

## The Prevalence of Dairy Goat's Subclinical Mastitis Related to Udder Morphology and Farming Management Practices

### *Prevalensi Kejadian Mastitis Subklinis pada Kambing Perah terkait dengan Morfologi Ambing dan Praktik Manajemen Pemeliharaan*

Himmatul Khasanah<sup>1,2</sup>, Roni Yulianto<sup>1,2</sup>, Nur Widodo<sup>1,2</sup> and Desy Cahya Widianingrum<sup>1,2\*</sup>, Riza Yuli Rusdiana<sup>3</sup>

<sup>1</sup>Study Program of Animal Husbandry, Faculty of Agriculture, University of Jember, Indonesia

<sup>2</sup>Animal Breeding and Production Research Group, Faculty of Agriculture, Universitas of Jember, Jember, Indonesia

<sup>3</sup>Department of Agronomy, Faculty of Agriculture, Universitas of Jember, Jember, Indonesia

\*Corresponding author; Email: dsycahya312@gmail.com

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#### Abstrak

Penelitian ini bertujuan untuk menganalisis prevalensi mastitis subklinis (SCM) dan korelasi antara skor positif dari *California Mastitis Test* (CMT) dan morfologi ambing dan management pemeliharaan pada kambing perah di beberapa kabupaten di Jawa Timur. Identifikasi SCM diuji menggunakan metode CMT. Data yang diperoleh dianalisis secara kualitatif dan kuantitatif serta ditentukan korelasinya dengan metode koefisien korelasi Kendall tau-b. Hasil penelitian menunjukkan prevalensi SCM di Blitar, Lumajang, dan Jember masing-masing sebesar 19,35%, 0,86%, dan 25%. Pengelolaan kontrol peternakan kambing perah yang diamati relatif sama seperti frekuensi pemerahan, manajemen pakan, kontrol kesehatan, dan jenis kandang. Produksi susu berkorelasi sedang dengan CMT ( $t_b = -0,417$ ) dan berkorelasi rendah dengan bentuk ambing ( $t_b = -1,51$ ), penampang ambing samping ( $t_b = -0,293$ ), sudut pisah puting antara puting ( $t_b = 0,204$ ) dan derajat pisah ambing ( $t_b = 0,128$ ). Skor CMT juga memiliki korelasi yang rendah dengan BCS ( $t_b = 0,146$ ), simetri ambing ( $t_b = 0,126$ ), penampang ambing dari samping ( $t_b = 0,153$ ). Skor CMT juga memiliki korelasi sedang dengan tipe kandang ( $t_b = -0,380$ ) dan frekuensi pemerahan ( $t_b = 0,365$ ). Kesimpulannya, prevalensi SCM relatif rendah hingga sedang dan korelasinya dengan morfologi ambing juga rendah hingga sedang.

**Kata kunci:** CMT; Management pemeliharaan; Mastitis Subklinis; Peranakan Etawah.

#### Abstract

This study aimed to analyze the prevalence of subclinical mastitis (SCM) and the correlation between CMT positive score, udder morphology and management practice in dairy goats in several regencies in East Java. The SCM identification was tested using the California Mastitis Test (CMT) method. The obtained data were analyzed qualitatively and quantitatively and the correlation was determined using Kendall's tau\_b coefficient correlation method. The results showed the prevalence of SCM in Blitar, Lumajang, and Jember amounted to 19,35%, 0,86%, and 25%, respectively. The control management of observed dairy farms was relatively similar such as the milking frequency, feeding management, health control, and cage type. Milk production was moderately correlated with CMT ( $t_b = -0.417$ ) and low correlation with the udder shape ( $t_b = -1.51$ ), side udder cross-section ( $t_b = -0,293$ ), teat angle of separation between teat ( $t_b = 0,204$ ), and degree of udder separation ( $t_b = 0,128$ ). The CMT also has low correlation with the BCS ( $t_b = 0,146$ ), udder symmetry ( $t_b = 0,126$ ), sided udder cross-section ( $t_b = 0,153$ ). Then CMT also has a moderate correlation with housing type ( $t_b = -0,380$ ) and milking frequency ( $t_b = 0,365$ ). In conclusion, the prevalence of SCM was relatively low to moderate and its correlation with udder morphology were low to moderate.

