Vol 10 No 1, p 69-77

PREVALENCE, CHARACTERISATION AND ANTIBIOTIC SENSITIVITY OF INTRAMAMMARY INFECTIONS IN CAMEL

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ABSTRACT

A total of 282 quarters milk samples were examined from 71 apparently healthy camels by cultural examination and somatic cell count to know the prevalence of non-clinical mastitis in this species. Out of these 39.72% (112/282) of quarters were culturally positive. Whereas, 65.60% (185/282) had somatic cell count (SCC) more than 50000 per ml of milk. Of these, 34.40% (97/282) and 5.32% (15/282) were having 'subclinical (culturally +ve and SCC>500000/ml)' and 'Latent (culturally +ve and SCC<500000/ml)' mastitis, respectively according to the International Dairy Federation criteria adopted for cattle. While 31.20% of the quarters were having nonspecific (culturally -ve and SCC>500000/ml)' mastitis. No apparent difference was observed between fore and hind quarters as regards to both infection level as well as elevation of SCC. Mean pH of quarter milk samples was within the normal range in all the non clinical quarters, however, in case of clinically infected quarters there was a significant rise in the mean pH (7.19).

Staphylococcus epidermidis was the most predominant (27.83%) organism followed by unclassified streptococci (20.87%), *Staph. aureus* (20.0%), *Str. agalactiae* (10.43%), *Str. dysgalactiae* (10.43%), *Corynebacterium* spp. (9.57%) and *Bacillus* spp. (0.87%). Amongst *Staph. aureus* strains 82.61% were associated with a SCC>500000/ml. Similarly, *Staph. epidermidis* 90%, *Str. agalactiae* 58.33%, *Str. dysgalactiae*, 100%; unclassified streptococci, 91.66%, *Corynebacterium* spp. 81.81% and *Bacillus* spp. 100%, respectively, were associated with SCC>500000 per ml. The mean SCC for the above pathogens was 11.1×10^5, 19.5×10^5, 11.7×10^5, 10.7×10^5, 12.4×10^5, 8.2×10^5 and 9.2×10^5, respectively.

A total of 55 isolates of staphylococci including 23 coagulase-positive isolates from camel intramammary infections were characterised by different biochemical tests. The different species of staphylococci identified in order of their frequency were *Staph. aureus* (30.91%), *Staph. hyicus* (10.91%), *Staph. intermedius* (7.27%), *Staph. haemolyticus* (7.27%), *Staph. auricularis* (7.27%), *Staph. sciuri* (7.27%), *Staph. hominis* (5.45%), *Staph. epidermidis* (3.64%), *Staph. capitis* (1.82%) and *Staph. warneri* (1.82%). Out of 55 isolates 9 isolates could not be identified with the present identification system used. All of these species were associated with raised SCC of milk.

As many as 114 isolates recovered from intramammary infections in camels were subjected to in vitro chemotherapeutic sensitivity testing by the disc-diffusion method using 19 antimicrobials. The isolates comprised of *Staph. aureus* (23), *Staph. epidermidis* (32), *Str. agalactiae* (12), *Str. dysgalactiae* (12), unclassified streptococci (24) and *Corynebacterium* spp. (11). Variable chemotherapeutic sensitivity pattern was observed for different species of organisms. In considering overall efficacy, irrespective of the species of the organisms, 100% of the isolates were sensitive to chloramphenicol, cephalexin, amoxycillin, and amoxyclav. More than 90% were sensitive to tetracycline, oxytetracycline, cloxacillin, gentamicin, ciprofloxacin, lincomycin and penicillin. Sensitivity to kanamycin, polymyxin-b, nitrofurantoin, neomycin, and ampicillin was more than 80%. Whereas 79.8, 76.3 and 72.8% of the isolates were sensitive to spiramycin, erythromycin and furazolidone, respectively.

Key words : Antibiotic sensitivity, camel, characterisation, intramammary infections, prevalence, *Staphylococcus* species

Mastitis appears to occur less frequently in camels than other milk producing livestock. In a preliminary study Sena *et al* (2000) have found an incidence of intramammary infections 28.28%. Subclinical mastitis is also important in camels and usually goes unnoticed by the animal owner because the milk and udder appears normal. This form of the mastitis can only be detected by the use of special tests. The present study was undertaken to study the

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prevalence of intramammary infections/mastitis by cultural examination and somatic cell count (SCC) and to know the antibiotic sensitivity of the microorganisms.

Materials and Methods

Milk samples were collected aseptically from 282 quarters of 71 camels for bacteriological examination by standard procedures (Brown *et al*, 1981) using 5% sheep blood agar and McConkey's lactose agar. Bacteria isolated were identified by colony morphology and Gram staining reaction. SCC of all the milk samples was performed as per the method of Schalm *et al* (1971) by using Giemsa stain.

