Food Science and Quality Management
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.119, 2022

Microbiological Quality of Yogurt in and Around Bahir Dar City, Amhara National Regional State, Ethiopia

Befekadu Wubante[1] Asaminew Tassew[2] Hailu Mazengia[2]
1. Bahir Dar University, College of Agriculture and Environmental Sciences
2. Bahir Dar Polly ATVET College

Abstract
The study was conducted to assess microbiological quality of yogurt in and around Bahir Dar city. The data were collected through laboratory analysis of yogurt. For this purpose, a total of 61 yogurt samples were collected to analyze the microbiological quality of yogurt. The laboratory work was performed from February 2019-March 2019 in Gondar University Biotechnology Department laboratory. The overall mean standard plate count, coliform count, staphylococcus, lactic acid bacteria, yeast and mold count and PH of yogurt produced in the area were 6.3±0.04 log_{10} CFU/mg, 6.13±0.04 log_{10} CFU/mg, 6.09±0.11 log_{10} CFU/mg, 6.3±0.06 log_{10} CFU/mg, 6.26±0.13 log_{10} CFU/mg and 4.16±0.02 respectively. There was significant difference between production system at ($p<0.05$) on lactic acid bacteria count. The yogurt samples which were produced from milk collected from unwashed udder, gourd container and unwashed hands revealed poor microbiological quality and are below yogurt quality standards. Generally, the hygienic practices of yogurt producers in the study area were poor; hence the yogurt was contaminated with various microorganisms. Therefore, improved hygienic measures, efficient yogurt preservation systems, and health packages are required in the study area.
Keywords: Bahir Dar, microbial load, yogurt.
DOI: 10.7176/FSQM/119-02
Publication date: September 30th 2022

1. Introduction

Delivery of good hygienic quality milk and milk products is desirable from a consumer health point of view. The consumption of raw milk products is common in Ethiopia [1] which is not safe from a consumer health point of view as it may lead to the transmission of various diseases. This is one reason why yogurt hygiene, as well as microbial qualities, will be assessed. Prior to the discovery and well-known adoption of pasteurization, for instance, raw milk and its products were responsible for serious bacterial infections such as diphtheria, scarlet fever and tuberculosis.

Advisory guidelines for microbiological quality have promoted that satisfactory Yogurts should contain more than l08 CFU/ ml of the starter organisms, < 1 coliform CFU/ml, *Staphylococcus aureus* count should be not higher than 10 CFU/ml. Indeed, the yeast and mold count must be lower than5 log_{10} CFU /ml. Moreover, the quality and safety of a fermented product entirely depend on the species and species composition of lactic acid bacteria that are involved in the fermentation process [2].

According to Jermen Mamo *et al.* [3] report the average count of standard plate count, coliforms, *Staphylococci* and yeast and mold in homemade traditionally produced yogurt ranges from 5 log CFU/ml to 9.1 log CFU/ml, 1.9 to 4.5 log CFU/ml, 2.1 to 4.7 log CFU/ml and 0 to 7.9 log CFU/ml, respectively. The information on microbiological quality of yogurt in and around Bahir Dar city is generally not known. Such information is critically vital for conniving proper hygienic yogurt handling practice, quality control measures, and for supplementary research development.

2. Material and methods

2.1. Description of the Study Area

Bahir Dar is the capital city of Amhara National Regional State, located at about 565 km away from Addis Ababa. The Regional State covers a total area of 152,600 km^2. The Region has 10.6 million cattle, 5.7 million sheep, 4 million goats, 2.1 million equines and 17,400 camels managed under extensive management system. Bahir Dar City is located at 11” 38’N, 37” 10’E on the South of Lake Tana where Blue Nile River starts. The elevation reported for the City is about 1801m.a. s l. The area receives an average annual rainfall ranging between 850mm to 1250mm with the minimum and maximum average daily temperatures of 10C^o and 32C^o, respectively [4]. In Bahir Dar city there are 20,193 oxen, 24, 551 cows, 8,353 bulls, 11,823 heifers, 14,720 calves, 17,884 sheep, 10,579 goats, 5,497 donkeys, 1,150 mules, 42,514 poultry, and 6, 983 honey bee colonies [5].

