixed for this test, and the production of gel indicated mastitis (Fig. 2).

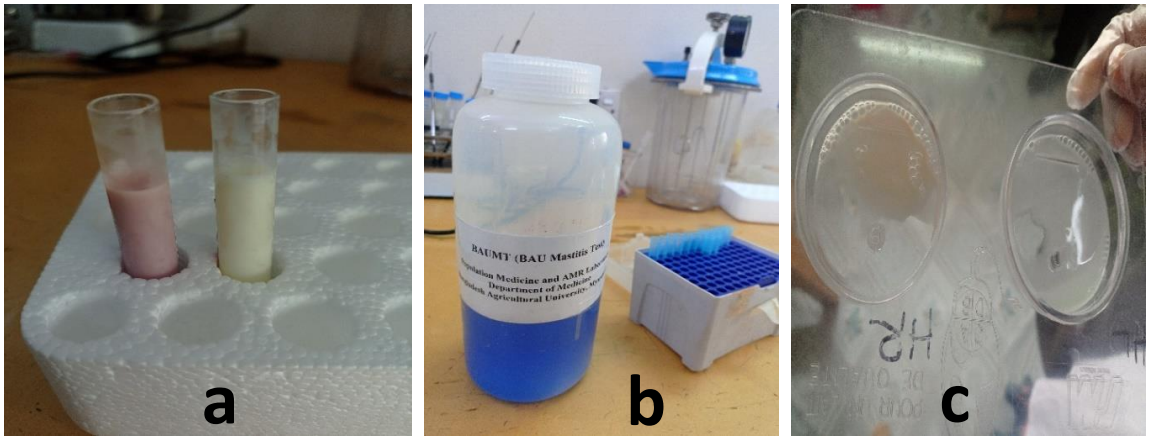

Fig. 2. (a) Milk sample was collected from the both affected and normal udder, (b) BAU Mastitis kit was used for confirmatory mastitis detection test, and (c) gel formation after mixing of milk with the kit.

Ultrasonographic Examination of Mammary Gland Before and After Milking

Before milking, the animals were restrained carefully and both the left and right side of the udder was cleaned with water. With a linear probe and B-mode digital ultrasound equipment (Esaote My Lab Five, Italy), ultrasonographic scanning was conducted at a frequency of 5 MHz. To prevent air from getting between the mammary gland and the probe, the ultrasound monitor was set a reasonable distance away from the animals, and the transducer of the probe was lubricated with an appropriate coupling gel (Konix Ultrasound Transmission gel). The direct contact method involved placing the probe directly on the skin (Fig. 3) First, the udder's left quarter was examined. There were several milk-filled alveoli in each gland cistern. The gland cistern's diameter was measured. The right part of the udder was then ultrasonographically examined. The gland cistern was measured similarly to the left side of the udder. The probe was placed on the caudal surface of each half along its longitudinal axis and moved upward and downward. For the examination of the gland cistern, the probe was placed with 80^{o} angle cranially just above the teat base.

Fig. 3. Ultrasonography of mammary glands of goats using linear probe

The udder's two halves were washed once again following milking. The lack of milk in the alveoli allowed for the observation of the gland's homogeneous echogenicity. Similar to before milking, the diameter of the gland cisterns on the quarter was measured.

Measurement of gland cistern in goats having lactation number of more than one

The left and right quarters of the udder were cleaned again. The homogenous echogenicity of the gland was observed due to the absence of milk in the alveoli. The diameter of the gland cistern of both quarters was recorded similarly to before milking based on lactation number.

Statistical Analysis

All the values related to the gland cistern were expressed as mean±SEM in Excel. The paired T-test was done with a confidence interval of 95% to find out the difference in the parameters before and after milking in goats. When the P value is less than 0.05, the difference was regarded as significant. A chi-square test was performed for relation of diseases with age and season. All the statistical analyses were done using the SPSS 22.0 version software program.

Results

Measurement of difference between the diameter of gland cistern before and after milking

Using ultrasonography, the gland cistern diameters (mm)were assessed before and after milking for both quarters. The gland cistern diameter of the left quarter is comparatively higher than the right quarter both before and after milking. Table 1 displays the mean±SEM of the diameter change between before and after milking. It has been demonstrated that the gland cistern's diameter significantly ($p<0.05$) decreases after milking. Results also reveal a significant ($p<0.05$) difference between left and right quarter gland cisterns diameter after milking and an insignificant ($p>0.05$) difference before milking.

