



**UNIVERSITI PUTRA MALAYSIA**

***PREVALENCE OF MASTITIS IN GOATS FROM LADANG ANGKAT UPM  
AND ITS RELATIONSHIP WITH SELECTED RISK FACTORS***

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FPV 2015 55**

**PREVALENCE OF MASTITIS IN GOATS FROM *LADANG ANGKAT* UPM  
AND ITS RELATIONSHIP WITH SELECTED RISK FACTORS**



**WAN MOHD SUKRI BIN WAN ISHAK**

A project paper submitted to the Faculty of Veterinary Medicine, Universiti Putra  
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VETERINARY MEDICINE

Universiti Putra Malaysia  
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## CERTIFICATION

It is hereby certified that we have read this project paper entitled “Prevalence of Mastitis in Goats from *Ladang Angkat* UPM and Its Relationship with Selected Risk Factors”, by Wan Mohd Sukri Bin Wan Ishak and in our opinion it is satisfactory in term of scope, quality, and presentation as partial fulfilment of the requirement for the course VPD 4999 - Final Year Project.

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## DEDICATION

This thesis is dedicated to God Almighty; my father, Mohd Noor Yahya; my mother, Siti Aliah Deraman, and my sisters, Norfaizah Mohd Noor, who had accompanied me in my journey of becoming veterinarian.



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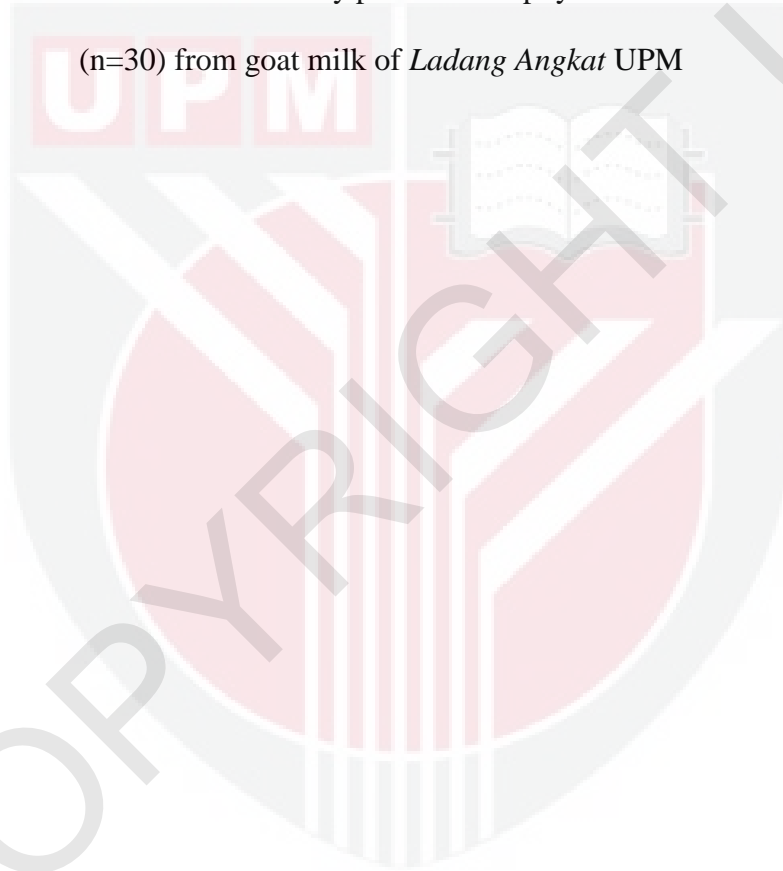
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**ABSTRAK**

Abstrak daripada kertas projek yang di kemukakan kepada Fakulti Perubatan Veterinar, UPM untuk memenuhi sebahagian daripada keperluan kursus VPD 4999- Projek Ilmiah Tahun Akhir.

**PREVALENS MASTITIS PADA KAMBING DARI LADANG ANGKAT UPM  
DAN HUBUNGKAITNYA DENGAN FAKTOR RISIKO TERPILIH**

Oleh

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**2015**

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**Penyelia bersama: Professor Madya Dr. Siti Khairani binti Bejo**

