Bacterial Quality of Goat Raw Milk in Khartoum State, Sudan

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Authors' contributions

This work was carried out in collaboration between both authors. Author EAAA designed the study, performed the statistical analysis and wrote the protocol and wrote the first draft of the manuscript. Author SAM managed the analyses of the study, managed the literature searches. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

This study was aiming at investigating the bacteriological quality of raw goat's milk in Khartoum State during 6 months of the year 2019. A total of 60 samples of raw goat's milk were collected from different localities of Khartoum State as follows: 20 samples from Khartoum Locality, 20 from Bahri Locality and 20 from Omdurman Locality. Samples were subjected for bacteriological Viable Count using Plate Count Agar (PCA) and Coliform Count (CC) methods.For goat's milk samples collected from Khartoum Locality, 11 (55.0%) scored the mean APC of 25×10^5CFU/ml and 9 (45.0%) scored the mean Aerobic Plate Count(APC) of 15×10^3CFU/ml. Coliforms were detected in 5 (25.0%) of milk samples with the mean CC of 10×10^3CFU/ml. Out of 20 goats' milk samples collected from Bahri Locality, 8 (40.0%) scored the mean APC of 20×10^5CFU/ml and 12 (55.0%) scored the mean APC of 18×10^3CFU/ml. Coliforms were detected in 6 (30.0%) of milk samples with the mean CC of 10×10^3CFU/ml. For goat's milk samples collected from Omdurman Locality, 14 (70.0%) scored the mean APC of 21×10^5CFU/ml and 6 (30.0%) scored the mean APC of 19×10^3CFU/ml. Coliforms were not detected in milk samples.

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1. INTRODUCTHION

Milk is the most popular food for human consumption and considered as a complete and nutritious food; not only for the new-born but for all age groups in both rural and urban people all over the world [1]. Milk is a sterile fluid when secreted into alveoli of udder; however, after secretion microbial contamination could occur from the udder itself, external part of the udder and from the surface of milk handling and storage equipment, and also the air, soil, feed, grass and feces are also possible sources of contamination[2]. The demand for safe and high quality milk by consumers has placed responsibility on producers, retailers and manufacturers to produce safe and good quality milk and milk products. Milk and milk products have a high value in feeding the population in both rural and urban areas. Wholesome milk and milk products have refreshing, potable, economical and nutritious food for human being [3]. However due to its high nutritive value and high moisture content, raw milk serves a good medium also for microbial growth that degrades the milk quality and shelf-life of milk. Hence, many dairy programs have been carried out to improve the production as well as quality of raw milk [4]. Contamination of milk and milk products with pathogenic bacteria is largely due to processing, handling, and unhygienic conditions [5]. Bacterial contamination of raw milk can originate from different sources: Air, milking equipment, feed, soil, feces and grass [6]. Hygienic handling practice of the milk with respect to quality has received a great concern around the world. It was also reported that dairy production has a great contribution in improving human nutrition, particularly women and children [7]. The unsafe handling practice results in the higher bacterial count, which in turn may cause spoilage of the milk and poor yields of its products [8]. Moreover, the rise of bacterial count could cause food borne diseases and imposes a great health risk on the consumer. Raw milk quality is closely monitored to ensure processed product quality and safety; in addition raw milk must meet other quality standards including freedom from drug residues, added water, sediment, contaminants and other abnormalities [9]. There is no evidence that the health hazards from raw goat's or ewe's milk is any lower [10]. Goat's and sheep's milk can be, similar to cow's milk, source of undesirable or even pathogenic bacteria which implicated in milkborne diseases including Listeria monocytogenes, *Escherichiacoli*, Salmonella spp. and Staphylococcus aureus [11]. These microorganisms could gain access to milk either from faecal contamination, particularly around the teats, or by direct excretion from the udder.Some of the pathogenic and spoilage bacteria such as *Staphylococcusaureus*, *Escherichiacoli*, Enterobactersp, and Klebsiella sp. are of great importance to highlight hygienic conditions at processing and handling the goat's milk [12]. 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 [13].

This study was aimed at quantifyingthebacterial load of goat raw milk in Khartoum State.

2. MATERIALS AND METHODS

2.1 Source of Samples

A total of 60 goat's raw milk samples were collected from Khartoum State (20 Khartoum Locality, 20 from Bahri Locality and 20 from Omdurman Locality) during the last 6 months of the year 2019.

2.2 Sampling Procedure

Prior to collection of samples, the bulk milk in the container was stirred thoroughly for proper mixing. From each farm approximately 50 ml of raw milk was collected. Milk samples were collected in sterile containers, kept in ice and sent to the laboratory of college of Veterinary Medicine, University of Bahri.