The differentiation between staphylococci and micrococci was made on the basis of oxidase test. A total of 55 isolates of Gram +ve and catalase +ve cocci, which on preliminary examination were identified as staphylococci, were further differentiated into coagulase +ve and coagulase -ve staphylococci and these were further grouped into novobiocin sensitive and novobiocin resistant strains on the basis of novobiocin sensitivity (30 µg discs, Hi-media). Oxidase +ve cultures were also included in the novobiocin resistant group as a few species are oxidase +ve. The isolates in each group were further characterised to species level by the identification scheme of Watts and Owens (1988 by means of different physiological and biochemical tests.

A total of 114 isolates of various species of organisms, obtained from latent/subclinical intramammary infections in camels, were subjected to *in vitro* chemotherapeutic sensitivity to 10 antimicrobials using the disc- diffusion method as suggested by Bauer *et al* (1966). Chemo-therapeutic sensitivity discs were obtained from Hi-media Laboratories, Bombay. The concentration of different chemotherapeutic disc was nitrofurantoin (300 µg), tetracycline (30 µg), oxytetracycline (30 µg), chloramphenicol (30 µg), cloxacillin (30 µg), ampicillin (10µg), polymyxin-b (300 IU), ciprofloxacin (5µg), penicillin (10 IU), linomycin (2µg), cephalexin (30 µg), furazolidone (50 µg), gentamycin (10µg), neomycin (30µg), kanamycin (30µg), erythromycin (15µg), spiramycin (30µg), amoxycillin (30µg) and amoxyclav (30 µg). The susceptibility was interpreted as sensitivity, intermediate and resistant according to the zone size interpretation chart supplied by the manufacturer.

Results

On the basis of infected quarters 39.72% (112/282) were culturally positive, whereas, 65.60% (185/282) had SCC more than 500000/ml of milk. Of these, 34.40% (97/282) and 5.32% (15/282) were having 'subclinical (culturally +ve and SCC>500000 ml)' and Latent (culturally +ve and SCC<500000 ml)' mastitis, respectively according to the International Dairy Federation criteria adopted for cattle. While, 31.20% (88.282) of the quarters were having 'nonspecific (culturally -ve and SCC>500000/ml) mastitis.

As reported in other species of the animals the mean SCC was found to increase proportionately to CMT score (Table 1).

No apparent difference was observed between fore and hind quarters as regards to both infection level as well as elevation of SCC (Table 2).

Mean pH of quarter milk samples was within the normal range in all the non clinical quarters however significant rise was seen in case of clinically infected quarters (Table 3).

Amongst 115 isolates from 282 healthy quarters revealed *Staph. epidermidis* as the most predominant organism followed by unclassified *Streptococci*, *Staph. aureus*, *Str. agalactiae*, *Str. dysgalactiae*, *Corynebacterium*, and *Bacillus* spp (Table 4). Mixed infections were present in the following combinations *Staph. epidermidis* and unclassified *Streptococci* (2); *Staph. aureus* and *Str. dysgalactiae* (1) (Table 4).

Association of infection found in various quarters with a SCC> 500000/ml has been given in Table 5. Higher per cent was found with *Bacillus* spp and *Str. agalactiae* (Table 5).

A total of 55 isolates of staphylococci including 23 coagulase +ve isolates from camel intramammary infections were characterised by different biochemical tests. Out of different species of staphylococci identified (Table 6) the frequency was higher with *Staph. aureus* and lower with *Staph. capitis* and *Staph. warneri*. Out of the 55 isolates, nine isolates could not be identified with the present identification system used.

Table 1. Mean somatic cell count of quarters with different California mastitis test score.

CMT score	No. of quarters	Mean SCC (10^5)
Negative	137	4.8
Trace	103	9.9
+1	27	17.2
+2	12	65.6
+3	3	122.3

Table 2. Quarter-wise incidence of subclinical infections and somatic cell count > 500000/ml.

Quarter	No. of quarters	No. infected	%	SCC> 500000/ml	%
RF	71	31	43.66	48	67.60
RH	70	25	35.71	47	67.14
LF	71	25	35.21	45	63.38
LH	70	31	44.29	45	64.29

All quarters were associated with SSC> 500000/ml in *Staphylococcus* infection except in *Staph. aureus* and *Staph. hyicus* where 94.12 and 83.33% quarters were associated, respectively.

Table 3. Mean pH of the quarter milk samples in different type of mastitis.

Type of Mastitis	No. of quarters	Mean pH
Negative	78	6.45
Sub clinical	89	6.39
Latent	14	6.32
Non specific	86	6.43
Clinical	5	7.19

Table 4. Relative frequency of different microorganisms amongst 115 isolates from 112 culturally positive quarters.

