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MICROBIOLOGICAL QUALITY EVALUATION OF RAW GOAT'S MILK IN EGYPT

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ABSTRACT

Microbiological quality of fresh goat's milk collected from ten flocks in Cairo and Giza Governorates were evaluated, as a measure of food safety. Milk samples were analyzed for Total Mesophilic Count (TMC), Total Psychotrophic Count (TPC), Total Lipolytic Count (TLC), Total Staphylococci Count (TSC), Total Coagulase Positive Staphylococci (CPS) & Coagulase Negative Staphylococci (CNS) Count, Total Yeast & Mold Count (TYMC) and Coliforms Count (CC). The obtained results were in mean values of (8.6 & 9.7), (4.5 & 5.0), (3.6 & 5.2), (7.7 & 8.9), (7.2 & 8.2), (7.5 & 7.4), (5.4 & 5.2) log CFU/ml. and (7.3 & 7.5) log MPN/ml. respectively in the two Governorates. Somatic Cell Count were found (5.88 & 6.14) cells log/ml respectively in the two governorates. Milk samples were also analyzed for the presence of selected foodborne pathogens such as *E. coli* and *Klebsiella pneumoniae*. Results revealed the presence of microbial contaminants which indicates bad milk quality and requires immediate attention as it can cause serious public health risk to consumers.

Keywords: Prevalence, Raw Goat's Milk, Pathogens, Safety, Quality, Somatic Cell Count

INTRODUCTION

The milk of small ruminant plays an important role in the nutrition of both agricultural and urban areas. Goat's milk is of specific economic interest in the developing countries. The production of this milk has to

be a useful strategy to stop the problems of poor nutrition in Africa and Asia [1].

The unique and beneficial characteristics of goat's milk that are superior to bovine milk include: improved digestibility; higher

buffering capacity and may have specific therapeutic value [2].

Goat's milk may harbor dangerous microorganisms that can pose serious health risks to the consumers especially to infants. This milk can get contaminated by various pathogenic or spoilage microorganisms during various stages of processing and storage from farm to table. Presence of high microbial load in milk can pose major economical loss for local farmers and small hold dairies, as milk price is determined based on the bacteria count, especially the pathogenic ones [3].

Some of the pathogenic and spoilage bacteria such as *Staphylococcus aureus*, *Escherichia coli*, *Enterobacter* species, and *Klebsiella* species are of great importance to highlight hygienic conditions at processing and handling the goat's milk [4]. Generally, for food safety, microbiological analysis is carried-out to monitor and evaluate the level of prevalent pathogenic and spoilage microorganisms in fresh goat's milk [5].

To our knowledge, no full detailed reports are available on the microbiological status of goat's milk in Egypt. Hence, the main objective of this study to analyze the microbiological quality of fresh goat's milk collected from ten flocks in Cairo and Giza Governorates, which is visualized to give

baseline information on the level of contamination and the prevalence of pathogenic bacteria. Results generated in this study is expected to be useful for health conscious consumers as well as the authorized agency to verify proper food safety measures to reduce the risk factors associated.

MATERIALS AND METHODS

Collection of Samples

One hundred of individual goat's milk samples were provided from ten flocks in Cairo and Giza governorates (fifty for each governorate). Milk samples were collected after pre and post milking washing and disinfecting the teats. The first milk stream was discarded and the samples were milked directly (150-250ml.) into a sterile bottle. The samples were transferred to the laboratory in an insulated ice box with a minimum of delay to be immediately examined for:

Microbiological Analysis

Goat's milk samples were analyzed for the Total Mesophilic Count (TMC), Total Psychrotrophic Count (TPC), Total Lipolytic Count (TLC), Total Staphylococci Count (TSC), Total Coagulase Positive Staphylococci Count (TCPSC), Total Coagulase Negative Staphylococci Count (TCNSC) and Thermo nuclease as well as its β hemolytic activity, Total Yeast and Mold Count (TYMC) and Coliforms Count (CC).

All tests procedures were carried out by employing standard methods according to [6-10]. Laboratory measurement of milk somatic cells by using of milk scans apparatus, (Bentley soma count 150) according to [11]

Statistical Analysis

The bacterial counts of milk samples were converted into logarithm of number of colony forming units per ml (log CFU/ml) for statistical analysis. Means were compared by employing analysis of variance [12] followed by t-test to determine difference among means at 95% confidence level (significance level at $P \leq 0.05$).

RESULTS

Data depicted in **Table 1** reveal that the mean value of examined goat's milk samples based on TMC, TPC, TLC, TSC, TCPSC, TCNSC and TYMC were (8.6 & 9.7); (4.5 & 5.0); (3.6 & 5.2); (7.7 & 8.9); (7.2 & 8.2); (7.5 & 7.4); (5.4 & 5.2) log CFU/ml. in Cairo and Giza governorates respectively.