Table 1. Values (mean±SEM) of gland cistern diameter(mm) measured by ultrasonography before and after milking in both quarter

Quarter	Gland Cistern Diameter (mm)		P Value
	Before Milking	After Milking	
Left	7.86 ±0.04	4.00 ±0.09	
Right	7.79 ±0.13	3.29± 0.06	**0.00**
P Value	**0.06**	**0.01**	

Effect of lactation number on the diameter of gland cistern measured through ultrasonography

The age and parity of the goats cause a substantial difference in the gland cistern sizes. The gland cistern diameters of parity one goat are smaller than those of parity more than one. Using ultrasonography, the gland cistern diameter (mean±SEM) in each quarter was evaluated depending on the lactation number of goats, and results were displayed in Table 2. It shows that the largest gland cistern diameter in the goat is in the third lactation.

Table 2. Values (mean±SEM) of gland cistern diameter (mm) measured by ultrasonography in goats of lactation groups (Before milking)

Lactation Number	Gland Cistern Diameter(mm)	Maximum	Minimum
Lactation-1(n=10)	7.86±.16	6.90	9.00
Lactation-2(n=10)	11.92± .76	8.03	15.40
Lactation-3(n=10)	13.25±.41	8.98	15.70

Effects of breed, age, and season on udder diseases

This retrospective study was conducted to evaluate the effect of breeds, age, and seasons of udder diseases in she-goats. Fig. 4 shows that the occurrence was higher (82%) in Black Bengal goats compared to Jamuna Pari.

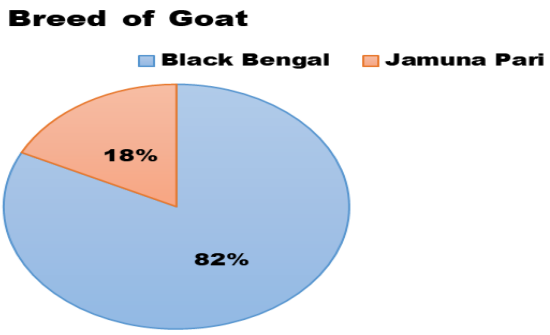

Fig. 4. Disease frequency regarding breed

Fig. 5 demonstrates that the impacted rate of mastitis is 23.9% for those over the age of three, 25.7% for those between the ages of two and three, and 24.8% for those under the age of two. The affected rate of mastitis is 11.5% for those under the age of two. It shows that the 2-3 years of age range for mastitis is higher than other age groups. Except for those older than three years, all age groups have an impacted incidence of 1.8% for udder wounds. Additionally, this finding shows that the group of goats under two years old has a greater rate of udder edema affection (3.5%). It was shown that none of the metrics were significant ($p>0.05$).