Kajian ini telah dijalankan untuk menentukan prevalens mastitis klinikal dan subklinikal, patogen dalam susu, dan hubungkait faktor risiko terpilih dengan mastitis di ladang kambing, Ladang Angkat Universiti Putra Malaysia (UPM). Sebanyak 158 sampel susu dari 80 kambing dari lapan ladang telah dikumpulkan secara aseptis. Mastitis klinikal dinilai berdasarkan keabnormalan ambing susu serta susu, subklinikal mastitis telah diuji di ladang menggunakan ujian California Mastitis Test (CMT), kultur bakteria untuk kenalpasti patogen, dan kaedah resapan cakera Kirby-Bauer untuk antibiogram. Faktor risiko terpilih ladang telah dikaji menggunakan soal selidik. Prevalens keseluruhan adalah 49% (klinikal 5% dan subklinikal 44%). Daripada 70 kultur positif, *coagulase negative staphylococci* (CNS) adalah yang terbanyak, 73% (n=51), *Bacillus sp.*, 11% (n=8), *Streptococcus*

*agalactiae*, 7% (n=5), *Streptococcus viridans*, 7% (n=5), *Staphylococcus aureus*, 4% (n=3), *Staphylococcus hyicus*, 4% (n=2), *Staphylococcus intermedius*, 3% (n=2), *Enterococci*, 3% (n=2), dan *Klebsiella pneumoniae*, 3% (n=2). Patogen yang sedikit (1% setiap satu) ialah *Escherichia coli*, *Acinetobacter iwoffii*, *Achromobacter sp.*, *Streptococcus dysgalactiae*, *Proteus mirabilis* dan *Pseudomonas fluorescense*. Tiga puluh pencilan *Staphylococcus sp.* diuji untuk perintang antibiotik menunjukkan rintangan tertinggi terhadap Penisillin (37%) dan kecenderungan tertinggi kepada streptomycin (97%). Terdapat hubungkait signifikan antara mastitis dengan lesi puting dan makanan tambahan ( $p < 0.05$ ). Penternak kambing *Ladang Angkat UPM* dicadangkan supaya menjalankan kaedah mencegah dan mengawal mastitis untuk meminimakan prevalens seterusnya mengurangkan kerugian disebabkan oleh penyakit tersebut.

**Kata Kunci:** Kambing, Mastitis, Kadar Jangkitan, Bakteria, Antibiotik, Faktor risiko.

## **ABSTRACT**

An abstract of the project paper presented to the Faculty of Veterinary Medicine,  
UPM in partial requirement for the course of VPD 4999- Final Year Project.

### **PREVALENCE OF MASTITIS IN GOATS FROM *LADANG ANGKAT UPM* AND ITS RELATIONSHIP WITH SELECTED RISK FACTORS**

By

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**2015**

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**Co-supervisor: Associate Professor Dr. Siti Khairani Binti Bejo**

This study was carried out to determine the prevalence of clinical and subclinical mastitis in goat farms of *Ladang Angkat UPM*, pathogens in milk, and to determine the relationship between selected risk factors and mastitis.

A total of 158 milk samples from 80 goats of eight farms were collected aseptically. Clinical mastitis was assessed based on abnormalities of the udder and milk, subclinical mastitis was tested on-site using the California Mastitis Test (CMT), bacteriological culture for identification of pathogens, and Kirby-Bauer disk diffusion method for the antibiogram. The selected farm risk factors for mastitis investigated using questionnaire. Overall

prevalence of mastitis at halves level was 49% (clinical, 5%; and subclinical, 44%). Of the 70 milk culture positive, coagulase negative staphylococci (CNS) were predominant, 73% (n=51). *Bacillus sp.*, 11% (n=8); *Streptococcus agalactiae*, 7% (n=5); *Streptococcus viridans*, 7% (n=5); *Staphylococcus aureus*, 4% (n=3); *Staphylococcus hyicus*, 4% (n=2); *Staphylococcus intermedius*, 3% (n=2); *Enterococci*, 3% (n=2); and *Klebsiella pneumoniae*, 3% (n=2). The least isolated pathogens (1% each) were *Escherichia coli*, *Acinetobacter iwoffii*, *Achromobacter sp.*, *Streptococcus dysgalactiae*, *Proteus mirabilis*, and *Pseudomonas fluorescense*. Thirty *Staphylococcus sp.* isolates tested for antibiotic resistance showed highest resistance against penicillin (37%) and highest susceptibility to streptomycin (97%). There was significant association between mastitis and teat lesions and feed supplement ( $p < 0.05$ ). It is suggested that goat farmers of *Ladang Angkat* UPM to institute preventive and control measures for mastitis to minimize prevalence thus to reduce losses due to this condition.

**Keywords:** Goat, mastitis, prevalence, bacteria, antibiotic, resistance, risk factors

## 1.0 INTRODUCTION

The goat population in Peninsular Malaysia is estimated around 400,000 in 2012 and projected to be about 420,000 in 2013 (DVS, 2014) indicating a rapid development of livestock industry in Malaysia. Approximately 8195 herds of dairy goats present in Peninsular Malaysia with more than 50% are reared in the southern state of Johor (AADGN country reports, 2013/2014).

