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ASSESSMENT OF MILK QUALITY SAMPLED ALONG ITS VALUE CHAIN IN NYALA CITY-SOUTH DARFUR STATE, THE SUDAN

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ABSTRACT

The present work was conducted to evaluate the quality of raw milk along its value chain in Nyala city, South Darfur state, the Sudan. A total of (219) milk samples were collected from dairy farms (immediately after milking), groceries (before boiling) and mini markets (without any treatments). The samples were collected in sterile iced containers at about 4°C, and then transferred to the laboratory of Institute of Molecular Biology, University of Nyala for further analysis to assess sensory measures and microbial quality. The results indicated that (55.3%) of samples from dairy farms showed clear appearance, where, (54%) and (38%) of groceries and mini markets milk samples correspondingly had normal appearance. The color assessment as white was 100%, 97.7% and 87% for mini markets, groceries and dairy farms respectively. The results elucidated that normal taste was dominant (74%, 69.4% and 44%) for raw milk samples from groceries, dairy farms and mini markets respectively, however, a few samples from the three sources showed color and taste abnormality. The mean ± standard deviation for standard plate counts SPC (expressed in log 10cfu/ml) for groceries milk samples was significantly ($P<.05$) higher (5.67±0.026) than dairy farms (5.56±0.026) and mini markets (5.59±0.064) ones. The results showed that coliform bacteria were detected in (20%) of mini markets milk samples. Raw milk samples from groceries had revealed highest (25%) coliform numbers of bacterial cells compared with both dairy farms (21%) and mini markets numbers. However, chi square test ($\chi 2=0.667$) declared no significant ($P>.05$) association between source of milk and presence of E.coli. Based on SPC; the raw milk samples collected from the three sources (farms, groceries and mini markets) in the present study is acceptable ,but, still more efforts are needed for dairy farms to apply hygienic measures in raw milk value chain as whole.

Keywords: Raw milk, quality assessment, Nyala, Sudan

1. INTRODUCTION

Milk is considered as one of the most important sources of human food ever known; as well it is a compensatory component of daily diets for aged people, pregnant women and growing children because, it contains all essential nutrients, it is easily digested and absorbed consequently it is so essential for maintenance and fitness of the body. Therefore, Milk is consumed in all cultures all over the world (Abate *et al*, 2015). The majority of the bulk milk yield is in Europe, followed by North America then Africa, (McGee and Harold, 2004).

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According to (MARF, 2012), cattle population in Sudan is estimated to be about 29, 84000 heads which approximately produces only (2,776,000) tons of milk. Generally, in Sudan milk production relies mostly on the traditional sector which produces more than 80% of the raw milk, (Elzubier and Mahala, 2011).

Although Sudan posses huge potential of animal resources and vast agricultural fertile lands, it is still unable to cover its domestic demand of raw milk. Often, there are gaps between demand and milk supplies. This situation has been attributed to a number of factors such as: rapid human population growth rate, rapid increases in per capita incomes and urbanization. Beside, low animal genetic potential of milk production in local cattle breeds, inappropriate technology, unfavorable environmental conditions all together have contributed to poor performance of dairy production. In addition to other management hinders (lack of macro plans and strategies to develop the dairy sub-sector, lack of regulation concerning grades and quality control measures which was the most important obstacle, (Hussein, 2008). The journey of milk from farm to collecting centers, dairy processing plants to consumers involves long turn including ; farms, farm workers, veterinarians and transportation to milk market or small vendors to ultimately reach the final consumers, (Salman and Hamad, 2011). Along this value chain; always raw milk is subjected to some shortcomings such as improper handling, microbial contamination and risk of addition of chemical preservatives to avoid spoilage during the transportation which always take several hours, (Hamza et al,2015). Nyala is the largest city in Western Sudan and ranks the third in terms of population density after Khartoum and Aljazeera states. Its raw milk supply comes from dairy farms raising cross breed dairy cattle around the city and also comes from the adjacent village herds (Bulbul and Kass, about 60 and 100 kg respectively, Western Nyala), (Hamza et al,2015). The milk is distributed to consumers as raw milk and without following any sort of quality control measures which increase the risk of infection by milk born diseases. The present work was undertaken to evaluate the quality of raw milk produced and distributed through different channels in Nyala city- South Darfur state.

2. MATERIALS AND METHODS

Milk Sampling

Purposeful milk samples were collected from different sources in Nyala city namely; dairy farms (100 samples), groceries (92) and from the markets (42). They were collected in 50 ml sterile glass bottles. The samples were labeled, and then preserved in ice box prior transporting them to the laboratory of institute of molecular biology for further analysis. The samples were immediately preserved cool in a refrigerator at 4°C and culturing was commenced within 24 h.