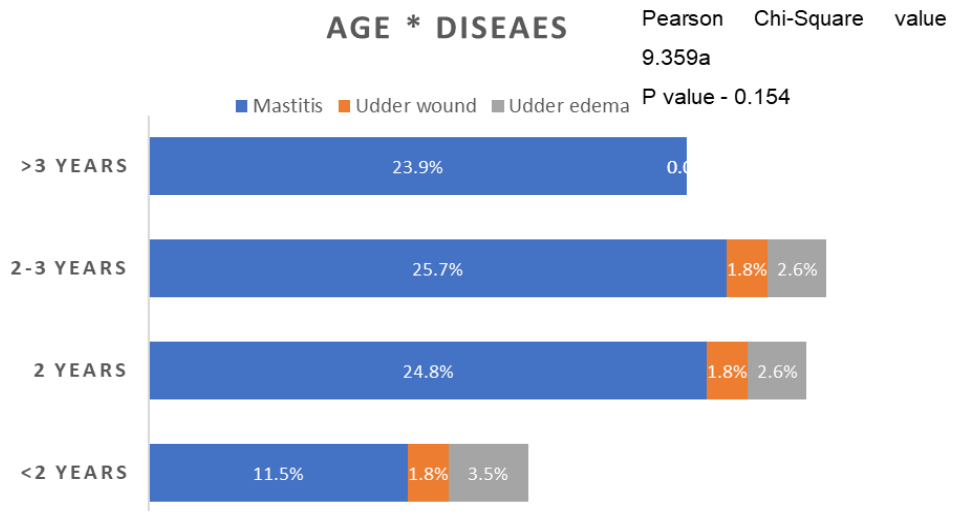

Fig. 5. Occurance of udder diseases according to the age of the goats

The impacted rate of mastitis was higher during the winter and lower during the wet season, as Fig. 6 illustrates. Additionally, the summertime (5.3%) and wintertime (0.9%) impacted rates of udder wounds were higher and lower, respectively. The affection rate for udder edema is highest (3.5%) during the winter and lowest (0%), during the rainy season.

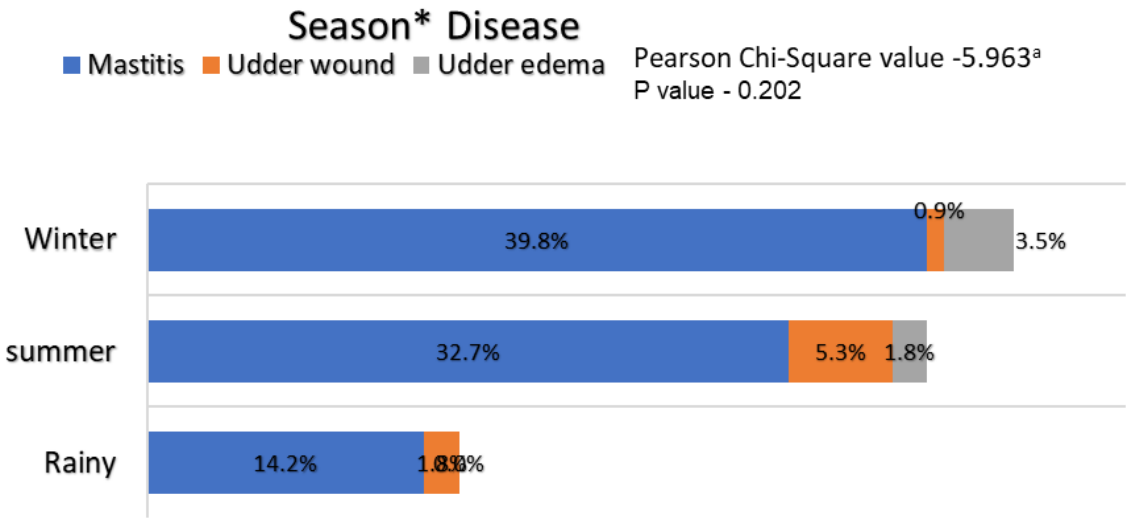

Fig. 6. Seasonal variation in the occurrence of udder diseases

Ultrasonographic observation of udder parenchyma before and after milking

The transmammary ultrasonography was conducted to observe the echotexture of the gland cistern of the mammary gland through ultrasonography findings are shown in Fig. 7. It shows that before milking the alveoli of the gland cistern were full of milk. The udder parenchyma was hyperechoic with a large anechoic area of gland cistern shown in Fig. 7(a). On the other hand, the udder parenchyma, and gland cistern became homogenous after milking (Fig. 7b).