Caprine mastitis is considered as one of the main diseases that may cause constraint to the Malaysian goat industry by affecting the milk production and health of the animals. The major income of dairy goats farming come from milk production which is sold as raw milk, pasteurized milk or even fermented products (Lietner *et al.*, 2008). The milk quality and quantity is affected when goats are infected with mastitis which may lead to an overwhelming effect on farmer's economic status. A recent study reported that milk yield and curd yield of the dairy goat can be damaged by the subclinical mastitis due to the increase in the somatic cell count (SCC) causing rejection or decreased milk quality based on the grading based on the SCC (Leitner *et al.*, 2004).

Singh *et al.* (2004) reported that the aetiologic agents for mastitis can be grouped into the environmental pathogens, contagious and normal flora of the teat.

The common bacteria infecting the udder include the coagulase negative staphylococci (CNS) and *Staphylococcus aureus* (Aiello *et al.*, 2010). Bacteria can be originated from the milker's hands, towels used for udder preparation, and the pen environment that could lead to mastitis in the farm (Singh *et al.* 2004; Marogna *et al.*, 2011). Thorberg *et al.* (2006) reported that the bacterial isolates from mastitis

cases in the studied cattle are similar to the bacterial isolates from milker's hands and elbow.

Antibiotic resistance of mastitis pathogens has been reported worldwide due to the indiscriminate usage of antibiotic (Marimuthu *et al.*, 2014) Antibiotics play an important role in the treatment and control of mastitis, hence surveillance for antibiotic resistance is needed to ensure appropriate antibiotic is used for mastitis treatment, thus, minimize the risk of the development and spread of resistance in dairy goat farms.

This study was undertaken to:

1. determine the prevalence of clinical and subclinical mastitis in goat farms of *Ladang Angkat UPM*
2. determine the prevalence of the bacterial pathogen in goat milk from *Ladang Angkat UPM*
3. determine the relationship between the selected risk factors and mastitis in goat farms of *Ladang Angkat UPM*
4. determine the antimicrobial resistance pattern of the staphylococci isolates obtained from the milk culture positive in goat farms of *Ladang Angkat UPM*

The hypotheses of the study were:

1. Prevalence of caprine mastitis in *Ladang Angkat UPM* is similar with previous local studies by Benedict (2014) & Siti Zubaidah *et al.*, (2005).

2. Bacterial isolates (*Staphylococcus spp.*) from the milk culture are not sensitive against the tested antibiotics.
3. There is no association between the selected risk factors and caprine mastitis in the selected goat farms.



## 2.0 LITERATURE REVIEW

### 2.1 Mastitis

Mastitis or the inflammation of the mammary gland, usually is a consequence of bacterial infection, although sometimes mycotic or mycoplasma is also involved (Erskine, 2014). Pathologic changes in the epithelial cell from the inflammatory process may cause the decrease in the function, and may reduce the productivity and potential weight gain for suckling offspring (Erskine, 2014). Mastitis is a sequel of the interaction in animal, management and environmental factors (Singh *et al.*, 2006). When there are changes on any one of the factors, microbes may surpass all defence mechanisms of ruminant udder and enabling them to proliferate, resulting in mastitis (Singh *et al.*, 2006).

Incidence of small ruminant clinical mastitis typically less than 5% per year but the problem herds may have clinical mastitis rate of 30% - 50% (Bergonier *et al.*, 2003). Two Malaysian studies reported that prevalence of overall mastitis in goats sampled from Selangor area were 58.3% (Siti Zubaidah *et al.*, 2005 – surrounding UPM campus) and 65.3% (Benedict, 2013 – in Lembah Klang and Selangor).

Bacterial pathogens responsible for clinical and subclinical mastitis in ruminant can be grouped into environmental, contagious, and normal flora (Singh *et al.*, 2006). Based on Pugh *et al.*, (2012), sporadic cases of clinical mastitis most frequently are caused by the *S. aureus*, CNS, *Archanobacterium pyogenes*, *Corynebacterium spp.*, *Pasteurella spp.*, and *Pseudomonas spp.* many studies have identified CNS as the most important cause of subclinical mastitis in does followed by *Staphylococcus epidermidis* and *Staphylococcus caprae* (Pugh *et al.*, 2012).

## 2.2 Risk factors for mastitis

Previous studies have shown that caprine mastitis is associated with several risk factors such as farm hygiene, teat lesion, feed supplement, age and etc (Singh *et al.*, 2006; Ameh & Tari, 1999; Waage *et al.*, 2008).