**Keywords:** CMT; Management Practice; Peranakan Etawah; Subclinical Mastitis

## Introduction

As a livestock product, milk has many advantages for farmers and consumers. Goat milk has high protein content and it was used as a source of protein. It is also used for various diseases treatment because it contains antioxidants and bioactive peptides categorized as a functional food (Lestari, 2020). Even in the era of the covid pandemic, goat's milk is used as an immune enhancer (Lima et al., 2018). Beside that, the productivity of dairy farms was robust (Setyawan et al., 2021) compared to other agriculture sectors and dairy farming also increased the local food supply chain (Hobbs, 2020). Milk production in Indonesia continues to grow, and about 52% (87,494,000 L) is met by production in East Java (Statistic Indonesia, 2019). However, Farmers still faced problem with mastitis, a mammary gland inflammatory action caused by pathogenic microorganisms in the udder that produce toxins that are dangerous to the mammary gland (Fratini et al. 2014, Widianingrum et al., 2022). Mastitis is categorized into clinical and subclinical mastitis. Clinical mastitis is characterized by swelling and the appearance of lesions on the udder and a drastic decrease in production. Meanwhile, subclinical mastitis does not show any infection, but there is a gradual decrease in milk production, altered milk quality and nutritional composition (Sharma et al. 2012, Fragkou et al., 2014, Abebe et al., 2016).

Previous research of the subclinical mastitis incident in dairy goats in Malang regency reported to be 58.6% (Mardian et al., 2020) and Banyuwangi amounted to 82.76% (Sevitasari, 2019). The Subclinical Mastitis (SCM) also become problematic in worldwide region such as in Egypt (Husseini et al. 2020), Thika-Kenya (Okoko et al., 2020), Pabhani-India (Tumbare et al., 2021), Bangladesh (Ferdous et al. 2018), Marmara-Turkey (Goncagul et al. 2021), Eastern Algeria (Gabli et al. 2019), China (Zhao et al., 2015), Mexico (Olivares-Pérez et al. 2015) and Iran (Tumbare et al. 2021); then the prevalence were identified in various percentage amounted to 52,56%, 72,7%, 65%, 38.75%, 27.2%, 5.64%, 45.82 %, 20.5 %. and 8,9%-14.7 % respectively. These situations are thought to be a significant factor causing economic losses

to dairy farmers and industry (Romero et al., 2018). The infectious agents can cause mastitis are bacteria, fungi, and yeast (Antanaitis et al., 2021) . The commonness of infection by these udder pathogens differs per country and region; consequently, preventative measurements and milking practices also different according to local and the regional farming conditions (Bradley 2002). Udder health and morphology also play an important role of this incident (Setianingrum et al., 2019; Vrdoljak et al., 2020; Menzies 2021; Wan-Azemin et al., 2021;). Beside that the management practice, nutrition and genetics also have contribution to this (Bramis et al., 2016). Information on the prevalence of incidence of clinical and sub-clinical mastitis related to udder morphology is needed to determine the direction of improvement, prevention, and control of bacterial infections that cause mastitis in dairy goats. Therefore, this study aimed to analyze the prevalence of clinical and sub-clinical mastitis in dairy goat farms in several regions in East Java and analyze the correlation of SCM prevalence and udder morphology.