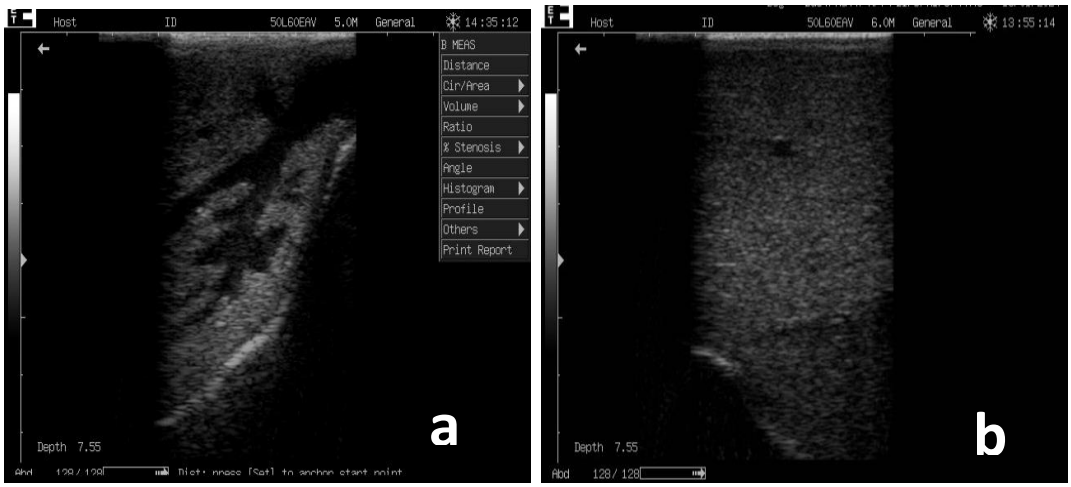

Fig. 7. (a)Anechoice gland cistern was found throughout the udder parenchyma before milking, (b)parenchyma become homogenous after milking (horizontal scan, 5 MHz linear probe, direct contact method)

Diagnosis of mastitis through ultrasonography

Normally udder parenchyma appears homogenous with anechoic glands. However, in the case of mastitis, it becomes heterogeneous (Fig. 8a). In the case of chronic mastitis, the hyperechoic fibrous line was found in the udder parenchyma (Fig. 8b).

Fig. 8. (a) Mastitis-affected udder parenchyma looks heterogeneous and lack of anechoic gland cistern in acute mastitis, (b) hyperechoic fibrous line in udder parenchyma was found in case chronic mastitis (Horizontal scan, 5 MHz linear probe, direct contact method).

Discussion

Monitoring of udder health and udder disorders should be identified as soon as feasible using various techniques to prevent this loss (Kuru et al., 2019). For examination of physiological echotexture and some pathological problems like fibrosis, inflammation, and mastitis, ultrasound is a very effective non-invasive approach (Patel et al., 2022). It can be used to ensure milk quality and the udder's health.

This study found that the gland cistern diameter decreases significantly after milking, which was measured through ultrasonography which is in agreement with the study conducted by Makamu et al. (2023). They measured the udder length and width both before and after milking and reported to decrease after milking. The size and internal consistency of the mammary gland can be evaluated by ultrasonography, which also provides information about the gland's size and overall condition (Senthilkumar et al., 2020) and to determine the relationship between milk production and mammary gland morphology (Adam et al., 2017).

Lactation number, genetics, nutrition, health, and management techniques all have an impact on milk productivity. According to our research, the diameter of the gland cistern was increased with the number of lactations. It revealed that lactation number three had the largest diameter. This outcome is contrasted to Krajinović et al. (2011). They stated that the number of lactations greatly affects the milk yield, which is higher at lactation number three than it is at lactation number one. This result is also consistent with some others' agreement (Milerski and Mareš, 2001; Ciappesoni et al., 2002a, Ralević et al., 2021). Goats' lactation frequency affects how much milk they produce and the amount gradually increases with the number of lactations.

In considering the breed, the Black Bengal breed was more affected by udder diseases than the Jamuna Pari breed and this result is in accordance with Islam et al. (2021). According to their statement, the Black Bengal breed had a comparatively higher incidence of udder disease than Black Bengal and Jamuna Pari goats. The variation may be the result of malnutrition or a poor goat management system. Age, parity, or lactation stage did not significantly affect the occurrence of mastitis in camels, cows, or goats (Balemi et al., 2021).

According to the study, mastitis was more common in goats between the ages of two and three than in other age groups. Additionally, Raquib et al. (2020) and Islam et al. (2021) reported the same findings that goats older than 24 months have a significantly higher risk of developing mastitis. The prevalence of mastitis has been increasing with age (Moroni et al. 2005).

Season is another risk factor for the development of mastitis in goats. In this study, we found that mastitis mostly occurred in the winter season than in the summer and the rainy season. Sardar et al. (2006) also stated that there was an increase in mastitis during winter which is consistent with our findings.

Udder affections cause discomfort and painful milking to animals. Chakrabarti et al. (2014) stated that udder and teat infection occurs mostly during the summer season due to Unsanitary goat sheds, mishandling, ignorance of clean milk production by the farmers, and

unscientific milking and management techniques. This finding is in contrast with our report. Summer had the highest frequency of udder wounds, followed by the rainy and winter seasons. Udder edema is a moderately common serious disorder that hampers both dairy output and animal welfare. It was found that udder edema occurred more in the winter season than summer and rainy seasons, and older she-goats are more susceptible which is similar to the report of Melendez et al. (2006). Udder edema is more likely in the winter due to higher intakes of potassium and salt compared to the summer (West et al., 2003; Melendez et al., 2006).

