International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 16, No. 5, p. 336-344, 2020

INNSPUB

RESEARCH PAPER OPEN ACCESS

Microbiology of raw milk collected from different vending sources in Shendi area, River Nile State, Sudan

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Key words: Raw milk, Microbiology, Vending source, Bacterial isolation

http://dx.doi.org/10.12692/ijb/16.5.336-344 Article published on May 30, 2020

Abstract

This study was conducted to evaluate the microbiological quality of raw milk collected from different sources in Shendi area, River Nile State, Sudan. A total of 120 raw milk samples were collected from dairy farms (30 samples), milk vending shops (30 samples), pickup trucks (30 samples) and vendors on donkey cart (30 samples). The samples were transported to the microbiology laboratory at 4°C for microbiological examination (total viable bacteria, coliform bacteria and *Staphylococcus aureus*) in addition to isolation and identification of some bacteria. Results showed that total viable bacteria count (TVBC), total coliform bacteria count (TCC) and *Staphylococcus aureus* count were high in raw milk from vendors on donkey cart (log 8.09±0.270, log 6.01±0.189 cfu/ml and log 6.12±0.404 cfu/ml, respectively), and low in milk from pickup trucks (log 7.93±0.337 cfu/ml, log 5.89±0.110 cfu/ml and log 5.84±0.131 cfu/ml, respectively). During the study, several bacteria were isolated from raw milk of different sources and these included *Streptococcus epidermidis*, *Escherichia coli*, *Bacillus* spp., *Klebsiella* spp., *Pseudomonas aeruginosa*, *Salmonella paratyphi* and *Citrobacter diversus*. The study concluded that the raw milk of different vending sources was contaminated with microorganisms and it is recommended that this practice should be avoided as much as possible.

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Introduction

As a complex biological fluid, milk is a good medium for growth of many microorganisms, which may originate from different sources such as air, milking equipment, feed, soil, faeces and grass, and so it is an important vehicle for transmitting milk-borne pathogens to humans (Coorevits *et al.*, 2008; Senarath and Adikari, 2017). The bulky nature and nutritional characteristics of milk attract microbes that contribute to its perishability, and this creates a need to ensure that small-scale farmers produce clean milk, as this depends on milking environment, milkers' hygiene, teats, and containers used for milk storage (John, 2016). Milk sold in the market as raw is much below standards in hygiene, and its bacteriological quality needs to be carefully monitored regarding the number and types of microflora present (Singh and Shankar, 2017). Milk is sterile in healthy udder cells and does not contain microorganisms in the mammary gland at the site of its secretion unless there is an intramammary infection and/or the animal has a systemic disease, but as soon as the milk is excreted, it is immediately contaminated with microorganisms that naturally dwell in the teat skin and the epithelial lining of the teat canal (Tekilegiorgis, 2018).

Milk is a good medium for the growth of various microorganisms, especially bacterial pathogens such as species of *Bacillus, Listeria monocytogenes, Salmonella, Streptococcus, Staphylococcus, Campylobacter, Escherichia, Klebsiella,* which may cause milk-borne diseases such as tuberculosis, brucellosis and gastroenteritis (Ruangwittayanusorn *et al.*, 2016).

Due to its characteristics, milk deserves special attention during its production, processing, marketing, and consumption, and several factors may influence the microbiological quality of milk products such as the health of the herd, sterility of the cleaning equipment and utensils, the health conditions of the milking place, the excretion from the udder of an infected animal and quality of water used in the farm (Nwankwo *et al.*, 2015). However, despite the fact that modern technology is used for milk production, many milk producers still use non-specialized methods resulting in poor-quality raw milk (Nwankwo *et al.*, 2015). The chain of people involved in dairy production in under-developed countries extends from milk production farms (farmers, farmworkers, and veterinarians) and transportation of milk to the market or small vendors to reach the final consumers either through milk vendors or from shops (Rahamtalla *et al.*, 2016). To protect public health against milk-borne infections, there are regulations for proper hygiene handling of milk and its pasteurization, but in under-developed countries, such regulations are not usually adhered to, hence milk-borne health risk is greater (Rahamtalla *et al.*, 2016).