## Material and Methods

### Field studies, interviews and milk sampling in dairy goat farmers.

This research was carried out in several districts of the eastern part of East Java Province in regencies with a relatively high population of dairy goats, namely Lumajang, Blitar, and Jember. The dairy goat farmer was choose by purposive sampling according to the region condition. In Lumajang, we took sample from Senduro District from 7 dairy farm that have more than 30 goats/farm, and the total of lactation goats amounted to 7-15 heads/farms. In Blitar Regency; we chose the largest farm with a population of 150 heads and 16 lactating goats. Meanwhile, in the dairy goat farm in Jember, samples were taken from Garahan District with a total population of 50 heads and eight lactating goats. We collected milk from each goat's teat of clinically healthy lactating goat and a total of 163 milk collected consisting of 116 samples from Lumajang, 31 from Blitar and 16 from Jember. The clinically healthy goat had no visual changes in the udder, milk, normal body

temperature, or feeding behavior. Milk sample collection procedures were discarded the first and second sprouts, then took about 10 mL of milk and kept in the 15 mL conical tube with identification number. Once collected, the milk samples were tested for CMT as soon as possible to determine subclinical mastitis incidence. The condition of goats, cage cleanliness, type of cage, feed management, health control, milking method and milk production were observed to determine management practice and incidence of clinical mastitis (Khasanah *et al.*, 2021).

### **California mastitis test (CMT) in dairy cattle.**

The CMT test was conducted by homogenizing 1 mL of milk sample, and 1 mL of CMT reagent in the paddle then moved horizontally for 10-20 seconds. The mixture reaction was observed and characterized by a thick mass with a negative (-), Trace, Positive +, positive ++, and positive +++ reaction rate (Kandeel, 2018). A CMT test result of positive 1 (+) is indicated by the presence of a slightly thickened mass, positive 2 (++) is indicated by the presence of a thickened mass, and positive 3 (+++) is characterized by the formation of a mass that resembles gelatin and is challenging to move (Khasanah *et al.*, 2021). SCM was determined by CMT positive 2. The CMT was used because has high sensitivity and specificity to determine the subclinical mastitis (Namira *et al.*, 2022).

### **Identification of udder and teat morphological characteristics of dairy goats.**

Morphological characteristics of the udder, including udder shape, nipple shape, udder degree separation, the angle of separation between nipples and the udder symmetry, were identified based on Margatho *et al.* (2020). Meanwhile, udder height, side udder cross-section and rump angle were identified based on Castañeda-Bustos *et al.* (2017). The Figure of udder and teat morphology presented in supplementary file 1.

### **Data Analysis**

The data obtained were examined qualitatively and quantitatively then tabulated

to determine the the prevalence, percentage of udder morphology in all sample and in positive CMT. We also calculated the percentage of all sample and CMT positive according to the management practice. The correlation of CMT positive and udder morphology and management practices were analysis using kendalls tau-b (Muñoz-Pichardo *et al.*, 2021) procedure of IBM SPSS 26 software.

## **Result and Discussion**

### **Prevalence of subclinical mastitis (SCM) in dairy goat.**

Mastitis in goats is a pathological disease that impacts economic status and can cause losses for farmers, especially in goats suffering from subclinical mastitis (SCM). The SCM diagnosis is tricky because it cannot be done by a general physical examination such as palpation or organoleptic examination (Bourabah *et al.* 2013). We did not find any clinical mastitis symptoms in all samples. Furthermore, the total sample of CMT negatives was 69.94%, and the total of CMT positives in several districts in East Java was 30,06%, consisting of 23,31% positive 1 and 6,75% positive 2. We didn't find any CMT-positive 3 in all samples. In Blitar, Lumajang, and Jember districts, the prevalence of SCM was 19,35%, 0,86%, and 25% (Table 1). The study results on the prevalence of SCM in dairy goats in East Java are known to be lower than dairy cows, namely 68.18% (Khasanah *et al.*, 2021). The SCM prevalence in goats was also reported by Mishra *et al.* (2018), who found that in Barbari and Jamunapari, goats kept in organized housing were 24.21% and 15.12%, respectively. The estimated prevalence of SCM in dairy goats in Bangladesh based on half udders using CMT was 50.9% (95% CI: 44.2–57.7%). SCM incidence was also reported to be significantly higher in poor and moderate body conditions than in cachectic goats, late lactating goats, Jamnapari breeds, and bottle-shaped teats rather than conical or cylindrical teats (Aker *et al.*, 2020). The inflammation of mastitis goats was also affected by glutathione peroxidase and superoxide dismutase levels; the glutathione peroxidase level was found to be higher in mastitis goats and the superoxide