For food animals, morphological udder characteristics are important (Modekar et al., 2017). According to Senthilkumar et al. (2020), ultrasonographic anatomy is essential to comprehend the functional state of the mammary gland and teat in healthy adult sheep and goats. The parenchyma of a healthy mammary gland was described by Flöck and Winter (2006) as a homogenous structure with average echogenicity, and lactiferous ducts. This study observes that gland cistern gave an anechoic ultrasonographic image when it was full of milk and these gland cisterns were distributed throughout the homogenous udder parenchyma. But after milking the anechoic gland cistern almost disappeared. This result is consistent with the report of Franz et al. (2009) and Fasulkov (2012).

Mastitis leads to parenchymal tissue change, fibrosis, or severe toxemia, which ultimately results in milk losses (Ahmed et al., 2020). It is proposed that the quantification of echogenicity can be utilized as a supplemental technique for the diagnosis of mastitis in goats because it is a valuable method for assessing the milk in animals with the condition (Santos et al., 2015). We found udder parenchyma becomes heterogeneous and hyperechoic. Moreover, the gland cistern appears hyperechoic with solid components rather than anechoic. This result is contrasted with the findings of Santos et al. (2015). In the case of chronic mastitis, hyperechoic fibrous line udder parenchyma was found and there was a lack of clear cistern. Kotb et al. (2020) also reported several hyperechoic structures in the teat cistern and udder parenchyma, thick, hyperechoic teat wall, and complete replacement of the milk alveoli by hyperechoic fibrous tissue in the case of chronic mastitis which is same as our findings.

Conclusion

Ultrasonographic examination helps to assess both physiological and pathological conditions in goats. There is a noticeable difference in the gland cistern diameters before and after milking, with the diameter being lower measured through ultrasonography. The gland cistern diameters vary with lactation number and it states that gland cistern diameter increases with lactation number. Mastitis, a common udder disease, is more common in black Bengals between the ages of two and three years old, and it generally occurs in the winter.

Acknowledgment

This study was funded by USDA under the research project "Measuring the Value of Improved Grain Measurement in Bangladesh" implemented by the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. This study was funded by USDA under the research project "Measuring the Value of Improved Grain Measurement in Bangladesh" implemented by the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. This study was funded by USDA under the research project "Measuring the Value of Improved Grain Measurement in Bangladesh" implemented by the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. This study was funded by USDA under the research project "Measuring the Value of Improved Grain Measurement in Bangladesh" implemented by the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. The authors acknowledge Bangladesh Agricultural University Research System (BAURES) for funding this project.

References

Adam, Z.E., Ragab, G.A., Awaad, A.S., Tawfiek, M.G., Maksoud, M.K. 2017. Gross anatomy and ultrasonography of the udder in goat. *Journal of Morphological Sciences*, 34(03): 137-42.

Ahmed, Y.F., Ezzo, O.H., Mansour, S. 2020. Some Udder Problems associated with productivity in Goats. *Egyptian Journal of Veterinary Sciences*, 51(1): 1-9.

Amin, M.R., Husain, S.S., Islam A.B.M.M. 2001. Reproductive peculiarities and litter weight in different genetic groups of Black Bengal does. *Asian-Australasian Journal of Animal Sciences*, 14: 297-301.

Arcos-Álvarez, D., Canul-Solís, J., García-Herrera, R., Sarmiento-Franco, L., Piñeiro-Vazquez, Á., Casanova-Lugo, F., Tedeschi, L.O., Gonzalez-Ronquillo, M., Chay-Canul, A. 2020. Udder measurements and their relationship with milk yield in Pelibuey ewes. *Animals*, 10(3): 518.

Ayadi, M., Caja, G., Such, X., Knight, C.H. 2003. Use of ultrasonography to estimate cistern size and milk storage at different milking intervals in the udder of dairy cows. *Journal of Dairy Research*, 70(1): 1–7.