In Sudan, raw milk distributed for consumption is not subjected to proper quality control measures (Mohamed and ElZubeir, 2007). In Khartoum State, 95% of milk is distributed as raw to the consumers (Salman and Hamad, 2011). Moreover, most of the milk producers in Khartoum State are unaware of the effect of animal health and environmental conditions on producing safe milk due to absence of full certification of employees, absence of staff and technicians, retardation of milk production and processing system and lack of training and extension programs (Abdalla and Elhagaz, 2011).

This study is conducted to evaluate the level of microbiological contamination of raw milk collected from different milk distributing channels around Shendi area, River Nile State, Sudan.

Materials and methods

Milk collection and sampling

One hundred and twenty (120) samples of raw milk were collected randomly from four different sources in Shendi area (30 samples from dairy farms, 30 samples from milk vending shops, 30 samples from vendors on donkey carts and 30 samples from pickup trucks).

The samples were collected in sterile containers and transported in an icebox at 4°C to the microbiology laboratory and analyzed for total viable bacteria (TVB), coliform bacteria and *S. aureus* counts, in addition to isolation and identification of some pathogenic bacteria.

Microbiological examination

Preparation of sample dilutions

Eleven milliliters (11mL) of raw milk were added to 99mL sterile distilled water and mixed to make 10^{-1} dilution, then 1mL from the above-mentioned dilution (10^{-1}) was added to 9mL sterile distilled water to make 10^{-2} dilution. This process was repeated to make serial dilutions of up to 10^{-8}.

Enumeration of bacteria

The bacterial count was determined according to Houghtby *et al.* (1992) using a standard plate count agar. The plates were incubated at 32°C for 48 hr and colonies were counted (Cheesbrough, 2006). *S. aureus* count was determined using mannitol salt agar medium. The plates were incubated at 37°C for 48 hr and colonies were counted (Cheesbrough, 2006). Total coliform bacteria count was determined using MacConkey agar medium, the plates wereincubated at 37°C for 45 hr and the colonies were counted (Cheesbrough, 2006).

Purification of identification of organisms

Purification was carried out by sub-culturing of a well isolated typical colony on nutrient agar medium for 24 hr, and the plates were checked by Gram stain, then the colonies were transferred to a plate containing a fresh solidified corresponding medium (Barrow and Feltham, 1993). The purified isolates were identified by Gram staining, oxidase test, catalase test, motility test, Kligler's iron agar (KIA) test, DNase test (for Gram +ve cocci), indole production test, citrate utilization test, starch hydrolysis test, coagulase test, gelatin hydrolysis test and reaction on blood agar (Barrow and Feltham, 1993).

Statistical analysis

Data analysis was carried out by Statistical Analyses Systems (SAS, ver. 9). General linear models (GLM) were used to determine the effect of source and sample number on the microbiological characteristics of raw milk. Mean separation was done by Duncan's multiple ranges test ($P \leq 0.05$).

Results and discussion

The use of plastic containers for milk storage by farmers and vendors can compromise milk quality since plastic can easily crack and these cracks harbour spoilage bacteria and are difficult to clean, thus the stainless steel and aluminum cans are advised in milk storage as they are easily cleaned (John, 2016). It is very important to wash the udder correctly by using unperfumed soap and Luke warm water followed by drying with a clean cloth (De Silva *et al.*, 2016). The use of unclean milking and transport equipment also contributes to the poor hygienic quality of the milk. The quality deterioration of raw milk had an effect on the quality of finished products microbially, organoleptically and chemically as well as its shelf life (De Silva *et al.*, 2016).