**Table 1.** Subclinical mastitis prevalence in Blitar, Lumajang and Jember

CMT results	Blitar(n=31)	Lumajang(n=116)	Jember(n=16)	Total(n=163)
Negative	20(64,52%)	94(81,03%)	0(0,00)	114 (69,94%)
Positive 1	5(16,13%)	21(18,10%)	12(75,00%)	38 (23,31%)
Positive 2	6(19,35%)	1(0,86%)	4(25,00%)	11(6,75%)
Positive 3	0(0,00%)	0(0,00%)	0(0,00)	0(0,00)

n= number of sample

dismutase level was found to be low in mastitis goats, but the changing levels of those enzymes weren't related to age or parity (Darbaz et al., 2019). The goat with CMT score positive 1 reported have *E. coli* with temoneira (TEM) and sulfhydryl variable (SHV) antibiotics gene resistant (Widianingrum et al., 2023).

### Udder morphology related to SCM incidence.

Table 3 shows variation in udder characteristics and morphology in subclinical mastitis goats. The udder shape characteristics (bowl, cylindrical, and funnel) of dairy goats having CMT were found in equal percentages, which amounted to 35%, 33%, and 31%, respectively. The udder symmetry of SCM dairy goat was dominated by symmetrical (57%), followed by moderately symmetrical (35%), and asymmetry udder was found to be 8%. The characteristic sided udder cross-section found in SCM dairy goats was extremely flat (49%), intermediate (49%), and extremely bulgy (2%). The typical udder height is dominated by the above hook (31%), the characteristic rump angle is dominated by the intermediat slope from hips to pins (59%), and the mostly teat shape is found in the cylindrical (47%) and bootle (45%) types. The angle of separation between nipples is predominantly about 120–160 degrees (65%), and the degree of udder separation is dominated by moderate (51%) and severe (41%). Udder morphology and characteristic influence on milk production (Mingoas et al., 2017). According to Cedden et al. (2008), wide udder width in dairy goats has a negative correlation between udder width and the number of somatic cells. In addition, the distance between the tip of the nipple and the number of somatic cells in goat's milk has also been reported to be negatively correlated. Furthermore, udder width and depth were also correlated with SCC, where high

SCC was found in deep udders and low SCC was found in 13–17 cm wide udders (Novotna et al., 2018). Udder circumference is also known to negatively correlate with the number of somatic cells (Santos et al., 2015). Rupp et al. (2011) concluded that the globular udder has a lower California Mastitis test value than milk obtained from udders of different shapes, and dairy goat udders should stick well to the abdominal wall but not too deep (hanging). As the udder depth increases, so does the number of somatic cells in the milk of French Alpine and Saanen goats. The most indicative morphological parameters associated with SCM incidence were an asymmetrical globular udder with slight part separation and a conical nipple. Therefore, when evaluating morphological parameters for presumptive diagnostic purposes, we should consider morphological factors, maintenance management, and breed. Branched pendular udders with vertical open teats placed tight to each other are probable to have more intramammary infection and were discovered to have high SCC. Other morphological characteristics, such as udder shape, degree of suspension, symmetry, and degree of separation, are significantly associated with SCC (Margatho et al., 2020).

Table 4 shows the correlation analysis between udder morphology, CMT, and milk production. The milk production is moderately correlated with the side udder cross-section and teat angle of separation, and there is a low correlation with the udder shape, udder height, and degree of udder separation. The extremely flat and intermediate degree of udder separation have higher SCM incident, this might be caused by teat distance from the rectal and influenced the cleanliness of udder and teat. Udder trait morphology determined the suitability for machine milking (teat position

and teat angle, teat size, udder depth, and cistern height) and was associated with the mammary gland health in sheep and goats (Vrdoljak *et al.*, 2020). The unbalanced udder was also identified as having problems with functional milk flow. The problem with milk flow will increase possibility of incomplete milking and bacterial infection. Dzidic *et al.* (2019) reported that the effort to select higher milk production in sheep increases teat angle insertion, and the genetic correlation of udder shape and teat placement is high (0.96).