Singh *et al.* (2006) and Ameh and Tari (1999) reported that the incidence of infected udder increases with age in which 2 to 5 years old goats are more likely to be mastitic compared to younger does. Similar findings were reported by Waage *et al.*, (2008). They also reported that with age, more milk yield was produced thus less chance for the kid to empty the mammary gland (in high producing ewe) lead to increased risk of mastitis.

Taponen and Pyorala (2009) reported that CNS species frequently isolated from teat was the same with milk culture from mastitis cases. Thorberg *et al.* (2006) study showed that *Staph. epidermidis* isolated from milk may be originated from humans as they share the same CNS strains. This indicates that human can be one of the sources of infections.

Teat lesions were considered as a major risk factor for mastitis in few studies (Sanchez *et al.*, 1999; Ameh and Tari, 1999; Waage *et al.*, 2008; and Marogna *et al.*, 2011). These authors reported significant relationship between teat lesions and mastitis. These lesions may harbour the bacterial agents for mastitis and as entry point for the pathogens (Singh *et al.*, 2006).

Sanchez *et al.* (1999) reported significant relationship between mastitis prevalence and parity. This may be due to number of animals in each of parity group may have influence the result as first parity was the highest prevalence of mastitis

while old does were replaced (culled) leading to underestimation of prevalence obtained from old-does-parity group.

### **2.3 Antimicrobial resistance pattern of *Staphylococcus* spp.**

Taponen and Pyorala (2009) reported that CNS tend to be more resistance to antimicrobials compared to CPS (*Staph. aureus*, *Staph. hyicus*, and *Staph. Intermedius*), and easily develop multi-resistance.

The most common resistance mechanism in staphylococci is the beta-lactamase production (Taponen and Pyorala, 2009), which results in resistance toward the Penicillin group of antibiotics. The beta-lactam antibiotics work by the inhibition of the cell wall synthesis of the bacteria, which bind at the penicillin-binding protein at the cell membrane, rendering them unable to perform their specific role on the cell wall synthesis resulting death of the bacterial due to osmotic instability, breaking the antibiotic structures through hydrolysis, hence deactivating the molecule's antibacterial properties (Lansing, 2011).

Franca *et al.*, (2012) observed high rate of antimicrobial resistance to staphylococci isolate from goat mastitis in Brazil (12%, doxycycline to 50%, amoxicillin) that could be associated with the heavy use of antimicrobial drugs for treatment in goats (Haveri, 2008; Franca *et al.*, 2012).

### **3.0 MATERIALS AND METHOD**

#### **3.1 Study design**

This is a cross-sectional study involving eight goat farms of *Ladang Angkat* UPM to investigate mastitis in the farms, bacterial pathogens involved, antibiotic sensitivity pattern and risk factors. Six farms are located in Selangor and two in Negeri Sembilan. In total, 80 lactating does were available for sampling. A total of 158 individual halves were available for sampling. The study was conducted for five weeks.

#### **3.2 Sample and data collection**

A total of 80 lactating does and 158 individual udder halves were sampled. Clinical mastitis was tested by examination of the udder and milk for any physical abnormalities such as udder that is swollen, hot, reddened and painful to touch, and abnormal appearance of milk.

The CMT was done to determine the subclinical mastitis on-site based on the score 0 to 3: 0 negative, 0.5 traces, 1 weak positive, 2 moderate and 3 strong positive. Due to normal high count of somatic cell in doe's milk compared to cow (Kinne, 2004), CMT scores traces and 1 were considered CMT negative while 2 and 3 CMT positive. Approximately 2 mL of raw milk samples were stripped into four-cup paddle and 3 mL of CMT reagent was added into the milk. Mixing was done by gentle circular motion of the paddle in horizontal plane. Results were then read based on the gelling reaction observed and recorded in a CMT results table.

Milk samples were collected aseptically. The teats and udders were first washed using water and diluted chlorhexidine, then dried using a cloth, and lastly the

teats we swabbed with cotton soaked with 70% alcohol. The first few streams of milk were stripped out before collecting the milk into a sterile universal bottle. All samples were kept in a cooler box with ice pack at 4°C for temporary storage before laboratory analysis.

### **3.2 Milk bacteriological culture**

Aseptic individual half milk samples were sent to the Bacteriology laboratory at the Faculty of Veterinary Medicine, UPM for bacterial isolation and identification. Samples were cultured on blood and MacConkey agar as primary culture. Then culture plates were incubated at 37°C for up to 48 hours. Bacteria on culture positive plates was specified according to their gram-stain reaction, haemolytic feature and colony morphology. Other biochemical test was also done. The identification of bacteria was following the standard procedure (Jang *et al.*, 2008).