The mean TBVC of milk did not show a significant ($P>0.05$) difference among the different sources, although the higher count was in milk from vendors on donkey cart (log 8.09±0.270 cfu/ml), followed by milk from dairy farms (log 8.01±0.307 cfu/ml), milk vending shops (log 7.99±0.275 cfu/ml) and pickup trucks (log 7.93±0.337 cfu/ml)(Table 1). The range of TVBC of samples from dairy farms, vending shops, pickup trucks and vendors on donkey cart were log 7.34±0.67 - 8.39±0.92 cfu/ml, log 7.71±0.88 - 8.51±0.86 cfu/ml, log 7.33±0.09 - 8.50±0.92 cfu/ml and log 7.70±0.70 - 8.51±0.09 cfu/ml, respectively (Tables 2 and 3). Similar results were reported by Kas *et al.* (2013) and Worku *et al.* (2012). Gemechu *et al.* (2014) reported that the total bacterial count was significantly ($P<0.05$) higher in milk from dairy cooperative milk collection centers and hotels compared to small shops and small-scale producers, and they attributed this to further contamination of milk from dairy cooperatives during transportation, use of poorly cleaned milk containers and absence of cooling systems in milk selling points. These results are slightly lower than those of Rahamtalla *et al.* (2016) who reported a significant ($P<0.001$) variation in total viable bacteria count from pickup trucks (log 9.22±0.84 cfu/ml), farms (log 9.06±0.64 cfu/ml) and venders on donkey cart (log 8.82±0.84 cfu/ml), and Edward and Inya (2013) who reported a total heterophilic count of log 8.99 cfu/ml in milk from different locations in Nigeria. Karthikeyan and Pandiyan (2013) reported lower total viable count of milk samples obtained from local vendors ($16x10^{4}$-$2.71x10^{5}$ cfu/ml), private manufacturers ($1.7x10^{2}$ - $2.9x10^{4}$ cfu/ml) and organized dairies ($7x10^{2}$ - $4x10^{3}$ cfu/ml). Gwandu *et al.* (2018) outlined that the mean total viable count (TVC) of milk container surfaces was log 9.7±10.5 cfu/ml, while total coliform count (TCC) was log 7.8±8.5 cfu/ml. Up to 55.1% of milk had TVC beyond the recommended levels. The average TVC was log 11.02±11.6 cfu/ml and TCC was 6.7±7.3 log cfu/ml. Up to 26.5% of milk samples had the TCC beyond levels. The higher bacterial count which exceeded the microbiological criteria applicable to raw milk indicates substandard hygienic conditions practiced during production and subsequent handling which include poor hygiene during milking or equipment used for milking and udder infection of the cow (Ali *et al.*, 2010; Farougou *et al.*, 2012; Shunda *et al.*, 2013).

The bacteria can enter the milk while it is still in the udder and most microorganisms found in raw milk are contaminants from the udder outer surface, milking utensils or vendors (Farougou *et al.*, 2012). Elzubeir and Ahmed (2007) reported that the higher total bacterial count of $2.6x10^{10}$ cfu/ml, which exceeded the international standards of raw milk, could be due to unsatisfactory hygiene and control measures and the health supervision applied to the farms. Orregard (2013) reported a significant difference between farmers and agents, and between farmers and shop's milk, while no significant difference was observed between small-scale and large-scale agents' milk in terms of total bacterial counts. Previous results revealed that higher microbial counts for SPC and TCC were observed in chilling centers, transportation vessels, and farmers when compared to the standards.

Table 1. Microbiological quality (cfu/ml) of raw milk collected from different milk sources (means±SD).

Source of milk	Total viable bacteria	Total coliform bacteria	*S. aureus*
Dairy farms	8.01±0.307^{a}	5.96±0.238^{a}	5.99±0.190^{a}
Milk vending shops	7.99±0.275^{a}	5.95±0.165^{a}	5.98±0.477^{a}
Pickup trucks	7.93±0.337^{a}	5.89±0.110^{a}	5.84±0.131^{a}
Vendors on donkey cart	8.09±0.270^{a}	6.01±0.189^{a}	6.12±0.404^{a}
CV (%)	20.02	23.79	21.12
SL	NS	NS	NS

Means in each column bearing similar superscripts are not significantly different (P>0.05)
NS = Not significant
SL = Significance level
SD = Standard deviation
CV = Coefficient of variation

Table 2. Microbiological quality (cfu/ml) of raw milk samples collected from dairy farms and vending shops (mean±SD).