2.2. *Method of Data Collection and Sampling Techniques*

Laboratory-based analysis was used to determine microbial quality of yogurt obtained from all urban yogurt producers, individual processors and cooperatives in the city and peri-urban (Tisabay, Zenzelima, Zegie, and

Meshenti) yogurt producers, individual processors and cooperatives found in the study area were used for yogurt sampling. After the assessment, a total of 61 samples that was traditionally produced yogurt samples from urban (11 farm owners 2 cooperatives and 15 individual processers) and from peri-urban (16 farm owners, 3 cooperatives and 13 individual processers) and industrially produced yogurt 1 samples from urban Agerie dairy plant each measuring 100g volume was randomly taken through sterile screw-capped sampling bottles. Then it was securely capped, labeled with permanent markers and kept in an ice box at a temperature+4 °C and transported as immediately as possible to Gondar university Biotechnology department microbiology laboratory as per the recommendations of IDF 50 ISO/DIS 707[6]. Samples of yogurt were taken in the morning from each household once over a period of two months (January and February 2019) which may represent most of the dry seasons/months/ in the year. Different methods and steps were used to test for the presence of microorganisms in yogurt. Colonies on selected plates were counted using a colony counter as shown by [7]. After counting and recording bacterial colonies in each petridish the number of bacteria in milligram was calculated by the following given formula [8].
cfu/ml = (no. of colonies x dilution factor) / volume of culture plate

2.3. Microbial Counts
2.3.1. Standard plate count
Appropriate serial dilutions were selected that has given the expected total number of colonies on a plate. Serial dilutions were made by transferring 1ml of the previous dilution in 9ml of 0.1% peptone water. Three adequate dilutions of the sample were selected and inoculated, 1 ml of each dilution in separate, sterile and empty Petri dishes. The culture medium was added. Pour 12–15 ml of previously melted and cooled to 44–46°C Plate Count Agar (PCA) onto the inoculated plates. The inoculum was mixed with the culture medium [9]. The plated sample was allowed to solidify and incubated under PCA – 32 ± 1°C/ for 48 ± 2h. The number of colonies forming units (CFU) per gram was counted and calculated [7].
2.3.2. Coliform count
Serial decimal dilutions were prepared using 0.1% peptone water 1g of sample 9 ml of Peptone Water (PW). Three appropriate dilutions of the sample were Selected and inoculated in Violet Red Bile (V RB) Agar through using pour plate technique and, after complete solidification of the medium, cover the surface with a 5–8 ml thick layer of the same medium [3]. The plates were incubated in an inverted position at 32 ± 1°C/24 ± 2 h. plates with 15–150 colonies were selected and counted only the typical coliforms colonies on the VRB medium red-purple, 0.5 mm or greater in diameter, surrounded by a reddish halo characteristic as shown by [7].
2.3.3. Staphylococcus aureus
Serial dilutions were prepared using 0.1% peptone water1g of sample 9 ml of Peptone Water (PW). Three appropriate dilutions of the sample selected and inoculated 0.1 ml each on Baird Parker Agar, using the spread plate technique. Inoculum spread over surface of agar plate, using sterile bent glass streaking rod. Retain plates in upright position until inoculum was absorbed by agar. Inoculate 1 ml of the first dilution and 0.1 ml of the two subsequent dilutions. Incubate 35 ± 1°C 48 h [10]. Plates for typical S. aureus colonies were examined: black or gray, small (maximum 2–3 mm in diameter), surrounded by an opaque halo and frequently with an outer clear halo [11].
2.3.4. Yeast and molds
Presence of yeasts and molds in yogurt also is indicative of poor sanitary practices in manufacturing or packaging. Samples of yogurt were serially diluted up to 10^{-7} in peptone water and volumes of 0.1 milliliter of appropriate dilutions were plated in duplicate. Spread plate technique was implemented using Dicloran Rose Bengal Chloramphenicol agar (DRBC) [12]. The inoculum spread with a glass spreader. The plates were stayed until dry (at least 15 minutes) and incubated in 30°C/5 days [13]. Colonies with a filamentous, cotton-like (i.e. powdery) appearance, counted as molds, and count the remaining colonies as yeasts [9].
2.3.5. Lactic acid bacteria
One ml of appropriate serial dilutions in peptone water of yogurt samples were added into a sterile dish. A molten MRS Agar (Oxide, UK) (45°C) was then poured onto the dish and was mixed thoroughly. After the medium had set, another layer of MRS Agar was poured over the surface to produce a layer plate. Colonies were counted after plates incubated at 35°C in an atmosphere of 5% carbon dioxide for 48 hours [14].
2.3.6. Power of hydrogen (pH)
Measurement of pH gives a critical quality control step in the production of dairy products, especially yogurt. pH delivers a sign of contamination from bacterium or chemicals, whereas additionally providing a convenient methodology to estimate the acid development of a yogurt. Electrode (pH meter 013M) was selected, calibrated, sensor maintained and measured the pH of yogurt [15].