### **3.3 Antibiotic Resistance Test**

Confirmed *Staphylococcus* sp. was subjected to Kirby-Bauer disk diffusion method to determine the bacterial in-vitro antibiotic sensitivity of the isolates against common antibiotics used in the farms as intramammary infusion (i.e. Oxacilin 5µg, Neomycin 30µg, Streptomycin 25µg and Penicillin 10µg). Pure culture of staphylococci isolated from each farm was selected and suspended into 1mL of normal saline and standardised into 0.5 McFarland Standard. Each mixture was swabbed over the Mueller-Hinton agar and incubated at 37°C for 24 hours to examine the zone of inhibition. Digital calliper was used for measuring the inhibition zone (in diameters) to classify the bacteria as susceptible, intermediate or resistant for each antibiotic (Clinical and Laboratory Institute CLSI table, 2008).

### 3.4 Data Analysis

The prevalence of mastitis at animal level was calculated as the proportion of doe positive (at least one half positive) on culture out of all does sampled (n=80). The prevalence of mastitis at halves level was calculated as the proportion of halves positive on culture out of all halves sampled (n=158). The prevalence of every bacteria isolated was based on all halves milk culture positive results (n=70). The antibiotic sensitivity or resistant level was determined based on the 30 staphylococci isolates. Descriptive statistics and charts were done in Microsoft Excel 2011 and statistical tests for association and odds ratios for risk factors of mastitis was done using statistical software for social sciences (SPSS) version 20.

## 4.0 RESULTS

### 4.1 Prevalence of caprine mastitis based on the bacteriological culture

The overall prevalence of caprine mastitis (both clinical and subclinical) at animal and udder halves levels are displayed in Table 1.

**Table 1. Overall prevalence of mastitis in goat farms of *Ladang Angkat UPM***

Level	Total number of samples	Milk culture positive	Prevalence (%)
Goat	80	51	64
clinical		8	10
subclinical		43	54
s	158	76	48
clinical		8	5
subclinical		68	43

From Table 2, the farm prevalence for subclinical mastitis ranges from 25-100% at animal and 17-88% at halves level, and for clinical mastitis, it ranges from 0-38% at animal and 0-19% at halves levels.

**Table 2. Prevalence of caprine mastitis by farms of *Ladang Angkat UPM***

Farm	Total number of samples		Prevalence			
			Subclinical mastitis (%)		Clinical mastitis (%)	
	Goat	Halves	Goat	Halves	Goat	Halves
1	4	8	100	88	0	0
2	8	16	75	50	0	0
3	8	16	63	69	38	19
4	5	10	40	40	0	0
5	13	25	38	32	15	8
6	20	39	75	53	0	0
7	10	20	30	26	5	20
8	12	24	25	17	8	4

There was no statistical different in the prevalence of mastitis between farms based on the overlapping 95% confidence interval (CI) of mastitis prevalence at the animal level (Table 3).

**Table 3. 95% Confidence intervals (CI) of mastitis prevalence at udder halves level in all eight farms**

Farm	Total number of halves sampled	Number of halves positive	Prevalence (%)	95% Confidence limit	
				Lower	Upper
1	8	7	88	39.8	100
2	16	8	50	34.9	96.8
3	16	14	88	24.5	91.5
4	10	4	40	5.3	85.3
5	25	10	40	13.9	68.4
6	39	21	53	50.9	91.3
7	20	9	46	6.7	65.3
8	24	5	21	5.5	57.2

#### 4.2 Prevalence of subclinical mastitis based on the CMT results

Prevalence of subclinical mastitis based on the CMT results were 40% (58/144) at halves level.

#### 4.3 Comparison of CMT with the milk bacteriological culture results

Of the 58 halves CMT positive, 44 were also culture positive (76%); whereas of the 86 CMT negative, 66 were culture negative (77%) (Table 4). Therefore the sensitivity and specificity of the CMT were 68.8% and 82.5%, respectively. Hence, the positive predictive value (PPV) was 76% and the negative predictive (NPV) value was 77%.

**Table 4. Comparison of CMT with the milk bacteriological culture results**

CMT	Culture positive	Culture negative	Total
Positive	44	14	58
Negative	20	66	86
Total	64	80	144

#### 4.4 Bacterial isolates from the goat milk of *Ladang Angkat* UPM

As displayed in figure 1, the most predominant bacterial isolates from positive halves milk culture (N=70) were the CNS with 79% (n=55) followed by *Bacillus* sp. 11% (n=8), *Streptococcus agalactiae* and *Streptococcus viridians*, 7% (n=5) each, *Staph. aureus* 4% (n=3), 3% (n=2) each of *Staph. intermedius*, *Staph. hyicus*, *Klebsiella pneumoniae*, *Enterococcus* spp., and 1% (n=1) each of *Pseudomonas* sp., *Proteus* sp., *Streptococcus dysagalactiae*, *Achromobacter* sp., *Acinetobacter iwoffii*, and *Escheria coli*. Five samples from clinical mastitis showed no growth of bacteria.