2.3 Serial Dilution

Test tubes containing 9 ml of physiological (0.9% NaCl) saline water were autoclaved before use. Tenfold serial dilution of raw milk was prepared. Initially, 1 ml of milk was mixed with 9 ml of saline water in a test tube in order to dilution 10^{-1} and mixed with 9 ml of saline in it by repeated pipetting in order to make tenfold dilution. Again, 1 ml from the 10^{-1} test tube was transferred to 10^{-2} labeled test tube and mixed with 9 ml saline solution in it by repeated pipetting. This action was repeated for the test tubes labeled as 10^{-3}, 10^{-4} and 10^{-5} [14].

2.4 Bacterial Count

2.4.1 Spread plate method

After finishing serial dilution, five Plate Count Agar (PCA) plates and five Violet Red Bile Agar (VRBA) plates were labeled as raw, 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, and 10^{-5}. From each of the diluted sample test tubes 0.2 ml of sample from the test tubes labeled raw, 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, and 10^{-5} was added on the respective plates and the drops will be spread using spread plate technique with a spreader. All plates were then incubated at 37∘C for 24-48 hours. After the incubation period the plates showing colonies were counted and noted down [15].

3. RESULTS

3.1 APC and CC Results of Goats' Milk Samples Collected from Khartoum Locality

Out of 20 goats' milk samples collected from Khartoum Locality, 11 (55.0%) scored the mean APC of $25X10^5$CFU/ml and 9 (45.0%) scored the mean APC of $15X10^3$CFU/ml. Coliforms were detected in 5 (25.0%) of milk samples with the mean CC of $10X10^3$CFU/ml and they were also positive for APCwith the mean of $25X10^5$CFU/ml (Table 1).

3.2 APC and CC Results of Goats' Milk Samples Collected from Bahri Locality

Out of 20 goats' milk samples collected from Bahri Locality, 8 (40.0%) scored the mean APC of $20X10^5$CFU/ml and 12 (60.0%) scored the mean APC of $18X10^3$CFU/ml. Coliforms were detected in 6 (30.0%) of milk samples with the mean CC of $14X10^3$CFU/ml and they were also positive for APC with the mean of $190X10^5$CFU/ml (Table 2).

3.3 APC and CC Results of Goats' Milk Samples Collected from Omdurman Locality

Out of 20 goats' milk samples collected from Omdurman Locality, 14 (70.0%) scored the mean APC of $21X10^5$CFU/ml and 6 (30.0%) scored the mean APC of $19X10^3$CFU/ml. Coliforms were not detected in milk samples (Table 3).

Table 1. APC and CC results of goats' milk samples collected from khartoum locality

Sample No.	APC CFU/ml	CC CFU/ml	Sample No.	APC CFU/ml	CC CFU/ml
1	$34 X 10^5$	0	11	$24 X 10^5$	0
2	$24X 10^5$	0	12	$12X 10^3$	0
3	$14X 10^5$	$12 X 10^3$	13	$13 X 10^3$	0
4	$27X 10^5$	$2 X 10^3$	14	$10 X 10^3$	0
5	$20X 10^5$	0	15	$21 X 10^3$	0
6	$25X 10^5$	0	16	$16 X 10^3$	0
7	$15X 10^5$	$18 X 10^3$	17	$18 X 10^3$	0
8	$22X 10^5$	$16 X 10^3$	18	$20 X 10^3$	0
9	$36X 10^5$	$11 X 10^3$	19	$16 X 10^3$	0
10	$19X 10^5$	0	20	$18 X 10^3$	0

Table 2. APC and CC results of goats' milk samples collected from bahri locality

Sample No.	APC CFU/ml	CC CFU/ml	Sample No.	APC CFU/ml	CC CFU/ml
1	$24 X 10^5$	$15 X 10^3$	11	$26 X 10^3$	0
2	$21 X 10^5$	0	12	$12 X 10^3$	0
3	$19 X 10^3$	$24 X 10^3$	13	$14 X 10^3$	0
4	$10 X 10^3$	$2 X 10^3$	14	$11 X 10^3$	0
5	$20 X 10^3$	0	15	$21 X 10^3$	0
6	$20X 10^3$	0	16	$15 X 10^3$	0
7	$24 X 10^5$	$18 X 10^3$	17	$14 X 10^3$	0
8	$28 X 10^5$	$16 X 10^3$	18	$20 X 10^5$	0
9	$26 X 10^5$	$11 X 10^3$	19	$14 X 10^5$	0
10	$18 X 10^3$	0	20	$12 X 10^5$	0