Organisms	No. of Isolates	Per cent
Staph. epidermidis	32	27.83
Unclassified *Streptococci*	24	20.87
Staph. aureus	23	20.0
Str. agalactiae	12	10.43
Str. dysgalactiae	12	10.43
Corynebacterium spp.	11	9.57
Bacillus spp.	1	0.87

Table 5. Quarters with different infections having somatic cell count > 500000/ml.

Infection	No. of Quarters	Quarters with SCC>50000/ml	Per cent	Mean SCC (x 10^5)
Staph. aureus	23	19	82.61	11.1
Staph. epidermidis	30	27	90.00	19.5
Str. agalactiae	12	7	58.33	11.7
Str. dysgalactiae	12	12	100	10.7
Unclassified *Streptococci*	24	22	91.66	12.4
Corynebacterium spp.	11	9	81.81	8.2
Bacillus spp.	1	1	100	9.2

Results of *in vitro* chemotherapeutic sensitivity of the isolates from latent / subclinical intramammary infections are presented in table 7. Amongst *Staph. aureus* strains tested, 100% were sensitive to chloramphenicol, cephalexin, amoxycillin, amoxyclav, tetracycline, oxytetracycline, cloxacillin, gentamycin followed by ciprofloxacin, kanamycin, neomycin, polymyxin-b, lincomycin, penicillin, ampicillin, furazolidone, nitrofurantoin, spiramycin and erythromycin.

Of the 32 *Staph. epidermidis* strains, 100% were sensitive to chloramphenicol, cephalexin, amoxycillin, amoxyclav, neomycin followed by tetracycline, oxytetracycline, cloxacillin, ciprofloxacin, kanamycin, gentamycin, polymyxin-b, lincomycin, penicillin, nitrofurantoin, ampicillin, spiramycin, furazolidone and erythromycin.

Amongst *Str. agalactiae* strains (12) tested 100% were sensitive to chloramphenicol, cephalexin, amoxycillin, tetracycline, oxytetracyline, lincomycin, penicillin, nitrofurantoin, ampicillin, erythromycin followed by cloxacillin, ciprofloxacin, polymyxin-b, gentamycin, kana-mycin, spiramycin and neomycin and furazolidone.

Table 6. Characterisation of 55 isolates of *Staphylococci*.

Staphylococcus	No. of isolates	%	% of quarterswith SCC>500000/ml
Staph. aureus	17	30.91	16/17=94.12
Staph. hyicus	6	10.91	5/6=83.33
Staph. intermedius	4	7.27	4/4=100
Staph. haemolyticus	4	7.27	4/4=100
Staph. auricularis	4	7.27	4/4=100
Staph. sciuri	4	7.27	4/4=100
Staph. hominis	3	5.45	3/3=100
Staph. epidermidis	2	3.64	2/2=100
Staph. capitis	1	1.82	1/1=100
Staph. warneri	1	1.82	1/1=100
Non-typable	9	16.37	–

Of the 12 *Str. dysgalactiae* strains tested 100% were found sensitive to chloramphenicol, cephalexin, amoxycillin, tetracycline, oxytetracyline, cloxacillin, gentamycin, lincomycin, penicillin, nitrofurantoin, ampicillin followed by ciprofloxacin, spiramycin, erythromycin, kana-mycin, polymyxin-b and neomycin and furazolidone.

Twenty four unclassified streptococci strains tested were found 100% sensitive to chloramphenicol, cephalexin, amoxycillin, amoxyclav, tetracycline, oxytetracyline, cloxacillin, lincomycin, penicillin followed by gentamycin, nitrofurantoin, spiramycin, polymyxin-b, ampicillin, erythromycin, ciprofloxacin, kanamycin, furazolidone and neomycin.

Of the 11 strains of *Corynebacterium* spp. tested 100% were sensitive to chloramphenicol, cephalexin, amoxycillin, amoxyclav, tetracycline, oxytetracyline, cloxacillin, gentamycin, penicillin, neomycin, spiramycin, erythromycin, furazolidone followed by ciprofloxacin, lincomycin, nitrofurantoin, kanamycin, ampicillin and polymyxin-b.

Discussion

In the present study mean SCC was found to increase proportionately to CMT score. This is in agreement with the findings of Abdurahman (1994) and Sena *et al* (2000).

No apparent difference was observed between fore and hind quarters as regards to both infection level as well as elevation of SCC. Increase in milk pH in clinical mastitis has also been reported by Sena *et al* (2000).