**Figure 1. Prevalence of bacterial isolates from positive halves milk culture (N=70)**

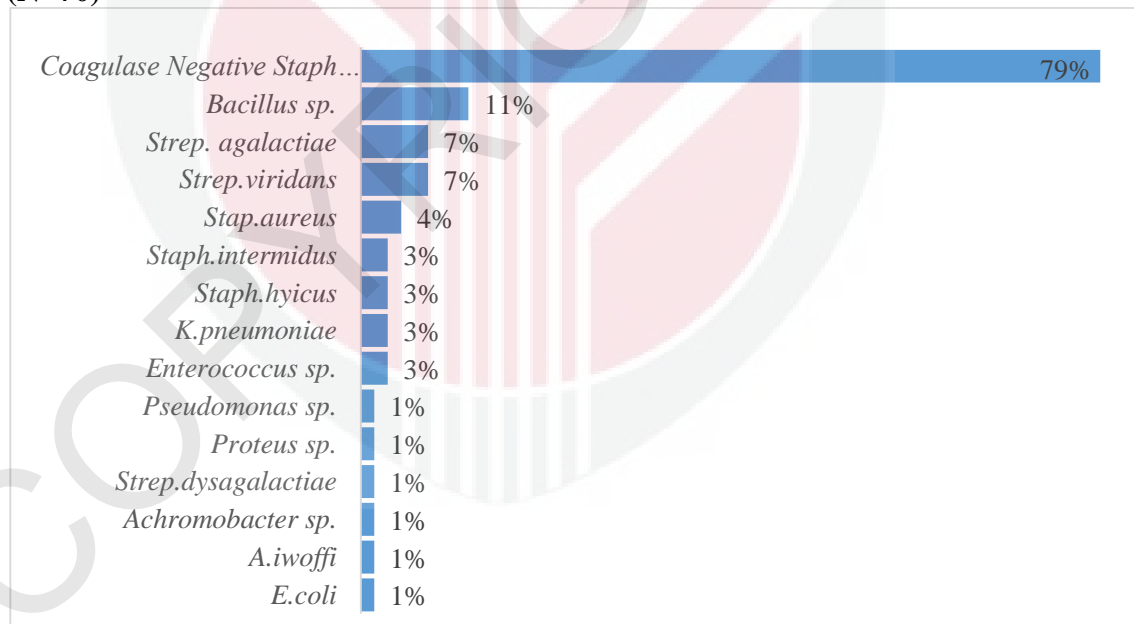
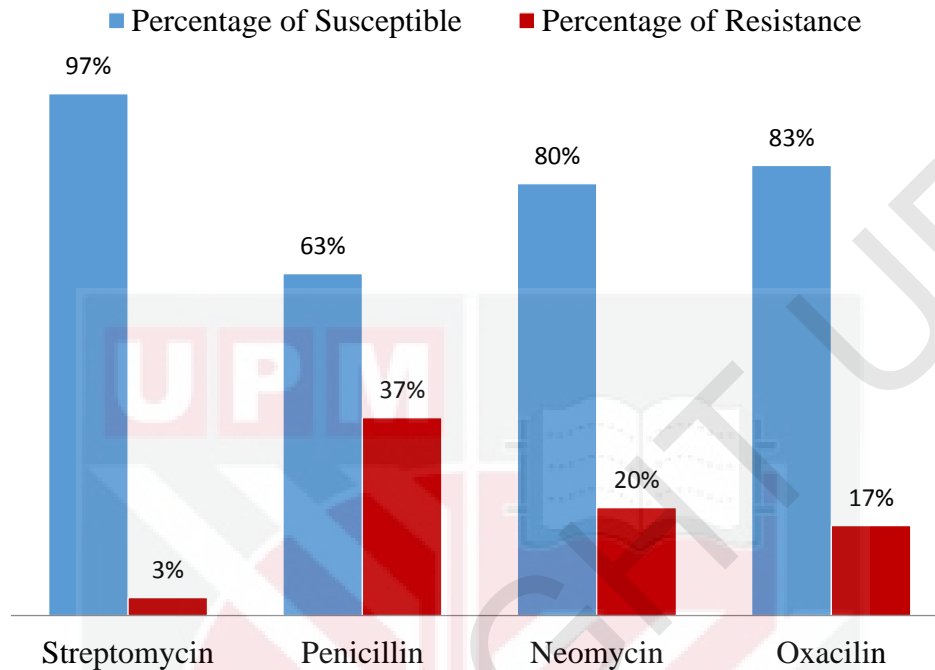


Figure 2 showed that *Staphylococcus* spp. (n=30) isolated from goat milk of *Ladang Angkat* UPM were susceptible toward streptomycin with 97% and only 3% were resistant. Penicillin had the highest percentage of resistance followed by Neomycin and Cloxacilin, 37%, 20%, and 17%, respectively.