Table 3. APC and CC results of goats' milk samples collected from omdurman locality

Sample No.	APC CFU/ml	CC CFU/ml	Sample No.	APC CFU/ml	CC CFU/ml
1	$23X 10^5$	0	11	$18 X 10^3$	0
2	$22X 10^5$	0	12	$12 X 10^3$	0
3	$26X 10^5$	0	13	$24 X 10^5$	0
4	$24X 10^5$	0	14	$26 X 10^5$	0
5	$28X 10^5$	0	15	$11 X 10^3$	0
6	$25X 10^5$	0	16	$10 X 10^3$	0
7	$26X 10^5$	0	17	$10 X 10^3$	0
8	$22X 10^5$	0	18	$28 X 10^5$	0
9	$19X 10^5$	0	19	$18 X 10^3$	0
10	$21X 10^5$	0	20	$14 X 10^5$	0

Table 4. Comparison between apc and cc results of goats' milk samples in different localities of khartoum state

Locality	No. of samples	Mean APC CFU/ml	Mean CC CFU/ml
Khartoum	20	$25X10^5$	$10X10^3$
Bahri	20	$20X10^5$	$14X10^3$
Omdurman	20	$21X10^5$	0

3.4 Comparison between APC and CC Results of Goats' Milk Samples in Different Localities of Khartoum State

The mean of APC of goat's milk samples was almost the same in the 3 Localities. It was $25X10^5$CFU/ml in Khartoum Locality,$20X10^5$CFU/ml in Bahri Localityand $21X10^5$CFU/ml in Omdurman Locality.

Coliforms were only detected in goat's milk samples collected from Khartoum and Bahri Localities with the means CC of $10X10^3$CFU/ml and $14X10^3$CFU/mlrespectively (Table 4).

4. DISCUSSION

Goat milk can easily get contaminated and spoiled due to poor hygienic conditions maintained at 'on farm' levels or due to improper handling, inadequate storage and transport conditions encountered. The reported outbreak of foodborne illness on consumption of raw goat milk has been attributed to presence of favorable nutrients, which in turn encourages the growth and proliferation of microorganisms [16].

In this study the mean of APC of goat's milk samples was almost the same in the 3 Localities of Khartoum State. It was $217X10^5$CFU/ml in Khartoum Locality, $197X10^5$CFU/ml in Bahri Locality and $210X10^5$CFU/ml in Omdurman Locality. According to [17], Total Bacterial Count of goat's milk in Europe should not exceed 10^4 CFU/ml. While in United States, bacterial count in goat milk is allowed up to 10^5CFU/ml. [18] reported similar results of total microscopic count of goat's milk in Khartoum State which ranged between $7.8x10^5$ to $38.1x10^5$ cell/ml. Also [19] reported similar results for goat's milk samples collected in Egypt. [20] reported the TPCof 10^5/ml in Penang Island, Malaysia andthat matched Malaysians Food Act 1983 and Food Regulations 1985, which states that the load of total bacteria should not exceed 10^5/ml. Relatively lower counts were reported by [21] ($3.98×104$CFU/ml) in goat milk samples collected from Switzerland, while comparatively higher counts were recorded by [22] (107 to 109 CFU/ml) in Egypt.

Coliform counts as thousands CFU/ml may indicate a problem of dirty goats being milked; an unclean udder, unsanitary milking practices, or milk contamination in the container [23]. In this study coliforms were only detected in goat's milk samples collected from Khartoum and Bahri Localities with the means CC of $10X10^3$CFU/ml and $14X10^3$CFU/ml respectively. [24] has stipulated that coliforms count should be not more than 10^2/ ml. goat's milk. [18] reported thatcoliform organisms were found in few numbers of goat's milk samples collected from Khartoum State. [19] reported coliforms in goat's milk samples collected from Egypt, with mean count values of $2.53±0.57×10^6$ and $1.67±0.87×10^5$CFU/ml. Comparatively lower findings were recorded by [25] in goat's milk

samples collected from Switzerland. Comparatively lower coliform counts were recorded by [22] for raw goat's milk collected from Egypt.

5. CONCLUSION AND RECOMMENDA-TIONS

From this study we can conclude that PCA results of goat's raw milk in Khartoum State were within the international standards of goat milk. Coliforms were found only in Khartoum and Bahri Localities and not found in Omdurman Locality. Following of good hygienic practices 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 pathogensin goat's milk. Revision of the Sudanese Standards requirements for raw goat's milk to cover all aspects of microbiological criteria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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