While the mean value of examined samples based on CC was (7.3 & 7.5) MPN/ml. in both governorates respectively. The higher frequency distribution were laid within the range of log (6 - < 8) for TMC, TSC, TCPSC, TCNSC, CC. While the higher frequency distribution were laid within the range of log (4 - < 6) for TPC, TLC and TYMC.

Data showed in **Table 2** reveal that the mean of β hemolytic strains of CPS & CNS was (7.0 & 7.9); (6.2 & 6.3) log CFU/ml. in both governorates respectively in examined samples.

As shown in **Table 3** *Escherichia coli* and *Klebsiella pneumonia* were found in a percentage of (16 & 30%) and (18 & 10%) in the examined samples in both governorates respectively.

The mean value of the examined samples based on Somatic Cell Count was (5.88 & 6.14) log cells/ml. in both governorates respectively (**Table 4**).

Table 1: Statistical Analytical Results of Microbiological Parameters in the Examined Goat's Milk Samples

Parameter	Cairo	Giza
TMC	8.6 (log CFU/ml.) ^a	9.7 (log CFU /ml.) ^b
TPC	4.5 (log CFU /ml.) ^a	5.0 (log CFU /ml.) ^a
TLC	3.6 (log CFU /ml.) ^a	5.2 (log CFU /ml.) ^b
TSC	7.7 (log CFU /ml.) ^a	8.9 (log CFU /ml.) ^b
TCPSC	7.2 (log CFU /ml.) ^a	8.2 (log CFU /ml.) ^b
TCNSC	7.5 (log CFU /ml.) ^a	7.4 (log CFU /ml.) ^a
TYMC	5.4 (log CFU /ml.) ^a	5.2 (log CFU /ml.) ^a
CC	7.3 (log MPN/ml.) ^a	7.5 (log MPN/ml.) ^a

NOTE: Means in the Same Row With Different Letters are Significantly Different ($P < 0.05$)

Table 2: Correlation Between TCPSC, TCNSC and β Hemolytic *Staphylococci* Count (log CFU /ml.) in the Examined Goat's Milk Samples

Area	TCPSC	TCPS β hemolytic Count	TCNSC	TCNS β hemolytic Count
Cairo	7.2	7.0 ^a	7.5	6.2 ^a
Giza	8.2	7.9 ^a	7.4	6.3 ^a

NOTE: Means in the Same Row With Similar Letters are not Significantly Different (P >0.05)

Table 3: Incidence of *Escherichia coli* and *Klebsiella pneumoniae* in the Examined Goat's Milk Samples

Type of microorganisms	Cairo		Giza	
	No.	%	No.	%.
<i>Escherichia coli</i>	8 ^a	16	15 ^a	30
<i>Klebsiellapneumoniae</i>	9 ^a	18	5 ^a	10

NOTE: Numbers in the same row with similar letters are not significantly different (P >0.05)

Table 4: Statistical Analytical Results of Somatic Cell Count (SCC/ml.) and its Relation with TCPSC, TCNSC and CC (log/ml.) in the Examined Goat's Milk Samples

Area	No. of examined samples	SCC	TCPSC	TCNSC	CC
Cairo	50	5.88 ^a	7.2	7.5	7.3
Giza	50	6.14 ^b	8.2	7.4	7.5

NOTE: Means in the Same Row with Different Letters are Significantly Different (P < 0.05)

DISCUSSION

The high count of bacterial load of goat's milk samples might be due to bad storage, transportation and handling conditions, infected udder of goat, unhygienic milking procedure, poor water quality used for cleaning and use of unsterilized equipment [13].

There was a significant difference ($p < 0.05$) between both governorates in all microbiological parameters except in TPC, TCNSC, TYMC and Coliforms Count. It was noticed a direct correlation between TMC and TPC with a correlation coefficient ($r = 0.186$). Also these data revealed that the direct highly significant correlation between TPC and TLC was ($r = 0.431$, $p < 0.01$).

Nearly similar findings reported by [14-18]. Lower findings reported by [19-23]. Presence of Psychrotrophic bacteria in both governorates emphasizes the tendency of this bacterium to grow and multiply when kept the milk at low temperature. If the agriculturiers fail to keep the milk under cooling conditions after milking for long duration of time, rapid contamination might occur by this bacterium [24]. Psychrotrophic microorganisms are capable of producing heat stable enzymes (proteolytic and/or lipolytic) at low temperatures, which can hydrolyze milk fat and protein leading to development of off-flavors of milk [25].

The high number of lipolytic bacteria and their activity may result in the degradation of

milk during transportation and storage. Microbial lipases are thermoresistant and remain active despite heating including UHT treatment, being able to cause the development of rancid taste and flavor in dairy products [26, 27].

Staphylococcus aureus has been identified as the most pathogenic staphylococcal infection both in its subclinical and clinical form in the caprine udder. This shows that *Staphylococcus aureus* microorganism as a causative agent for udder diseases remains widespread and consumers of raw goat's milk run the risk of food poisoning [28].

The transmission of this pathogen through contaminated hands to mammary glands of the goat might have occurred. According to [29] toxins of this pathogenic bacterium in milk will start at 6.0 log CFU/ml. and then this limit is unacceptable.