Milk quality assessment

Sensory evaluation (Organoleptic tests):

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Organoleptic tests (color, odder, texture and general appearance) for the raw milk collected from dairy farms, groceries and markets around Nyala city were assessed according to the method described by the method described by(Marshall, 1992).

Microbial assessment

Standard Plate Count (SPC)

Standard Plate Count (SPC) determines the total number of bacteria in a milk sample that can grow and form countable colony forming units on a Standard Methods Agar plate. So, in the present work (SPC) was calculated as follows:
Ten ml of raw milk were taken from each sample then transferred to 90ml sterile peptone water (0.1%) and thoroughly mixed to give 1:10 dilution "first dilution". Serial dilutions were made by transferring 1ml of the previous dilution in 9ml of 0.1% peptone water. Aerobic Bacterial Counts were made by incubating surface plated duplicate decimal dilutions of milk samples on Plate Count Agar (Oxid) plates. Colonies were counted after the culture media is incubated for 48-72 hours. Total number of colonies on plates varied from 30 to 300 per plates was selected and colonies were counted using colony counter.

Data statistical analysis:

Data concerning sensory evaluation were analyzed using descriptive statistics (frequencies and percentages) where, bacterial count results were initially transformed into (log10) prior to statistical analysis and chi square was used to determine the association between source of milk and presence of *E.coli*, utilizing SPSS version 20.

3. RESULTS AND DISCUSSION

Organoleptic tests:

Table (1) shows the evaluation of general appearance for raw milk samples collected from three sources (dairy farms, groceries and markets) in Nyala city. The results indicated that 55.3% of samples from dairy farms showed clear appearance, 54% from groceries and 38% of market milk samples had normal appearance. Dairy farms raw milk samples showed minimum (5.9%) abnormal appearance where, milk samples from mini markets experienced the highest (14%) fault appearance followed by the samples collected from the groceries (11%).

Table (1): Evaluation of general appearance for raw milk collected from groceries, dairy farms and mini markets in Nyala city

Milk source	**Parameters**		
	General appearance		
	Clear	Normal	Fault

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	N	%	N	%	N	%
Groceries	35	35.0	54	54.0	11	11.0
Dairy Farms	47	55.3	33	38.8	5	5.9
Mini-Markets	24	38.0	19	38.0	7	14.0

Screening of color for raw milk samples collected from the three sources (groceries, dairy farms and mini markets) is presented in table (2). It was found that the major color in the tested milk samples in the three sources was white (100%, 97.7% and 87%) for mini markets, groceries and dairy farms respectively. However, few samples were recorded with yellowish coloration, (3 and 14.1%) for samples from groceries and dairy farms respectively. A few (1.2%) reddish color was observed for milk samples from dairy farms which indicates abnormality. The abnormality of color might be due to diseases (mastitis) or adulteration, but generally, there are many factors that affect milk color like genetic and environmental factors. Animals grazing on pasture or fed on green forage tend to yield yellowish milk where those offered concentrate feeds produce white milk, (Bashir et al, 2013).

Table (2): Assessment of raw milk color collected from groceries, dairy farms and mini markets

Milk source	**Parameter**			
	color			
	white		Yellowish	Reddish
	N	%	%	%
Groceries	97	97.0	3.0	0
Dairy Farms	72	84.7	14.1	1.2
Mini markets	50	100.0	0	0

Taste evaluation for raw milk samples from different sources is explained in table (3). The results elucidated that normal taste was dominant (74%, 69.4% and 44%) for raw milk samples from groceries, dairy farms and mini markets respectively. However, (16.5%) of milk samples from groceries were sweet and a considerable number of samples (20%) from mini markets tastes were acidic. Similar findings were reported by (Bashir *et al*, 2013) who obtained various tastes for milk samples collected from different parts in Rawalakot Azad Kashmir in Pakistan.

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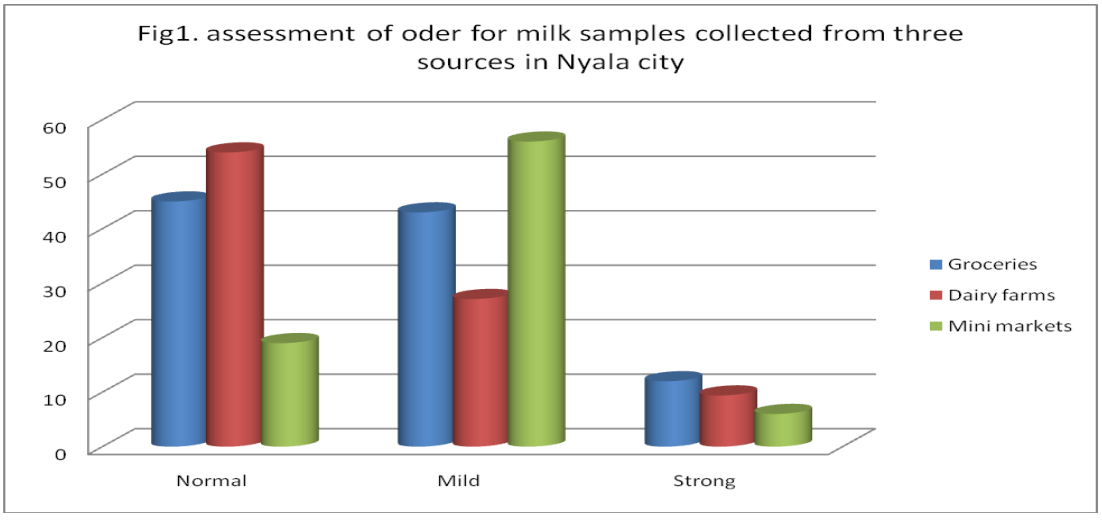
Table (3): Taste evaluation for milk samples from groceries, dairy farms and mini markets