Sample No.	Milk distribution channels					
	Dairy Farms			Vending Shops		
	Total viable bacteria	Total coliform bacteria	*S. aureus*	Total viable bacteria	Coliform bacteria	*S. aureus*
1	8.27±0.24^{a}	ND	6.11±0.69^{a}	8.17±0.97^{ab}	5.85±0.75^{b}	5.64±0.86^{c}
2	8.39±0.92^{a}	ND	6.13±0.77^{a}	7.71±0.88^{b}	6.09±0.71^{ab}	5.71±0.83^{c}
3	8.37±0.74^{a}	ND	6.13±0.68^{a}	8.40±0.13^{a}	5.95±0.81^{b}	5.85±0.74^{c}
4	7.85±0.04^{b}	ND	5.83±0.77^{a}	7.89±0.97^{b}	5.81±0.84^{b}	5.56±0.05^{c}
5	7.86±0.83^{b}	ND	5.83±0.87^{a}	7.88±0.65^{b}	5.91±0.87^{b}	5.82±0.04^{c}
6	7.34±0.67^{c}	5.61±0.90^{a}	5.96±0.90^{a}	7.76±0.86^{b}	6.34±0.81^{b}	6.11±0.72^{b}
7	8.04±0.10^{a}	6.08±0.73^{a}	5.95±0.88^{a}	8.51±0.86^{a}	5.89±0.97^{b}	5.85±0.74^{c}
8	7.91±1.60^{b}	6.12±0.73^{a}	5.95±0.87^{a}	7.79±0.82^{b}	5.79±0.77^{b}	6.14±0.82^{b}
9	8.00±1.02^{a}	6.17±0.70^{a}	6.36±0.16^{a}	7.96±0.80^{b}	5.84±0.80^{b}	7.23±0.09^{a}
10	8.04±1.94^{a}	5.82±0.73^{a}	5.71±0.89^{b}	7.86±0.83^{b}	5.99±0.86^{b}	5.85±0.75^{c}
SL	*	NS	NS	***	**	*

Means in each column bearing similar superscripts are not significantly different (P>0.05)
The data are means of three replicates (n = 3)
*** = P<0.001
** = P<0.01
* = P<0.05
NS = Not significant
SL = Significance level
SD = Standard deviation

Table 3. Microbiological quality (cfu/ml) of raw milk samples collected from pickup trucks and vendors on donkey cart (mean±SD).

Sample No.	Milk distribution channels					
	Pickup trucks			Vendors on donkey cart		
	Total viable bacteria	Total coliform bacteria	*S. aureus*	Total viable bacteria	Total coliform bacteria	*S. aureus*
1	7.66±0.72[b]	5.90±0.81[a]	5.72±0.64[a]	8.30±0.92[a]	5.85±0.02[a]	5.67±0.82[b]
2	8.31±0.10[a]	5.76±0.96[a]	6.19±1.00[a]	7.70±0.70[b]	5.97±0.79[a]	5.73±0.86[b]
3	8.19±1.00[a]	5.77±0.80[a]	5.83±0.72[a]	7.82±0.73[ab]	6.22±0.74[a]	6.43±0.21[ab]
4	8.50±0.92[a]	5.90±0.82[a]	5.86±0.68[a]	7.95±0.88[ab]	6.13±0.65[a]	6.21±0.91[ab]
5	7.93±0.77[ab]	5.95±0.81[a]	5.84±0.80[a]	8.51±0.09[a]	6.11±0.87[a]	5.98±0.93[b]
6	7.87±0.64[ab]	5.96±0.02[a]	5.75±0.77[a]	8.33±1.00[a]	6.00±0.99[a]	7.04±0.59[a]
7	7.94±0.62[ab]	6.12±0.67[a]	5.82±0.04[a]	8.18±0.07[a]	5.59±1.00[a]	5.99±0.84[b]
8	7.33±0.09[b]	5.82±0.78[a]	5.76±0.10[a]	7.86±0.90[ab]	5.93±0.77[a]	5.78±0.74[b]
9	7.74±0.71[b]	5.91±0.75[a]	5.82±0.10[a]	8.33±0.16[a]	6.11±0.77[a]	6.22±0.75[ab]
10	7.81±0.75[ab]	5.79±0.83[a]	5.79±0.77[a]	7.96±0.87[ab]	6.20±0.77[a]	6.18±0.75[ab]
SL	***	NS	NS	**	NS	*