In the present study quarter infection rate of 39.72% was found slightly higher in comparison to the findings of Sena *et al* (2000) and Chaffer *et al* (2000), whereas lower in comparison to the Egyptian camels (Jakee, 1998). Predominance of *Staph. epidermidis*/coagulase negative staphylococci in the present study is in agreement with the findings of other workers (Chaffer *et al*, 2000; Jakee, 1998 and Almaw and Molla, 2000) but is contrary to the findings of Sena *et al* (2000) who reported predominance of *Str. agalactiae*. *Escherchia coli* infection reported by Sena *et al* (2000) was not encountered in the present study.

Increase in SCC with major mastitis pathogens (*Staph. aureus* and *Str. agalactiae*) occurs in cattle (Serieys, 1985) but here increase in SCC with all the infections might be due to the low milk yield (4-5 litre/day). The dilution of milk is a factor confusing SCC interpretation (Dentine and McDaniel, 1983; Miller and Paape, 1985). Management mishaps, such as accidental water or feed deprivation, results in drastic decreases in milk yield with corresponding proportional increases in SCC in cattle (Martin, 1973; Miller and Paape, 1985). Holmes *et al* (1996) observed that in Holstein-Friesian cows, once daily milking caused a larger decrease in daily milk yield in cows with the high initial SCC. Camel in the present study are milked once daily. Wagner and Stott (1968) reported that increase in SCC might result from physiological stress factors without any inflammatory reaction in the udder.

Several new species of staphylococci have been described from animals and man (Schleifer and Kloos, 1975; Kloos, 1980). In the present study among the 55 isolates of staphylococci obtained from intramammary infections in camels, 23 were found to be coagulase - positive and 32 coagulase negative. In all 10 species of staphylococci were identified. *Staph. aureus* (30.91%) was the most frequent species. Earlier to this no published report about the characterisation of staphylococci as per recent classification appears to be available from camels. Hodges *et al* (1984), Hogan *et al* (1986), Watts and Owens (1988), Watts and Washburn (1991), Tuteja *et al* (1993) and Sharma and Kapur (1996) found *Staph. aureus* and *Staph.*

Table 7. *In vitro* antibiotic sensitivity testing (S = Sensitive, I= Intermediate, R = resistant).

Antibiotic		No. of isolates tested							
		Staph. aureus (23)	*Staph. epidermidis* (23)	*Str. agalactiae* (12)	*Str. dysgalactiae* (12)	Other *Streptococci* (24)	Coryne-*bacterium* spp. (11)	Total (114)	%
Chloramphenicol	S	23	32	12	12	24	11	114	100
	I	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	0
Cephalexin	S	23	32	12	12	24	11	114	100
	I	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	0
Amoxycillin	S	23	32	12	12	24	11	114	100
	I	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	0
Amoxyclav	S	23	32	12	12	24	11	114	100
	I	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	0
Tetracycline	S	23	31	12	12	24	11	113	99.1
	I	0	1	0	0	0	0	1	0.9
	R	0	0	0	0	0	0	0	0
Oxytetracycline	S	23	31	12	12	24	11	113	99.1
	I	0	1	0	0	0	0	1	0.9
	R	0	0	0	0	0	0	0	0
Cloxacillin	S	23	31	11	12	24	11	112	98.2
	I	0	0	1	0	0	0	1	0.9
	R	0	1	0	0	0	0	1	0.9
Gentamycin	S	23	29	10	12	23	11	108	94.7
	I	0	0	2	0	0	0	2	1.8
	R	0	3	0	0	1	0	4	3.5
Ciprofloxacillin	S	22	31	11	11	20	10	105	92.1
	I	1	1	0	0	3	1	6	5.3
	R	0	1	1	1	1	0	3	2.6
Lincomycin	S	20	26	12	12	24	10	104	91.2
	I	3	4	0	0	0	0	7	6.1
	R	0	2	0	0	0	1	3	2.6
Penicillin	S	20	25	12	12	24	11	104	91.2
	I	0	0	1	0	0	0	1	0
	R	3	7	0	0	0	0	10	8.8
Kanamycin	S	22	30	10	9	20	9	100	87.7
	I	0	1	0	2	2	1	6	5.3
	R	1	1	2	1	2	1	8	7.0
Polymyxin-b	S	21	29	11	9	22	8	100	87.7
	I	0	1	1	0	1	0	3	2.6
	R	2	2	0	3	1	3	11	9.6
Nitrofurantoinv	S	17	23	12	12	23	10	97	85.1
	I	0	1	0	0	1	0	2	1.8
	R	6	8	0	0	0	1	15	13.2
Neomycin	S	22	32	8	6	17	11	96	84.2
	I	1	0	3	3	4	0	11	9.6
	R	0	0	1	3	3	0	7	6.1
Ampicillin	S	20	23	12	12	22	9	98	86.0
	I	0	0	0	0	1	0	1	0.9
	R	3	9	0	0	1	2	15	13.2
Spiromycin	S	13	23	10	11	23	11	91	79.8
	I	8	8	2	1	0	0	19	16.7
	R	2	1	0	0	1	0	4	3.5
Erythromycin	S	13	20	12	10	21	11	87	76.3
	I	6	10	0	1	2	0	19	16.7
	R	4	2	0	1	1	0	8	7.0
Furazolidone	S	18	22	8	6	18	11	83	72.8
	I	2	3	0	1	1	0	7	6.1
	R	3	7	4	5	5	0	24	21.1