Milk samples source	Parameter							
	Taste							
	Normal		Sweet		Salty		Acidic	
	N	%	N	%	N	%	N	%
Grocery	74	74.0	12	12.0	10	10.0	4	4.0
Dairy farms	59	69.4	14	16.5	10	11.8	2	2.4
Market	22	44.0	6	12.0	12	24.0	10	20.0

odder assessment for the samples collected from different sources in Nyala city is shown in fig. (1). It is well known that odor of milk is influenced by many factors such as type of feeds and fodders particularly fermented forages (silage), also, direct heat and light treatment, lipolysis, microbial activities can affect milk flavor (Palo, 1985). Milk can absorb odors from the surrounding atmosphere. Fortunately, the odor disappears when milk is cooled immediately after milking (Eckles *et al.*, 1986).



Microbial quality:

Standard plate count (SPC)

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The results of the microbial quality assessment of raw milk samples collected from different sources in Nyala city are summarized in table (4).

The mean ± standard deviation for standard plate counts (expressed in log 10cfu/ml) for groceries milk samples was significantly (P<.05) higher (5.67±0.026) than dairy farms samples (5.56±0.026) and mini markets (5.59±0.064).

The SPC determines the total number of bacteria in a milk sample that can grow and form countable colony forming units on a Standard Methods Agar plate when 1 ml of milk is incubated aerobically at 32°C for 48 hours. Ideally, raw milk should contain less than 5,000 bacterial cells /ml, when full sanitary measures are applied. The maximum legal limit for SPC is 100,000 bacterial cells /ml**.** The lowest SPC was found in raw milk samples collected from dairy farms and the highest was in groceries, similar findings were demonstrated by (Orregard, 2013) who investigated quality of raw milk along the value chain of the informal milk market in Kiambu County, Kenya, and found that the microbial counts in farmers' milk (*S. aureus*, coliforms and total plate count) were significantly lower than in milk from the agents (p < 0.001). Also,(Hussain ,2001) reported that in Khartoum North, the lowest total viable bacteria (TVB) and coliform bacteria were found in farms, while the highest counts were found in vendors'. This might be due to the fact that dairy farms were the first step in milk distribution channels before the initiation of bacterial growth and multiplication. The obtained results lied under the maximum legal limit for SPC. The present findings were lower than the average values of TVB from milk samples collected by Rahamtalla et al, 2016 from Omdurman and Khartoum North, (9.29 ± 0.66 and 8. 23 ± 0.76 log10cfu/ml respectively). They were also lower than those of (Abdalla and Elhagaz, 2011) who reported TVB count of (Log10 8.93 cfu/ml) for raw milk samples collected from cows without application of hygienic practices. On the other hand, the results obtained from the present work were slightly higher than the total aerobic bacteria for milk samples collected directly from the udder (5.401 log10cfu/ml), in and around Jigjiga city of Somali Region, Eastern Ethiopia, (Melese et al, 2015). Also our findinds were higher than TVB count reported by (Haile et al, 2012) (4.57 cfu/ml), for milk samples collected from raw milk produced under different farm sizes in Hawassa, Southern Ethiopia. According to (Kurwijilla *et al.*, 1991); a grade of raw milk based on standard plate count (SPC), a sample of raw milk that contains (200,000 -1,000,000 bacterial cells per a milliliter) is good.