Means in each column bearing similar superscripts are not significantly different (P>0.05).
The data are means of three replicates (n = 3)
*** = P<0.001
** = P<0.01
* = P<0.05
NS = Not significant
SL = Significance level
SD = Standard deviation

The SPC and TCC showed a significant difference (P<0.05) between low and high-risk chilling centers, low and high-risk farmers, chilling centers and transportation vessels and chilling centers and farmers (Senarath and Adikari, 2017). The mean total bacterial count of raw milk samples collected from the local producers, collectors, and dairy markets was $5x10^3$ - $3.18x10^8$ cfu/ml (Tekilegiorgis, 2018).

The TCC of milk from different sources indicated a non-significant variation (P>0.05), although the higher count was in milk from vendors on donkey cart (log 6.01±0.189 cfu/ml), and the lower count was in milk from pickup trucks (log 5.89±0.110 cfu/ml) (Table 1). Coliform bacteria were not detected in some samples (samples 1-5), and in other samples, the count ranged between log 5.61±1.90 and log 6.17±0.70 cfu/ml in milk from dairy farms, while in milk from vending shops the count was log 5.81±0.84 - 6.34±0.81 cfu/ml, and in samples from pickup trucks and vendors on the donkey cart, the count was log 5.76±0.96 - 6.12±0.67 cfu/ml and log 5.59±1.00 - 6.22±0.74 cfu/ml respectively (Tables 2 and 3). Mohamed *et al.* (2017) found a lower mean value of coliform counts (log 3.91 cful/ml) in raw milk collected from farmers and dairy producers in Djibouti, which was higher than the maximum recommended value. The results in this study are in disagreement with these of Rahamtalla *et al.* (2016) who reported that coliform bacteria count was significantly higher (P<0.001) in milk form pickup trucks followed by farms and vendors on the donkey cart. Fresh milk collected from different sources is heavily contaminated and possible reasons for this could be due to infected udders, unhygienic procedures or equipment and/or inferior microbiological quantity of water used for cleaning utensils and animals as well as milk storage conditions (Ali *et al.*, 2010).

The presence of high numbers of coliforms in milk provides an index of the hygienic standard used in the production of milk or unclean udder and teats can contribute to the presence of coliforms from a variety of sources such as manure, soil, feed, personnel and even water (Farougou *et al.*, 2012; Hadrya *et al.*, 2012). Orregard (2013) stated that farmers' milk had significantly (P<0.001) lower coliform counts than agents' milk and milk from shops implying that farmers' milk is of better quality. Karthikeyan and Pandiyan (2013) reported that coliform bacteria count was higher in milk from local vendors ($3x10^2$ - $2.9x10^3$ cfu/ml) compared to private manufactures ($1x10^2$ - $6.0x10^2$ cfu/ml) and organized dairies

(1.0x10² - 3.0 x10² cfu/ml). Gemechu *et al.* (2014) reported that coliform bacteria count was significantly higher in milk from dairy cooperatives compared to hotels, small shops and small-scale milk producers. Singh and Shankar (2017) reported that the coliform count of samples from milk vendors was log 3.33 - 4.65 cfu/ml, with a mean of log 4.01±0.1413 cfu/ml, while the count of milk samples from vending shops was log 3.46 - 5.39 cfu/ml, with a mean of log 4.36± 0.180 cfu/ml. The total coliform count of raw milk samples collected from the local producers, collectors, and dairy markets were 1.81x10² - 3.08x10⁶ cfu/ml (Tekilegiorgis, 2018).