## Management Practice related to CMT Positive

Dairy goat milk production at the observed locations varied widely from less than 0.5 liters to more than 1.1 liters. The percentage of CMT-positive goat milk produced was 0.5-0.8 liters, which amounted to 78%, followed by 0.8-1.1 liters, about 14%, and the least goat milk produced <0.5 liters, about 8%. The goat's condition is also good, as shown by a moderate BCS or higher. Of the CMT-positive dairy goats

**Table 2.** Descriptive statistic of udder and teat morphology in dairy goat farms related to CMT positive

Variables	Observed animal (n=163)		CMT positive (n=51)	
	Number	Percentage	Number	Percentage
Udder shape				
bowl	35	21%	18	35%
cylindrical	60	37%	17	33%
funnel	68	42%	16	31%
Udder symmetry				
asymmetric	4	2%	4	8%
moderate	103	63%	18	35%
symmetrical	56	34%	29	57%
Side udder cross-section				
1-5 poin (Extreamly flat)	99	61%	25	49%
25 poin (Intermediet)	63	39%	25	49%
45-50 poin (Extreamly bulgy)	1	1%	1	2%
Udder high				
floor extreamly high	85	52%	17	33%
floor above hocks	68	42%	31	61%
floor well below hocks	10	6%	3	6%
Rump angle				
extreamly level from hips to pins	62	38%	3	6%
intermediat slope from hips to pins	84	52%	30	59%
extremely steep from hips to pins	17	10%	18	35%
Teat shape				
Bottle	70	43%	23	45%
Cylindrical	76	47%	24	47%
Funnel	17	10%	4	8%
Teat angle of separation				
90-120	68	42%	17	33%
120-160	85	52%	33	65%
160-180	10	6%	1	2%
Degree of udder separation				
slight	17	10%	4	8%
moderate	62	38%	26	51%
severe	84	52%	21	41%

managed by feeding by bottle, 51 goats were 100% CMT-positive. Based on the lactation stage, we identified that early and late lactation have a high percentage of CMT positives, which are 21% and 22%, respectively. Farmers' pen types in CMT-positive goats were observed as individual pens amounted to 36% and group pens amounted to 58%. The cleanliness of the cage is an essential factor in dairy farming. Cleaning management is different for each farm,

where there are farmers who clean the cages and goats before and after milking, and there are also those who only clean before milking. The cleanliness of the cages on the observed farms was 56% good and 44% adequate. The housing type and milking frequency are moderately correlated with the CMT, while pre-dipping with warm water before milking has a low correlation with the CMT (Table 5). According to Menzies (2021), the staphylococcal SCM is

**Table 3.** Descriptive Statistics of Management practices implemented in dairy goat farms related to positive CMT Variables

Management	Observed animal (n=163)		CMT positive (n=51)	
	Number	Percentage	Number	Percentage
<b>Lamb feeding</b>				
Direct feeding	42	26%	0	0%
Bottle	121	74%	51	100%
<b>Milk production per day</b>				
< 0,5 litre	5	3%	5	8%
0,5 - 0,8 litre	96	59%	42	78%
0,8-1,1 litre	50	31%	4	14%
>1,1 litre	12	7%	0	0%
<b>BCS</b>				
Fat	72	44%	30	59%
Adequate	89	55%	19	37%
Thin	2	1%	2	4%
<b>Lactation stage/Day in milk (DIM)</b>				
< 1 month (30 days)	40	25%	21	41%
<2 months (60 days)	1	1%	2	4%
<3 months (90 days)	2	1%	6	12%
<4 months (180 days)	116	71%	22	43%
<b>Housing type</b>				
Individual	70	43%	35	69%
Group	93	57%	16	31%
<b>Milking frequency</b>				
Once a day	60	37%	6	12%
Twice a day	103	63%	45	88%
<b>Cleaning before milking</b>				
Yes	92	56%	20	39%
No	71	44%	31	61%
<b>Cleaning after milking</b>				
Yes	80	49%	20	39%
No	83	51%	31	61%
<b>Predip with warm water before milking</b>				
Yes	44	27%	2	4%
No	119	73%	49	96%
<b>Housing cleanliness</b>				
Good	90	55%	30	59%
Adequate	73	45%	21	41%