Table (4): Microbial assessment of milk samples from groceries, dairy farms and mini markets in Nyala city

Source of Milk	Standard plate count SPC		
	N	Log (Mean±SD)	Actual (mean)
Grocery	100	5.67^{a}±0.026	467735
Dairy farms	92	5.56^{b}±0.026	363078
Mini markets	41	5.59^{ab}±0.064	389045
Sig. level		*	

* Significant at P<0.05; NS Not significant at P>.05

* Means with the same letters were insignificantly different (P>0.05)

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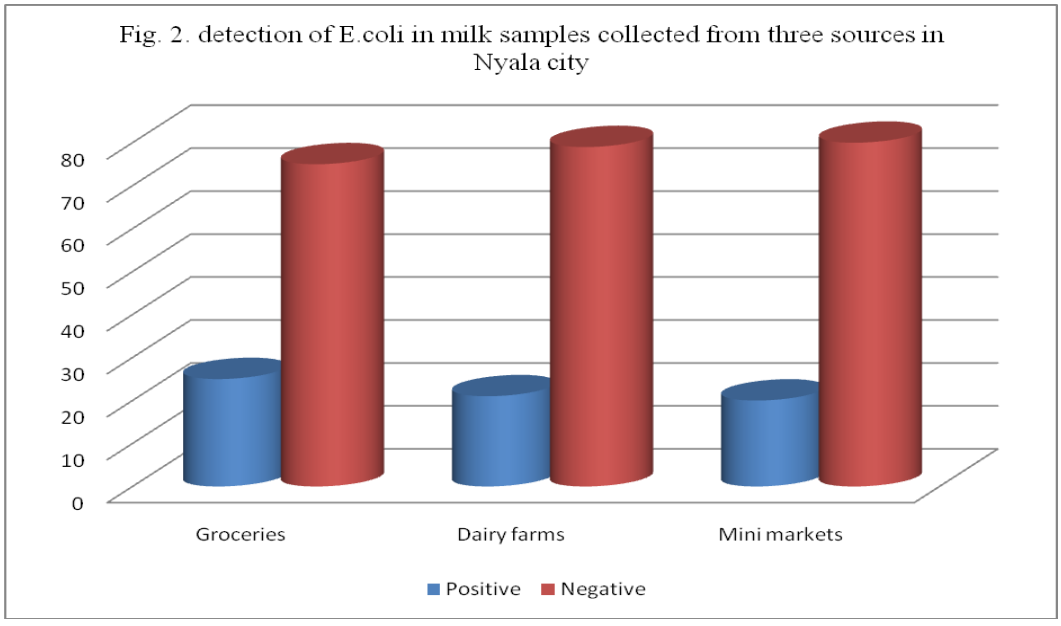
Coli form bacteria

Fig (2) shows the presence of coliform bacteria in the studied raw milk samples. The results indicated that coliform bacteria were detected in (20%) of mini markets milk samples. Moreover, groceries, raw milk samples reported highest (25%) coliform bacteria numbers compared to both dairy farms (21%) and markets. However, chi square test (χ^2=0.667) revealed no significant (P>0.05) association between source of milk and presence of *E.coli*.

Coliforms are a group of bacteria, which are found in intestinal tracts of humans and animals. They are excreted in large number with human excreta and animal droppings. They also may be, found in other places such as contaminated soils, vegetables and water (Gebra-Emanuel, Teka, 1997).

Raw milk can be contaminated by coliform bacteria from different sources like cow manure, unclean milkers and improper cleaning and sterilization of utensils, (Desalegn, 2014). The present findings were in agreement with (Orregard, 2013) who reported that Farmers' milk had significantly lower coliform counts than agents' milk ($p < .001$), and milk from shops ($p < .05$). This might be an indication of good milking practices by dairy farmers.

The coliform bacteria obtained in the present study was lower than those obtained by (Rahamtalla et al, 2016) from milk samples collected from different sources (vendors on donkeys' cart, carts) in Omdurman and Khartoum North-Sudan. Also, our findings were lower than those obtained by (Hussain, 2001) who found that in Omdurman the highest coliform bacteria count was in milk samples collected from vendors.



CONCLUSION

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Milk quality in term of physical examination for the majority of milk samples collected from different sources in Nyala city shows normal appearance, color and taste; although a few abnormal samples were recorded; that might be attributed to environmental factors such as feed sources or ethical reasons (adulteration).

Milk quality in term of microbial counts verified that milk samples collected from dairy farms immediately after milking recorded lower SPC and coliform bacteria compared to samples collected from groceries and mini markets which indicated commence of milk quality deterioration by time elapsed from milking to reach the final consumer.

The obtained results for (SPC) laid under the maximum legal limit for SPC, (≤ 100,000 bacterial cell/ml).

Based on SPC; raw milk samples collected from the three sources (farms, groceries and mini markets) in the present study is tolerable, (Kurwijilla *et al.*, 1991 considered raw milk that contains (200,000 -1,000,000 bacteria is good). However, this might be referring to the fact that dairy farms were the first step in milk distribution channels before the initiation of bacterial growth and multiplication.

Considerable number of samples from mini markets showed substantially lower bacterial counts than groceries ones, this may indicate boiling milk or practicing adulteration by adding antibiotics or hydrogen peroxide.
Further researches are needed to detect antibiotics residues and milk adulteration in Nyala city.

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