Staphylococcus aureus count was high (log 6.12±0.404 cfu/ml) in milk from vendors on donkey cart, followed by dairy farms (log 5.99±0.190 cfu/ml), milk vending shops (log 5.98±0.477 cfu/ml) and pickup trucks (log 5.84±0.131 cfu/ml) although the difference was not significant (Table 1). *S. aureus* count ranged between log 5.71±0.89 cfu/ml and log 6.36±0.16 cfu/ml in dairy farms, while in milk from vending shops, pickup trucks and vendors on donkey cart the count was log 5.56±0.05 –7.23±0.09 cfu/ml, log 5.72±0.64 –6.19±1.00 cfu/ml and log 5.67±0.82 – 7.04±0.59 cfu/ml, respectively (Tables 2 and 3).

Table 4. Number of isolates and prevalence (%) of different bacterial species in raw milk collected from dairy farms and vending shops.

Bacterial species	Milk distribution channels			
	Dairy Farms		Vending Shops	
	Number of isolates	Prevalence (%)	Number of isolates	Prevalence (%)
Staphylococcus aureus	36	60	17	26.2
Bacillus spp.	0	0	17	26.2
Escherichia coli	9	15	15	23.0
Klebsiella spp.	0	0	14	21.5
Streptococcus epidermidis	15	25	2	3.1
Total	60	100	65	100

The results in this study are higher than those of Khan *et al.* (2008) who reported staphylococcal count of log 2.812 -2.988 cfu/ml in raw farm milk, Hadrya *et al.* (2012) who reported an average *S. aureus* count of 1.4x10⁵ cfu/ml in informally marketed raw milk, and slightly lower than those of Ali *et al.* (2010) who reported *S. aureus* count of log 7.08 cfu/ml in raw milk collected from Khartoum North city, Sudan. Rahamtalla *et al.* (2016) reported that *S. aureus* count was significantly (P<0.001) higher in milk from pickup trucks, followed by milk from vendors on the donkey cart and milk from farms. Kas *et al.* (2013) reported a count of 3.0 x10² – 6.5 x10³ cfu/ml in raw cow's milk. Orregard (2013) reported that *S. aureus* count in the shops' milk was significantly (P<0.001) higher than milk from farmers, and there was no significant difference in the count between the milk of small-scale and large-scale agents, neither was there any significant difference between agents' and shops' milk. *S. aureus* is recognized as a causative agent of clinical and subclinical mastitis (Farougou *et al.*, 2012), and the presence of *S. aureus* in milk is related to environmental conditions and the tropical climate seriously disposes animals to infection by the pathogen *E. coli* (Afif *et al.*, 2008; Fook *et al.*, 2004). Out of 160 raw milk samples collected from 80 dairy herds in Northern China, 52.50% were *S. aureus* positive, and that the prevalence of *S. aureus* was influenced by season, herd size, milking frequency and disinfection frequency (Lan *et al.*, 2017). The microbiological analysis of samples from all direct sale points revealed that *Staphylococcus* spp. were found in all milk samples with a count ranging from 1.6 × 10³ to 5.1 × 10⁴ cfu/mL (Pyz-Lukasik *et al.*, 2015).