Intoxication by Staphylococcal enterotoxin is one of the most frequent causes of food poisoning and these enterotoxins could be produced not only by *Staphylococcus aureus* but also by coagulase negative staphylococci species [30]. The consumption of raw goat's milk is associated with *Staphylococcus aureus* intoxication (staphylococcal enterotoxin D) in Swiss, 2008 and the count was reached to 5.0×10^7 CFU ml [31].

There was not a significant difference ($p > 0.05$) based on β hemolytic Count of Staphylococci between both governorates. Also there was no significant difference ($p > 0.05$) between TCPSC and TCPS β hemolytic Count. From the results achieved, there was a significant difference ($p < 0.05$) between TCNSC and TCNS β hemolytic Count which revealed that β hemolytic strains of Staphylococci are usually not associated with CNS in the examined samples. From the above mentioned data, our findings were nearly similar to [32].

Diseases caused by Staphylococci are the result of a synthesis of several virulence factors including the different hemolysins, which are important for virulence of the *S. aureus* and other species [33].

Staphylococcal hemolysins are important virulence factors that contribute to bacterial invasion and escape from the host immune response [34]. Alpha-haemolysin or alpha toxin is a main pathogenicity factor because of its hemolytic, dermonecrotic and neurotoxic effects [35].

The presence of yeasts and molds in goat's milk samples collected from the two governorates in this study emphasizes improper hygienic conditions concurrence in the place of milking.

There was not a significant difference ($p > 0.05$) based on an incidence of *Escherichia coli* and *Klebsiella pneumonia* between both governorates. The presence of *E. coli* in both governorates indicates that the milk samples may be contaminated with fecal matters. Such contamination may reflect the presence of other pathogens e.g. *Klebsiella pneumonia*.

Nearly similar findings reported by [36, 37]. Lower findings reported by [38]. Consumption of unpasteurized goat's milk has been implicated in the development of *Escherichia coli* O157:H7 associated hemolytic uremic syndrome [39].

Consumption of raw goat's milk cheese has been implicated in the three outbreaks in France by *E.coli* [40].

Klebsiella pneumoniae is a bacterium that can be responsible for arthritis and septicemia outbreaks in kids and newborns [41] may be responsible for pneumonia and necrotic damage of the lungs [42].

According to [43], in Europe, Goat's milk quality is monitored based on the presence of Total Bacterial Count, which should not exceed 4.5 log CFU/ml. While in United States, bacterial count in goat's milk is allowed up to 5.0 log CFU/ml. with Somatic Cell Count of 6.0 log cell /ml.

Egyptian standard, 2005, [44] has stated that *Staphylococcus aureus* should be not more than 100 CFU / one ml. milk and *E. coli* should be absent.

European Council, 1992, [45] has stipulated that Coliforms count should be not more than 2.0 log / one ml. goat's milk. From the above mentioned criteria, our findings concerning the microbiological examination of goat's milk samples exceed these standards.

Lower findings reported by [46]. Higher findings reported by [47] based on Somatic Cell Count.

There was a significant difference ($p < 0.05$) between both governorates. The direct correlation between SCC & CC, TCPSC and TCNSC with correlation coefficient (r) was 0.098, 0.023 and 0.008 respectively. This correlation revealed that the significance increase of SCC is usually associated with high count of Coliforms and CPS in the examined samples. From the above mentioned data, our findings were nearly similar to [22].

Milk Somatic Cell Counts (MSCC) are the basis of milk quality control programs [48]. Somatic Cell Count and bacterial counts were used as indicators to monitor the udder health and milk quality.

In the United States, the legal limit of SCC established by Food and Drug Administration

for dairy goats is 1,000,000 ml.⁻¹ and currently there is no legal limit for goat's milk in the European Union [49]. The present study shows that the SCC of goat's milk samples is exceed the US limit and there is no definite limit in Egyptian Standards. Somatic Cell Count (SCC) in goat's milk can be higher than in the cow's milk, provided that the milk comes from healthy animals. Changes in SCC are affected by the method of milking and the health status of the animals. Higher SCC in goat's milk can also be caused by a different type of secretion in goats, namely apocrine secretion, as opposed to the merocrine secretion in cows [47].

CONCLUSION

The aim of good hygienic practices is to minimize the pathogens and spoilage bacteria. Hand washing in between milking of the goat during pre-milking and post-milking stages by using proper disinfectants can improve the safety of fresh milk. Heat treatment such as pasteurization before consumption is also vital to manage the microbial pathogens in goat's milk.

The microbial quality of goat's milk collected from two governorates revealed that the fresh milk may be harbor foodborne pathogens that may cause severe health risks to the consumers in Egypt. Sufficient procedures need to be undertaken by authorized agency

to reduce the risks associated, by providing adequate training to the dairy goat's producers and educating health aware consumers. It is also recommended to revise the Egyptian Standard requirement for raw goat's milk to cover all aspects of microbiological criteria.

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