Balemi, A., Gumi, B., Amenu, K., Girma, S., Gebru, M.U., Tekle, M., Rius, A.A., D'Souza, D.H., Agga, G.E., Kerro, Dego, O. 2021. Prevalence of mastitis and antibiotic resistance of bacterial isolates from CMT-positive milk samples obtained from dairy cows, camels, and goats in two pastoral districts in Southern Ethiopia. *Animals*, 11(6): 1530.

BBS, 2022-23. Livestock economy at a glance. Department of Livestock Service (DLS).

Blowey, R. and Edmondson, P. 2010. Mastitis Control in Dairy Herds. *Centre for Agriculture and Bioscience International Oxfordshire* (2nd edition), 1–4.

Chakrabarti, A., Chandran, P.C., Kumar, P., Dey, A. 2014. Teat and udder disorders in goats (Capra hircus) in Bihar, India. *Asian Journal Life Sciences*, 2(2): 20-2.

Ciappesoni, C.G., Milerski, M., Gabrielová, H. 2002. Estimation of breeding values in dairy goats with test day model. *Sborník přednášek*, (5): 93-6.

Fasulkov, I.R. 2012. Ultrasonography of the mammary gland in ruminants: A review. *Bulgarian Journal of Veterinary Medicine*, 15: 1-12.

Flöck, M. and Winter, P. 2006. Diagnostic ultrasonography in cattle with disease of the mammary gland. *The Veterinary Journal*, 171: 314–321.

Franz, S., Floek, M., Hofmann-Parisot, M. 2009. Ultrasonography of the bovine udder and teat. *Veterinary Clinics of North America: Food Animal Practice,* 25(3): 669– 685.

Fricke, P.M 2002. Scanning the Future Ultrasonography as a reproductive management tool for dairy cattle. *Journal of Dairy Science*, 85(8): 1918– 1926.

Islam, M.A., Samad, M.A., Rahman, A.K.M.A. 2011. Bacterial pathogens and risk factors associated with mastitis in Black Bengal goats in Bangladesh. *Bangladesh Journal of Veterinary Medicine*, 9: 155-159

Islam, S., Akhand, M.S.R., Khan, M.B., Hossain, M.K. 2021. Prevalence of the Infectious Diseases of Goats in Sylhet District, Bangladesh. *Scholars Journal of Agriculture and Veterinary Sciences*, 4: 42-50.

Khan, M.Z. and Khan, A. 2006. Basic facts of mastitis in dairy animals: A review. *Pakistan Veterinary Journal*, 26: 204–208.

Kotb, E., El-Fattah, A., Ola, A., Azab, A.M., Leil, A.Z. 2020. Ultrasonography, histopathological udder alterations and bacteriological investigations for diagnosis of mastitic goats. *Journal of Applied Veterinary Sciences*, 5(2):77-86.

Krajinović, M., Pihler, I., Simin, V., Jocić, A., Nićin, S., Žujović, M. 2011. The influence of a number of lactation on milk yield parameters in German fawn goats. *Biotechnology in Animal Husbandry*, *27*(4): 1469-1475.

Kumar, R., Gupta, D.K., Bansal, B.K., Singh, S., Sharma, S., Kumar, A., Uppal, S.K. 2016. Prevalence, current antibiogram, and risk factors associated with mastitis in dairy goats in Punjab. *International Journal of Science, Environment, and Technology*, 5(6): 4580-93.

Kuru, M., Oral, H., Kulaksiz, R. 2019. Determination of gestational age by measuring defined embryonic and fetal indices with ultrasonography in Abaza and Gurcu goats. *Acta Veterinaria Brno,* 87(4): 357-362.

Makamu, T.C., Madikadike, M.K., Mokoena, K., Tyasi, T.L. 2023. Relationship between body measurement traits, udder measurement traits and milk yield of Saanen goats in Capricorn district of South Africa. *Revista mexicana de ciencias pecuarias*, 14(2): 423-33.

Martin, L.M., Stöcker, C., Sauerwein, H., Büscher, W., Müller, U. 2018. Evaluation of inner teat of morphology by using high-resolution ultrasound: Changes due to milking and establishment measurement traits of the distal teat canal. *Journal of Dairy Science*, 101(9): 8417-8428.

Melendez, P., C. Hofer, Donovan, G.A. 2006. Risk factors for udder edema and its association with lactation performance on primiparous Holstein cows in a large Florida herd, U.S.A. *Preventive Veterinary Medicine*, 76: 211-221.