hyicus to be the common isolates from milk samples in cows. Whereas, Tuteja (1999) found *Staph. haemolyticus* and *Staph. saprophyticus* to be the more frequent isolates from milk samples in buffaloes. Cox *et al* (1984) identified *Staph. intermedius*, *Staph. epidermidis*, *Staph. aureus*, *Staph. sciuri*, *Staph. hyicus* from selected clinical strains from animal infections, especially dogs.

Knowledge of species level distribution of staphylococci is important for disease control and epidemiological studies (Hogan *et al*, 1987 and Watts and Owens, 1989). Species level identification is also necessary for recognition of pathogenic species of staphylococci (Watts, 1985). Among the coagulase +ve staphylococci, identification of *Staph. aureus*, a primary mastitis pathogen is necessary. *Staph. intermedius* another coagulase positive species is beta-toxin producing staphylococci isolated from carnivores (Cox *et al*, 1984). This is a predominant coagulase-positive organism isolated from dogs and has been infrequently isolated from bovine mastitis. Therefore, *Staph. intermedius* should be distinguished from *Staph. aureus* in veterinary diagnostic laboratories. Furthermore, distribution of Staphylococcus species such as *Staph. aureus*, *Staph. hyicus* and *Staph. epidermidis* in different herds has been found to be associated with different control measures adopted (Watts and Owens, 1989).

Staph. epidermidis, *Staph. capitis*, *Staph. saprophyticus*, *Staph. warneri*, *Staph. haemo-lyticus* and *Staph. hominis* have also been reported from human infections (Swell *et al*, 1982 and Hovelius *et al*, 1977). There is evidence in man that some of the coagulase-negative stahylococci may be more pathogenic and more resistant to antimicrobials than other staphylococcal species (Aldridge *et al*, 1983; Eng *et al*, 1982 and Nicolle *et al*, 1983). As most of the research in veterinary field has been directed towards coagulase positive staphylococci, the relative pathogenicity of coagulase - negative staphylococci still remains to be elucidated. The apparent increased virulence of human associated coagulase - negative staphylococci for the bovine mammary gland suggests an unnatural host parasite relationship (Watts, 1985). Species identification of coagulase-negative staphylococci may help as to learn more about the diversity, resistance pattern, epidemiology and virulence of the isolates, which were previously identified as *Staph. epidermidis* (Watts and Washburn, 1991). The association of certain staphylococcal species with species host animals became apparent as more circumscribed species descriptions became available. However, host specificity does not preclude cross-colonisation particularly when close association occurs between host species.

In the present study all the species were associated with raised SCC (>500000/ml) of milk. Whereas in cattle (Tuteja *et al*, 1993) and buffaloes (Tuteja, 1999) few species were not associated with raised SCC of milk. The possible reasons for this could be the dilution effect, since camels are low milk yielders therefore the number of SCC per ml of milk were more.

Antimicrobial therapy remains a primary tool for treatment and control of intramammary infections of dairy animals (Watts *et al*, 1995). Rarely does the veterinarians have the facility of microbial identification and susceptibility testing to guide initial therapy decisions. Development of resistant bacterial strains and improper treatment intervals and procedures may also play a role in treatment failures. Resistance patterns, particularly within the genus Staphylococcus can vary greatly from one geographic location to another and from herd to herd (Watts and Owens, 1988). In general, the choice of an antimicrobial agent is dictated by antibiotic sensitivity. Too often sensitivity patterns are expressed in qualitative terms such as sensitive, intermediate or resistant. At best, this information can guide the practitioner as to which drugs are not to be used.

In the present study antibiotic sensitivity of *Staph. aureus* strains was almost similar, in cattle and buffaloes for neomycin and chloramphenicol (Jhala, 1976; Kapur *et al*, 1979; Tuteja, 1999) gentamycin and cloxacillin (Kapur *et al*, 1979) low sensitivity pattern against penicillin (Jayappa *et al*, 1977; Babu *et al*, 1979; Kalorey *et al*, 1983; Tuteja *et al*, 1993), nitrofurantoin (Rahman and Baxi, 1984, Dahiya and Kapur, 1984), oxytetracycline and polymyxin-b (Tuteja *et al* 1993) has been reported.