During the study, several bacteria were isolated from milk of different sources. In addition to *S. aureus*, *Streptococcus epidermidis* (25%) and *E. coli* (15%) were isolated from milk from farms, while *Klebsiella* spp. (22%), *S. epidermidis* (16%), *Salmonella paratyphi* (4%) and *Citrobacter diversus* (2%) were isolated from milk of vending shops, *Bacillus* spp. (26.2%), *Klebsiella* spp. (21.5%) and *S. epidermidis* (3.1%) were isolated from milk of pickup trucks, and *S. epidermidis* (6.2%), *Klebsiella* spp. (6.2%), *Pseudomonas aeruginosa* (13.8%) and *Bacillus* spp. (43.0%) were isolated from milk of venders on donkey cart (Tables 4 and 5). Shunda *et al.* (2013) isolated *S. aureus* from dairy farms (13.3%), milk vending shops (4.4%) and houses and cafeterias (8.9%), while *Streptococcus* spp. were isolated in percentages of 8.9%, 11.1%, and 6.7% respectively, and *E. coli* was isolated in percentages of 11.1%, 11.1%, and 22.2%, respectively. Elzubeir and Ahmed (2007) isolated *S. aureus*, *E. coli* and *Salmonella* spp from bulk raw milk of some dairy farms in Khartoum State.

Table 5. Number of isolates and prevalence (%) of different bacteria species in raw milk collected from pickup trucks and vendors donkey cart.

Bacterial species	Milk distribution channels			
	Pickup trucks		’endors on donkey cart	
	umber of isolates	Prevalence (%)	umber of isolates	Prevalence (%)
S. aureus	10	15.4	14	28
E. coli	10	15.4	14	28
Streptococcus epidermidis	4	6.2	8	16
Klebsiella spp.	4	6.2	11	22
P. aeruginosa	9	13.8	0	0
Salmonella paratyphi	0	0	2	4
Citrobacter diversus	0	0	1	2
Bacillus spp.	28	43.0	0	0
Total	65	100	50	100

Mubarak *et al.* (2010) reported that the dominant flora associated with raw milk in Coimbatore district of India was in the order of *Lactobacillus* spp. > *S. aureus* > *E. coli* > *Bacillus* spp. > *Pseudomonas fluoerescens* > *Salmonella* spp. They added that the presence of these bacteria in milk is suggestive of contamination from various sources such as animal, human, environment, utensils, and others. Adjlane-Kaoucke *et al.* (2014) stated that *S. aureus* was detected in 33% of the samples at the end of the collection period. Salman and Hamad (2011) isolated and identified different species of coliforms from vendor and market milk of Khartoum State, Sudan which included *E. coli* (32%), *Enterobacter cloacae* (13.6%) and *Enterobacter aerogenes* (11.3%). Edward and Inya (2013) reported that among the organisms isolated from raw milk *E. coli, S. aureus*, and *Streptococcus* ssp. had a 100% occurrence being present in all samples tested. Worku *et al.* (2012) isolated *E. coli* (12.89%), *Klebsiella pneumaniae* (6.67%), *Klebsiella oxytoca* (5.33%), *S. aureus* (6.78%), *Pseudomonas aeruginosa* (2.67%), *Salmonella typhi* (6%), *Salmonella typhimurium* (5%) and *Critrobacter diversus* (2.78%) from milk drawn directly from cow udder. Msalya (2017) isolated ten groups or species of bacteria from raw milk, and these were *E. coli*, *Salmonella* spp., *Klebsiella* spp. and *Proteus* spp. (four groups of bacteria not identified to species level) in addition to six species including *P. aeruginosa*, *L. monocytogenes*, *L. innocua*, *L. ivanovii*, *S. aureus*, and *B. abortus*. Hassan *et al.* (2015) isolated *E. coli*, *S. aureus*, *Bacillus cereus, E. coli* O157:H7 and *Salmonella* spp. from raw market milk samples collected randomly from different supermarkets and retailer shops in Cairo and Giza governorates.

Conclusion

Milk from pickup trucks was the best having low total bacteria, total coliform bacteria and *S. aureus* counts. The high count of *S. aureus* from all sources which is higher than the standards indicates that the milk is of low quality and may be hazardous to the consumers. In addition, the isolation of pathogenic bacteria such as *S. aureus*, *E. coli*, *Klebsiella* spp., *Salmonella typhimurium*, *Bacillus* spp. also indicates that the milk is produced and distributed under unhygienic conditions, therefore, it is the responsibility of the local authorities to monitor the production and distribution of the milk to reach the consumer with acceptable levels of microorganisms.

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