



Assessment of Bacterial Loads of Camel Milk from Farms and Sale Points in Khartoum State, Sudan

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ABSTRACT

This study was carried out to evaluate raw camel milk from two sources that include farms and sale points in Khartoum State. Fifty milk samples were collected during summer and winter seasons from different farms and sale points. The milk samples were examined for total bacterial counts (TBC), coliform count and psychrotrophic count. The TBC, coliform and psychrotrophic count of camel milk samples were higher during summer season (\log_{10} 4.6 ± 0.08 , \log_{10} 3.4 ± 0.09 and \log_{10} 0.8 ± 0.1 , respectively). Moreover, the counts of TB and coliform were higher in the milk samples collected from the dairy farms (\log_{10} 4.33 ± 0.0 and \log_{10} 3.1 ± 0.09 , respectively). However psychrotrophic bacteria was higher in the milk samples collected from the sale points (\log_{10} 0.9 ± 0.16). The milk samples collected from different sources showed significant ($P \leq 0.001$) differences in TBC, coliform and psychrotrophic counts. In addition, during the different seasons the bacterial loads revealed highly significant ($P \leq 0.001$) differences. Generally the quality of milk obtained from farms and collection points was good, although the bacterial load was higher during summer. Hence, the study suggested that more efforts are needed to improve milk hygiene and quality by regular monitoring, raising awareness among camel's owners and initiation of collection centers equipped with cooling facilities.

Key words: Camel milk, Farms, Sale points, Season, Bacterial load

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INTRODUCTION

Keeping camel under nomadic production system was well recognized in the eastern region where camel exists such as Kenya and Ethiopia (Bekele *et al.*, 2002 and Mehari *et al.*, 2007) as well as in Sudan (Musa *et al.*, 2006 and Shuipep, *et al.*, 2014). However Hammadi *et al.* (2010) reported on the existence of intensive camel dairy farms in Tunisia. Intensive camel dairy production system in Sudan, is limited (Babiker and El Zubeir, 2014).

Most of the consumers in Sudan use raw milk without cooling (Elmagli and

El Zubeir, 2006). Raw camel milk may contain some potential pathogens (Yaqoob and Nawaz, 2007; Shuipep *et al.*, 2007; Shuipep *et al.*, 2009). Investigations showed that camel milk is highly contaminated when milked under nomadic conditions (Khedid *et al.*, 2003; Shuipep *et al.*, 2007). Because of its properties, camel milk bacteriology is relevantly different in comparing to milk from other species (Semereab and Molla, 2001; Karimuribo *et al.*, 2005). Karimuribo *et al.* (2005) stated that the lack of awareness on health risks associated with milk consumption among

nomadic communities needs to be addressed in order to safeguard their health.

Total bacteria of camel milk is reported with values that vary between 10^2 - 10^8 cfu/ml and if the total bacterial count is low, raw milk was observed not to turn sour for 4 days, when it kept in a clean container and in a refrigerator (Younan, 2004). El-Ziney and Al-Turki (2007) examined the microbiological quality and safety of raw camel milk from different farms in Qassim region (Saudi Arabia) and found the total bacteria count, psychrotrophic and coliform were 5.0, 3.8, and 1.4, respectively. Benyagoub *et al.* (2013) in southwest Algeria studied the microbiological and physicochemical quality of camel milk, counts showed, total coliform was 6.75, while fecal coliform was 4.41. Mohamed and El Zubeir (2014) found the total bacterial count, coliform count and thermotrophic bacterial count in raw camel milk samples were 3.02×10^{10} - 3.2×10^{10} cfu/ml, 1.1×10^7 - 1.4×10^7 cfu/ml and 1.3×10^8 to 1.8×10^8 , respectively. Similarly samples of camel milk were collected from different zones of Al-Ahsa area revealed log total bacteria count and coliform of 4.9 and 1.3×10^7 and 7×10^7 , respectively (El-Demerdash and Al-Otaibi, 2012).

MATERIALS AND METHODS

This study was carried out in Khartoum State, Sudan. Twenty five samples of raw camel milk were collected from the sale points and 25 raw camel milk samples from the collection points. The samples were collected during summer and winter seasons in order to study the bacteriological quality of camel milk samples.

Collection of camel milk samples: The samples were collected into clean sterile bottles and transported in an ice-

box (4-5°C) to the laboratory of the Department of Dairy Production, Faculty of Animal Production, University of Khartoum for the analysis.

Examination of camel milk samples:

Plate count agar no. 298 (Bio-mark Laboratories) was used for enumeration of TBC and psychrotrophic count (Houghtby *et al.*, 1992). Mac Conkey agar no. 779 (Bio-mark Laboratories) was used for enumeration of coliform count (Christen *et al.*, 1992). Plates for enumeration of TBC and coliform were incubated at 32°C for 48 hrs and 37°C for 24 hrs, respectively. Plates for enumeration of psychrotrophic count were incubated at 7°C for 10 days. The developed colonies were counted using manual colony counter. The plates counting 25-250 colonies were selected as described by Houghtby *et al.* (1992). The number of reciprocal of the dilution factor was recorded as cfu (Marshall, 1992).