Milerski, M. and Mareš, V. 2001. Analysis of systematic factors affecting milk production in dairy goats. 43-50.

Modekar, S.S., Dhande, P.L., Shankpal, V.D., Gaikwad, S.A., Patil, A.D., Chawan, S.R., Saini, J. 2017. Assessment of udder characteristics of lactating and non-lactating mammary gland of non-descript goats of Maharashtra region. *Indian Journal of Veterinary Anatomy*, *29*(2).

Moroni, P., Pisoni G., Ruffo, G., Boettcher, P.J. 2005. Risk factors for intramammary infections and relationship with somatic-cell counts in Italian dairy goats. *Preventive Veterinary Medicine*, 69: 63–73.

Mourya, A., Shukla, P.C., Gupta, D.K., Sharma, R.K., Nayak, A., Tiwari, A., Singh, B., Singh, A.P., Sahi, A.A., Jain, A. 2020. Ultrasonographic alteration in subclinical mastitis in cows. *Journal of Entomology and Zoology Studies*, 8(4): 2058-2063.

Neijenhuis, F., Klungel, G.H., Hogeveen, H. 2001. Recovery of cow teats after milking as determined by ultrasonographic scanning. *Journal of Dairy Science*, 84(12): 2599–2560.

Patel, N.P., Talekar, S.H., Kumar, V., Bhatt, R.H., Trangadia, B.J., Dodia, V.D., Padaliya, N.R. 2022. Diagnosis of different mammary gland affections in Gir cows by ultrasonography. *International Journal of Science, Environment, and Technology*, 11: 370–375.

Ragab, G.H., Seif, M.M., Qutp, M.M. 2016. Ultrasonography of the mammary gland in ruminants. *Journal of Veterinary Medical Research*, 23(2): 125-132.

Ralević, R., Papović, T., Pihler, I., Kučević, D., Ivković, M., Dragin, S., Čobanović, K., Mekić, C., Polovinski-Horvatović, M. 2021. Influence of lactation number and parity on milk yield of Saanen goat's breed. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, *73*: 923-928.

Raquib, A., Uddin, M.M., Chowdhury, M.S., Hossain, M.M., Rahman, M.M. 2020. Occurrence and distribution patterns of the diseases of goat in Dhaka, Bangladesh. *Turkish Journal of Veterinary Research*, 4(2): 51-6.

Santos, V., Simplício, K., Sanchez, D., Coutinho, L., Teixeira, P., Barros, F., Almeida, V., Rodrigues, L., Bartlewski, P., Oliveira, M. 2015. B-Mode and doppler sonography of the mammary glands in dairy goats for mastitis diagnosis. *Reproduction in Domestic Animal*, 50: 251–255.

Sardar, S.A., Samad, M.A., Ehsan, M.A., Anower, A.K. 2006. Incidence of goat diseases in the selected area of Dhaka and Mymensingh districts. *Journal of the Bangladesh Agricultural University*, 4(2): 299-304.

Senthilkumar, S., Kannan, T. A., Gnanadevi, R., Geetha Ramesh, Sumathi, D. 2020. Ultrasonographic anatomy of udder in indigenous Madras red sheep, 182-184.

Smith, M.C., Roguinsky, M. 1977. Mastitis and other diseases of the goat's udder. *Journal of the American Veterinary Medical Association*, 171(12): 1241-8.

Szencziová, I. and Strapák, P. 2012. Ultrasonography of the udder and teat in cattle: perspective measuring technique. *Slovak Journal of Animal Science*, 45(3): 96–104.

Twardon, J., Dziecio, M., Nizamski,, M., Dejneka, G.J. 2001. Use of ultrasonography in diagnosis of teat disorders. *Journal of Veterinary Medicine*, 57(12): 874–875.

West, J.W., Mullinix, B.G., Bernard, J.K. 2003. Effects of hot, humid weather on milk temperature, dry matter intake, and milk yield of lactating dairy cows. *Journal of Dairy Science*, 86: 232-242.

Wojtowski, J., Ślósarz, P.I., Junkuszew, A., Milerski, M., Szymanowska, A., Szymanowski, M. 2006. Application of ultrasound technique for cistern size measurement in dairy goats. *Archives Animal Breeding*, 49(4): 382-8.