For the *Staph. epidermidis* similar sensitivity, in cattle and buffaloes against chloramphenicol and cloxacillin (Kapur *et al*, 1980; Tuteja *et al*, 1993; Tuteja, 1999), cloxacillin (Kapur *et al*, 1980), higher sensitivity against nitrofurantoin (Kapur *et al*, 1978) and low sensitivity against nitrofurantoin

by Tuteja (1999) and low sensitivity against gentamicin (Shlke *et al*, 1998) has been observed.

Amongst *Str. agalactiae* strains if compared in cattle and buffaloes similar sensitivity pattern to chloramphenicol (Jhala, 1976; Tuteja *et al*, 1993; Tuteja, 1999) amoxycillin and erythromycin (Bertoldini *et al*, 1985; Tuteja, 1999). Higher sensitivity to neomycin (Lafi and Hailat, 1998; Tuteja, 1999) has been observed.

Of the *Str. dysgalactiae* strains of the camel origin have sensitivity pattern similar against penicillin (Dahiya and Kapur, 1984), oxytetracycline, chloramphenicol, ampicillin, cloxacillin and higher sensitivity to neomycin (Dahiya and Kapur, 1984; Tuteja, 1999) and low sensitivity to penicillin (Jhala, 1976) in cattle and buffaloes.

Unclassified streptococci of camel intramammary infections showed similar sensitivity pattern to chloramphenicol, oxytetracyline, higher sensitivity to erythromycin and neomycin (Jamkhedkar *et al*, 1969; Tuteja, 1999) and low sensitivity to penicillin (Jamkhedkar *et al*, 1969; Sharma *et al*, 1971; Jhala, 1976) reported from cattle and buffaloes.

Corynebacterium spp. tested were 100% sensitive to penicillin, chloramphenicol whereas Sharma *et al* (1971) reported 100% of the isolates resistant to penicillin and Tuteja (1999) reported similar results for chloramphenicol in cattle and buffaloes.

When the pH of milk is weakly acidic (pH 6.4 to 6.8), antimicrobial agents that are weak bases (e.g. polymyxin-b) are thought to be referentially concentrated in the mammary gland by ion trapping. However, milk from clinical mastitis cases can have a pH in the range of serum pH, so antimicrobial agents that are weak acids (e.g. penicillins) may reach effective antimicrobial concentrations in milk (Cullor, 1993). Therefore for the treatment of subclinical and clinical mastitis different antibiotics might be considered depending upon the sensitivity and other factors.

Nickerson and Owens (1990) method of drug infusion may actually cause mastitis by inadvertently introducing bacteria through the teat duct. Full insertion of the conventional mastitis tube canula can result in temporary dilation of the teat sphinctor muscle and the keratin plug that normally occludes the teat duct is sometimes removed allowing entry of bacteria. Because of twin duct anatomy of the teat canal in camel the most effective therapeutic method for treating intramammary infections may be via. systemic administration. Soback (1987) suggested that the pharmacokinetic characteristics of a drug must be considered before rational decisions concerning therapy can be made. The ability of the drug to move from the blood into the mammary tissue and into leukocytes is a critical pharmacokinetic consideration for systemic drugs. Systemic therapy offers an alternate route for antibiotic to reach deep tissue foci of infection. Also, systemic therapy does not risk infection with organisms introduced via the teat duct during infusion.

It is concluded that intramammary infections of camels should not be undermined and there is immediate need to carry out pharmaco-kinetic studies of antibiotics administered via systemic route for the treatment.

Acknowledgements

Authors are thankful to Sh. Dinesh Munjal and H.S. Kaundal for the computer related operations.

References

Abdurahman OAS (1994). Detection of subclinical mastitis in camels: relationship between udder infection and inflammatory indicators in milk. Actes du colloque, 24-26 October, Nouakchott, Mauritanie. pp 31-33.

Aldridge KE, Stratton CW, Patterson LS, Evans ME and Hodges RL (1983). Comparison of the *Staphylococci* indent system with a conventional method for species identification urine and blood isolates of coauglase-negative staphylococci. Journal of Clinical Microbiology 17:516-520.

Almaw G and Molla B (2000). Prevalence and etiology of mastitis in camels (*Camelus dromedarius*) in Eastern Ethiopia. Journal of Camel Practice and Research 7(1):97-100.

Babu TS, Pargaonkar VN, Murthy KG and Rao VP (1983). Study on antibiotic sensitivity pattern of mastitis milk. Indian Veterinary Journal 56:211-213.

Bauer AW, Kirby WMM, Sherris JC and Turck M (1966). Antibiotic susceptibility testing by a standardised single disc method. American Journal of Clinical Pathology 45:493.

Bertoldini G, Brunner F and Redaelli G (1985). Further studies on the antibiotic sensitivity of *streptococci* and *staphylococci* associated with bovine mastitis. Archivio Veterinarian Italiano 36:94-101 (Abst. Vet. Bull. 56:1432).