**Figure 2. Antibiotic sensitivity pattern of staphylococci isolates (n=30) from goat milk of Ladang Angkat UPM**



#### 4.5 Relationship between the selected risk factors and mastitis

Nine risk factors including age, breed, lactation stage, parity, milk stripping, hands hygiene, teat dip usage, supplement provided for lactating goat and teat lesions, were studied. Two risk factors were found statistically significant.

Teat lesions were associated with caprine mastitis (Chi-square=5.38, p-value=0.02) with odds ratio of 2.53 (95% CI: 1.15, 5.64). Supplement given to lactating does was also significantly associated with mastitis in this study (Chi-square=13.94, p-value=0.00) and odds ratio of 6.2 (95%CI: 2.18, 17.59).

#### 4.6 Comparison of results of bacteriological culture from milk, teats, and workers' hands samples

The bacteriological culture results from teat swabs, worker's hands and milk (Table 5) showed that some level of similar organisms have been isolated.

**Table 5. Frequency distribution of bacteriological culture results from milk, teats, and workers' hands**

Bacteria	Milk culture positive (n=70)	Teat swabs (n=158)	Workers' hands swabs (n=8)
Coagulase negative staphylococci	55	223	15
<i>Bacillus sp.</i>	8	26	0
<i>Strep. agalactiae</i>	5	0	0
<i>Strep. viridans</i>	5	5	0
<i>Staph. aureus</i>	3	11	0
<i>Staph. intermedius</i>	2	3	0
<i>Staph. hyicus</i>	2	0	2
<i>Klebsiella pneumoniae</i>	2	4	1
<i>Enterococcus sp.</i>	2	1	0
<i>Pseudomonas sp.</i>	1	0	0
<i>Proteus sp.</i>	1	1	0
<i>Strep. dysagalactiae</i>	1	0	0
<i>Achromobacter sp.</i>	1	0	0
<i>Acinetobacter iwoffii</i>	1	3	0
<i>Escherichia coli</i>	1	0	1

## 5.0 DISCUSSION

The overall prevalence of caprine mastitis in *Ladang Angkat* UPM showed lower prevalence than the previous two local studies by Siti Zubaidah *et al.*, (2005) and Benedict, (2013). There's possibility that the reason for lower prevalence in our study were due to more farms studied thus bigger sample size included compared to the other two studies. Furthermore in our study, the goats are kept for meat (n=32), dairy (n=20) and both meat and dairy (n=28). It has been reported that dairy breed has higher risk of getting mastitis due teat injury from continuous aggressive hand milking procedure (Ameh and Tari, 1999; Marogna *et al.*, 2012; Marogna *et al.*, 2015). This study reported similar prevalence of clinical mastitis (10% at goat level) with that reported by Benedict (2013).

The high prevalence of subclinical mastitis found in this study could be due to farm hygiene status (Singh *et al.*, 2006) which may have contributed to the flare-up of the environmental pathogens, inappropriate or inadequate control of the risk factors such as teat lesions, hands hygiene, farm hygiene and inapparent signs of inflammation on the udder thus the farmer may have overlooked the problem until it became clinically apparent and irreversible (Erskine, 2013).

The prevalence of mastitis of goats in this study was similar to a previous study of 30% to 50% prevalence of mastitis in small ruminant in Italy (Bergonier *et al.*, 2003). Contereras *et al.* (2007) reported 5-30% prevalence of mastitis in goats in Jordan which is lower than our findings (i.e. 25%-100%). There was no significant difference of caprine mastitis level between studied farms indicated that the management of farm was similar.

The CMT performance compared to the bacteriological culture as the gold standard for diagnosis of intramammary infection in ruminants (Contereras *et al.*, 2007), showed that the CMT has high number of false negative results than false positives. This could be due to the subjectivity of the interpretation of the CMT. In a study in goat farms in Spain, higher sensitivity of the CMT was reported than our findings (Gonzales and Carmenes., 1996).