**Table 4.** Coefficient Correlation ( $r_{ij}$ ) among the udder morphology and CMT positive

Variables	Milk production	BCS	Udder shape	Udder symmetry	Side udder cross-section	Udder high	Rump angle	teat shape	Teat angle of separation	Degree of udder separation	CMT
Milk production	1.000	-0.57	-.151*	-.047	-.293**	-.182**	.030	.024	.204**	.128*	-.417**
BCS		1.000	.314**	-.363**	.379**	-.240**	-.199**	.195**	.120	.095	.146*
Udder shape			1.000	-.003	.447**	-.125*	-.291**	-.031	-.335**	-.369**	.220**
Udder symmetry				1.000	-.226**	.261**	.138*	-.288**	-.249**	-.435**	.126*
Side udder cross-section					1.000	-.260**	-.191**	.038	-.362**	-.134*	.153*
Udder high						1.000	.234**	-.087	.044	-.024	.153*
Rump angle							1.000	-.201**	.083	-.044	-.044
teat shape								1.000	.276**	.307**	.007
Teat angle of separation									1.000	.599**	-.096
Degree of udder separation										1.000	-.118
CMT											1.000

\*\* Correlation is significant at the 0.01 level (1-tailed), \* Correlation is significant at the 0.05 level (1-tailed).

**Table 5.** Coefficient Correlation ( $r_{ij}$ ) between CMT and Management Practices.

Variables	CMT	Housing type	Milking frequency	Cleaning before Milking	Cleaning After Milking	Pre dip with warm water before milking	Housing cleanliness
CMT	1.000	-.380**	.365**	-.060	.016	.175*	-.027

\*\* Correlation is significant at the 0.01 level (1-tailed), \* Correlation is significant at the 0.05 level (1-tailed).

associated with udder health and proper milking preparation, such as udder pre- and post-milking management, which are crucial factors in controlling mastitis. The significant, negatively moderate correlation between CMT positivity and housing type was found in this study (Table 5). We also found that CMT positivity has a significant correlation with milking frequency (0.365) and a low correlation with pre-dipping with warm water before milking (0.175). Furthermore, the review conducted by Menzies (2021) reported some factors associated with SCM in dairy goats: time-weakened immune system, infection increase in the late stage of lactation, nursing child, lactation number (older tended to be at higher risk), viral infection, udder size and shape, teats, environmental factors such as stocking density, poor housing and management, poor milking technique and equipment, genetics, and low energy and vitamin E in the diet. Controlling mastitis needs a multi-faceted approach involving best management practices, treatment, vaccination culling, and steps to reduce transmission (Manning *et al.*, 2021).

### Conclusion

It can be concluded that the relatively low to moderate of SCM prevalence found in dairy goats in Blitar, Lumajang, and Jember amounted to 19,35%, 0,86%, and 25%, respectively. Milk production had a negatively moderate correlation with CMT ( $t_b = -0.417$ ) and a low negative correlation with the udder shape ( $t_b = -0.151$ ), side udder cross-section ( $t_b = -0,293$ ), teat angle of separation between teat ( $t_b = 0,204$ ), and degree of udder separation ( $t_b = 0,128$ ). The CMT also has a low correlation with the BCS ( $t_b = 0,146$ ), udder symmetry ( $t_b = 0,126$ ), and side udder cross ( $t_b = 0,153$ ). The housing type and milking frequency have a moderate correlation with the CMT. The udder morphology might influenced the robustness of dairy goat on mastitis infection.

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