Brown RW, Barnum DA, Jasper DF, McDonald JS and Schultze WD (1981). Microbiological Procedures for Use in the Diagnosis of Bovine Mastitis. 2nd Ed. National Mastitis Council Inc., 30F Street, N.W. Washington D.C.

Chaffer M, Leitner G, Glickman A, VanCreveld C, Winkler M, Saran A and yag R (2000). Determination of udder health (*Camelus dromedarius*). Journal of Camel Practice and Research 7(2):171-174.

Cox HV, Newman SS, Roy AF and Haskins JD (1984). Species of *staphylococcus* isolated from animal infections. Cornell Veterinarian 74:124-135.

Cullor JS (1993). The control, treatment and prevention of various types of bovine mastitis. Veterinary Medicine 88:571-578.

Dahiya BS and Kapur MP (1984). Bacteriological examination and therapeutic trials with the cloxacillin sodium in clinical cases of mastitis. Indian Journal of Veterinary Medicine 4:1-4.

Dentine MR and McDaniel BT (1983). Evidence for non linearity in the relationship between milk and fat yields and the logarithm of the geometric mean of monthly somatic cell counts. Journal of Dairy Science 60(1):12.

Eng RHK, Wang C, Person A, Kiehn TE and Armstrong D (1982). Species identification of coagulase - negative staphylococcal isolates from blood cultures. Journal of Clinical Microbiology 15:439-442.

Hodges RT, Jones YS and Holland JTS (1984). Characterisation of staphylococci associated with clinical and subclinical bovine mastitis. New Zealand Veterinary Journal 32:141-145.

Hogan JS, Cornetto A and Pankey JW (1986). Comparison of four test procedures to identify *Staphylococcus aureus* isolated from bovine intramammary infections. American Journal of Veterinary Research 47:2017-2019.

Hogan JS, White DG and Pankey JW (1987). Effect of teat dipping on intramammary infections other than *Staphylococcus aureus*. Journal of Dairy Science 70:873-879.

Holmes CW, Kamote H, Mackenzie DDS and Morel PCH (1996). Effects of a decrease in milk yield, caused by once daily milking or by restricted feeding on the somatic cell count in milk from cows with or without subclinical mastitis. Australian Journal of Dairy Technology 51:8.

Hovelius B, Mardh PA, Peterson AC, Hovelius K and Nilson PO (1977). Diagnosis, occurrence and clinical significance of coagulase negative, novobiocin resistant staphylococci. Svensk Veterinartidning 29:635-640 (Abst. Vet. Bull. 48:664).

Jakee EIJ (1998). Microbiological studies on mammary glands of one humped she camels in Egypt. Journal of Camel Practice and Research 5(2):243-246.

Jamkhedkar PP, Varaya NA, Kadvekar LK and Murkibhavi GR (1969). Antibiotic sensitivity of streptococci from buffalo cow udder. Indian Veterinary Journal 46:830-831.

Jayappa HG, Keshavamurthy BS and Rajasekhar M (1977). Penicillin resistant staphylococci from cases of bovine mastitis and their resistance profile to antibiotic and metal ions. Indian Veterinary Journal 45:338-341.

Jhala VM (1976). *In vitro* trials on antibiotic sensitivity of bacteria in milk samples received at Gujarat Veterinary College, Anand. Indian Veterinary Journal 53:247-251.

Kalorey DR, Purohit JH and Dholakia PM (1983). Studies on the incidence of subclinical mastitis, its etiology and *in vitro* sensitivity of isolates. Indian Journal of Animal Sciences 53:961-963.

Kapur MP, Singh RP and Khanna BM (1978). *In vitro* chemotherapeutic sensitivity of microorganisms isolated from clinical cases of mastitis in dairy animals. Indian Veterinary Journal 55:848-852.

Kapur MP, Kaushik RK and Gautam OP (1979). Antibiogram of *Staphylococcus aureus* isolates of bovine mammary origin. Haryana Veterinarian 18:121-123.

Kapur MP, Gautam OP, Kaushik RK and Chhabra PC (1980). Antibiogram of *Staphylococcus epidermidis* of bovine mammary origin. Haryana Veterinarian 19:136-138.

Kapur MP, Khanna BM and Singh RP (1982). A peracute case of mastitis in a she camel associated with *Klebsiella pneumaniac* and *Escherichia coli*. Indian Veterinary Journal 59(8):650-651.

Kloos WE (1980). Natural population of the genus *Staphylococcus*. Annual Review of Microbiology 34:559-592.

Lafi SQ and Hailat NQ (1998). Incidence and antibiotic sensitivity of bacteria causing bovine and ovine clinical mastitis in Jordan. Pakistan Veterinary Journal 21:88-94.