The bacterial findings of this study showed that the environmental pathogens were the most prevalent as similarly reported by other studies (Marogna *et al.*, 2011; Gebrewahid *et al.*, 2011; Moroni *et al.*, 2005; Lafi *et al.*, 1998). The CNS (mainly *Staph. caprae*) was predominant in this study. In contrast, *Staph. aureus* was predominant in other studies (Benedict, 2013; Contereras *et al.*, 2007; Bergonier *et al.*, 2013; Sanchez *et al.*, 1999). It was a possibility that *Staph. caprae* in the milk is originated from the teats and transmission was through milker's hands (Marogna *et al.*, 2011) as all studied farms practised hand milking. It could also be due to injury from rough hand milking which pulls on teats and excessively strip after milk-out causing opportunistic bacteria such as *Staph. caprae*, a common normal flora of the goat teat to invade and establish infection (Ameh and Tari, 1999; Marogna *et al.*, 2011). The high prevalence of *Staph. epidermidis* found in this study also suggests that teat dipping was not performed after milking (Marogna *et al.*, 2011).

Thirty *Staphylococcus spp.* isolates tested for antibiotic sensitivity showed higher resistance pattern on penicillin, amoxicilin and oxacilin which are beta-lactam drugs. Similar findings were reported by others (Haveri *et al.*, 2008; Taponen and Pyorala., 2009). Taponen and Pyorala (2009) stated that CNS has tendency to be more resistant to antimicrobials than *Staph. aureus* and easily develop into multi-resistance bacteria. The most common resistance mechanism in staphylococci is

beta-lactamase production which results in resistance to aminopenicillin and Penicillin-G (Taponen and Pyorala, 2009).

This study reported significant relationship between mastitis and teat lesions and supplement given to lactating does. These results were in agreement with others (Ameh *et al.*, 1999; Waage *et al.*, 2008; Marogna *et al.*, 2011). Teat injury caused by the suckling kids had produced teat lesions on lactating does. Waage *et al.* (2008) reported that lambs, especially on 3-5 weeks of lambing when the teeth of the kids have been erupted causing teat injury from suckling and hence act as the entry point for the pathogens resulting in mastitis.

Sanchez *et al.* (1999) suggested that sample size particularly the number of animal in each parity in which it could be the reason for non-significant finding observed in our study for other factors such as breed, lactation stage, parity, milk stripping, hands hygiene and teat dip. This may be due to increased replacement of culled does causing small number of older goats included in the study thus underestimating the effect of parity on mastitis in goats. Our study revealed that mastitis pathogens could have been originated from milkers' hands and teats of goats. Also, the results indicate that pre-milking preparation of milkers' hands and cleaning of teats between goats was inadequately done. Taponen and Pyorala (2009) reported that CNS species frequently isolated from teats were the same with mastitis culture. Thorberg *et al.* (2006) reported that *Staph. epidermidis* isolate from milk may be originated from human as it has the same CNS strain from milk and milkers' hands. Both studies (Taponen and Pyorala, 2009; Thorberg *et al.* 2006) support that workers' hands and teat normal flora act as risk factor for mastitis in goats. High

prevalence of *Staph. caprae* from the milk culture with high prevalence of same bacteria on teats of goats and worker's hands was also reported by Marogna *et al.* (2011) which found high number of *Staph. caprae* isolated from milk samples in farm practising manual milking and stripping. Furthermore, the data from the questionnaire revealed that workers did not clean the udder before milk stripping and did not wash their hands with soap or antiseptic before and in-between milkings.



## 6.0 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study reports high prevalence of caprine mastitis in *Ladang Angkat* UPM based on the milk bacteriological culture and the CMT. The bacteria responsible for caprine mastitis in this study was predominantly due to CNS particularly *Staph. caprae*. Some resistant pattern in staphylococci was found for streptomycin, neomycin, oxacillin and penicillin. Teat lesions and supplement given to does showed significant relationship with caprine mastitis in the studied farms. Same bacteria were isolated from some of the milk samples, worker's hands and goat teats. The findings of this study provides insight to mastitis in goat farms of *Ladang Angkat* UPM and may be used for the development and implementation of mastitis control and prevention in the studied farms.

Based on the findings of this study, farmers of goat farms of *Ladang Angkat*, UPM should:

1. establish practical recording system for efficient use of data so that objective evaluation can be done for farm performance, monitoring treatment, prevention and control measures for mastitis
2. perform CMT once a month to detect mastitis early so that subsequently, milk culture can be done to identify the bacteria involved
3. request antibiotics sensitivity test on antibiotics commonly used for mastitis in the farm be done so that appropriate antibiotic can be used for treatment and prevention of mastitis in the farm
4. give supplement to goats to reduce risk of mastitis
5. treat goat teat lesions immediately to prevent entry of pathogens into the milk

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