Statistical analysis: The obtained data was analyzed by factorial design using Statistical Packages for Social Sciences (SPSS version 11.5, 2004) computer program

RESULTS AND DISCUSSION

The total bacterial count in raw camel milk samples collected during winter season was lower than summer season (Table 1). These results supported Shuiep *et al.* (2007) who reported that TBC of camel milk was higher during winter than summer season. The total bacteria count of raw camel milk samples was higher than that reported by Semereab and Molla, 2001; Shuiep *et al.*, 2007 and Mohamed and El Zubeir, 2014). The high total counts indicate low quality of some raw camel milk, which may be due to milking procedures (Shuiep *et al.*, 2007).

Camel milk samples collected from different sources showed significant

differences (Table 2). This might be due to growth of microbes as the milk is stored at room temperature and for long time after milking. Nevertheless, the results are consistent with those reported by Shuiep *et al.* (2007) who stated that most of camel owners

practiced less hygiene during milking and storage of their milk.

The coliform in milk samples collected during different seasons revealed highly significant differences; it was higher during summer (Table 1).

Table 1: Comparison of bacteriological load of camel milk samples collected during winter and summer in Khartoum State

Bacterial loads	Seasons	Minimum	Maximum	Mean ±SE	Sig (level) P-value
Log total bacterial count	Winter	3.5	3.8	3.7±0.08	0.001***
	Summer	4.4	4.8	4.6±0.8	
Log coliform count	Winter	2.2	2.6	2.4±0.09	0.001***
	Summer	3.2	3.6	3.4±0.09	
Log psychrotrophic count	Winter	0.1	0.7	0.8±0.1	0.07 ^{NS}
	Summer	0.5	1.1	0.8±0.1	

NS = non-significant

***= highly significant at $P \leq 0.001$

In addition, the samples collected from the different sources revealed high significant differences (Table 2). Contamination of coliform may be the result of a rapid increase in fecal flora initially present in raw milk that can be transmitted by the milker's hands and the animal during milking (Shuiep *et al.*, 2007 and Mohamed and El Zubeir, 2014). Moreover Chye *et al.* (2004) reported that the high coliform and other pathogens in milk are related to water cleaning and utensils used in the production of milk. This might be because, most of the producers of camel milk use water from resellers, which increase the risk of microbial contamination (Katinan *et al.*, 2012). Also it could be due to the lack of good practices and sanitation at the treatment, collection, transportation and storage of raw camel milk (Benyagoub *et al.*, 2013). The coliform bacterial count of raw camel milk samples was higher than that reported previously. Benkerroum *et al.* (2003) reported that coliform bacteria were not detected in 1 ml of some camel milk samples. In addition Semereab and Molla (2001) found that coliform

count in more than half of camel milk samples was less than 10 cfu/ml. Khedid *et al.* (2003) indicated that coliforms were the most abundant microorganisms in camel milk and they ranged from less than 1 cfu/ml to 8×10^4 cfu/ml. Shuiep *et al.* (2007) reported that the mean coliform bacterial count of camel milk samples collected from Khartoum State was 1.70×10^7 cfu/ml. The high coliform count in some milk samples could be due to contamination and transmission of mastitis infection from cattle as some camels are kept in the dairy farms (Shuiep *et al.*, 2007).

Psychrotrophic bacteria found in camel milk samples collected during the different seasons showed non significant differences (Table 2). However, the value was lower than that (3.8 log cfu/ml) reported by El-Ziney and Al-Turki (2007) in Saudi Arabia. Derar and El Zubeir (2013) also found the value of psychrotrophic bacteria was 8.69×10^5 and Mohamed and El Zubeir (2014) reported a mean of 1.7×10^8 for psychrotrophic bacteria in camel milk samples.

Table 2: Comparison of bacteriological loads of camel milk samples collected from farms and sale points in Khartoum State

Bacterial loads	Sources	Minimum	Maximum	Mean ±SE	Sig-level P-value
Log total bacterial count	Farms	4.1	4.5	4.33±0.08	0.001***
	Sale points	3.8	4.1	4.02±0.08	
Log coliform count	Farms	2.9	3.3	3.1±0.09	0.001***
	Sale points	2.5	2.8	2.7±0.09	
Log psychrotrophic count	Farms	0.6	1.2	0.3±0.16	0.07 ^{NS}
	Sale points	0.03	0.7	0.9±0.16	

NS = non significant

***= highly significant at $P \leq 0.001$

The present study concluded that most of camel milk samples studied, obtained an acceptable bacteriological quality. The present study recommended that milk should be cooled immediately after milking, during transportation and storage to eliminate the growth multiplication of microorganisms. Moreover heat treatment for camel milk should be encouraged by establishment of collection centers and mobile dairy factories for processing of clean and safety camel milk in the production areas. Also it is necessary to increase the awareness on health risks associated with consumption of raw camel's milk.

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How to cite this paper:

- Warsma, L.M., and El Zubeir, I.E.M. (2015). Assessment of Bacterial Loads of Camel Milk from Farms and Sale Points in Khartoum State, Sudan. *Sud. J. Sci. Tech.* **16**(Suppl.): 118-123.