Martin JM (1973). Milk yield interrelationships with somatic cells and chemical constituents over lactation and during restricted water consumption. M.S.Thesis, North Carolina State University, Raleigh.

Miller RH and Paape MJ (1985). Relationship between milk somatic cell count and milk yield. Proceedings of National Mastitis Council. p 60.

Mitchell RC, Alder VG and Rosendal K (1974). The classification of coagulase - negative micro-coccaceae from human and animal sources. Journal of Medical Microbiology 7:131-135.

Nickerson SC and Owens WE (1990). New treatment strategies. Proceedings of the 29th Annual meeting of the National Mastitis Council Inc. Louisville, K.Y. p 114.

Nicolle LE, Hoban SA and Harding KM (1983). Characterisation of coagulase negative staphylo-cocci from urinary tract specimens. Journal of Clinical Microbiology 16:509-516.

Rahman H and Baxi KK (1984). Antibiogram of microorganisms isolated from buffaloes with subclinical mastitis. Livestock Advisor 9:51-53.

Schalm OW, Carroll EJ and Jain NC (1971). Bovine Mastitis. 1971 Edn. Lea and Febiger, Philadelphia.

Schleifer KH and Kloos WE (1975). Isolation and characterization of Staphylococci from human skin. I. Amended descriptions of staphylococcus and descriptions of three new species. *Staphylococcus cohnii*, *Staphylococcus haemolyticus* and *Staphylococcus xylosus*. International Journal of Systemic Bacteriology 25:50-61.

Sena DS, Gorakhmal, Kumar R and Sahani MS (2000). Detection of subclinical mastitis in camels. Journal of Camel Practice and Research 7(2):203-204.

Serieys F (1985). Cell counts in milk from individual cows, influence of mammary infection parity, stage of lactation and milk yield. Annals de Researches Veterinaries 16:255-261 (Abst. Vet. Bull. 56:1438).

Sharma A and Kapur MP (1996). Characterisation of coagulase - positive *Staphylococci* from intramammary infections of cows and buffaloes. XVII Annual convention, ISVM, 5-7 February, Bhubaneshwar, India. p 3.

Sharma VK, Bhatnagar A and Rajani HB (1971). Chemotherapeutic sensitivity of microorganisms isolated from bovine udder. Indian Journal of Animal Sciences 41:96-100.

Shlke DD, Keskar DV, Jagadish S, Bhalero DP and Sharma LK (1998). Subclinical and clinical mastitis in cross bred cows: aetiology and antimicrobial sensitivity. Indian Veterinary Journal 75:458-459.

Soback S (1987). Therapeutic success or failure in mastitis therapy - a pharmacokinetic approach. 26th Annual meeting. National Mastitis Council Inc. Arlington, VA. pp 1.

Swell CM, Clarridge JE, Young EJ and Gunthrie RK (1982). Clinical significance of coagulase-negative staphylococcal. Journal of Clinical Microbiology 16:236-239.

Tuteja FC (1999). Studies on mastitis in buffaloes with special reference to serum selenium status and control by treating teat canal infections. Ph.D. thesis. CCS HAU, Hisar, India.

Tuteja FC, Kapur MP and Sharma A (1993a). Antibiogram of microorganisms isolated from bovine intramammary infections. International Journal of Animal Sciences. pp 103-106.

Tuteja FC, Kapur MP and Sharma A (1993b). Isolation and characterization of *Staphylococcus* species originating from bovine intramammary infections. Indian Journal of Animal Sciences 63:1050-1051.

Wagner TN and Stott GH (1968). Effect of ACTH-induced leucocytosis on abnormal milk production. Journal of Dairy Sciences 51:967.

Watts JL (1985). Impact of new *Staphylococcal* species descriptions on mastitis research. In: Nikerson, SC (Ed.) Dairy Research Reports (1986). Hill Farm Research Station, Homer, L.A. pp 394-398.

Watts JL and Owens WE (1988). Laboratory procedures on bovine mastitis. American Society for Microbiology. Annual Meeting Workshop held at Miami Beach, F.L.

Watts JL and Owens WE (1989). Prevalence of staphylococcal species in four dairy herds. Research in Veterinary Science 46:1-4.

Watts JL and Washburn PJ (1991). Evaluation of the *Staph.* Zym system with *Staphylococci* isolated from bovine intramammary infections. Journal of Clinical Microbiology 29:59-61.

Watts JL, Salmon SA, Yancey RJ Jr., Nickerson SC, Weaver LJ, Holmberg C, Pandey JW and Fox LK (1995). Antimicrobial ssusceptibility of microorganisms isolated from the mammary glands of dairy heifers. Journal of Dairy Science. 78:1637.