2.4. Methods of Data Analysis

Raw data were entered into a Microsoft Excel sheet. The data of microbial counts were first transformed to logarithmic values (log_{10}) to realize parametric statistical tests and these transformed values were analyzed using the General Linear Model (GLM) for least squares means in [16]. The Least Significant Difference (LSD) check was accustomed to separate the means that for all analysis, 95 % Confidence interval and P-value<0.05 was set for statistical significance of an estimate. The following linear models have been used during the analysis of the microbial count of yogurt.

$$Y_{ijrck} = \mu + M_i + Pj + Qr + Nc + Lk + e_{ijrck}$$

Where Y_{ijrck} = microbial load (SPC, St. aureus, LABC, YMC, CC and pH) of yogurt μ = the overall mean

M_i = The effect of i^{th} production systems (i=urban, peri urban).

Pj = effects of the j^{th} sources of yogurt (where j= farm owners, cooperatives and individual processers).

Q_r = The effect of r^{th} hygiene of cows' udder (r=washed udder, unwashed udder)

Nc = The effect of c^{th} milking and processing container (c=gourd, plastic, Aluminum and clay)

L_k = The effect of k^{th} personnel hygiene (k=washed hand, unwashed hand)

e_{ijrck} = Overall standard error

3. Results and Discussions

3.1. Microbiological Counts and pH of Yogurt

3.1.1. Microbiological counts and PH of traditionally produced yogurt in the study area

Standard plate count: The average count of standard plate count, coliforms*, staphylococcus aureus, lactic acid bacteria,* and yeast and mold in traditionally produced yogurt in and around Bahir Dar city was shown in Table 1. Production of good quality yogurt by producers is important for consumers and producers themselves. Standard plate count is a good indicator for monitoring the sanitary conditions practiced during the production and handling of yogurt. The overall mean of standard plate count was 6.36±0.04 log_{10} CFU/ml obtained in the current study. The mean standard plate of traditionally produced yogurt in the current study is lower than other research reports [17] which was 11.63 log CFU/ml in Cameroon. However, higher values of SPC (5-9.1 log CFU/ml) were reported in the North Shoa District of Ethiopia [3].

Approximately, urban individual processer (6.56±0.03 log_{10} CFU/ml) and peri-urban individual processer (6.57±0.05 log_{10} CFU/ml) had equivalent standard plate counts. This result is lower than Ekram *et al.* [18] reports in Sudan. Whereas samples collected from Peri-Urban farm owners (6.33±0.09 log_{10} CFU/ml) is higher than Urban farm owners (6.06±0.13 log CFU/ml). Thus, a high load of bacteria present in yogurt indicates that the level of contamination was high. This high contamination could be a result of initial contamination initiating from the udder surface, unhygienic milking equipment and poor personal hygiene as well as failure to cool milk rapidly.

The standard plate count (6.54±0.06 log_{10} CFU /ml) analyzed from the yogurt samples in gourd milking and processing container was significantly (p<0.05) higher than that of the plastic container (6.27±0.08 log_{10} CFU/ml). This is due to gourd absorbs waters together with some microorganisms during washing. There was also, a statistically significant difference between yogurt produced from milk milked with washed and unwashed udder in the urban and peri-urban farm owners. However, there was no a statistically significant difference between yogurt produced from milk milked with washed and unwashed hand in the urban and peri-urban farm owners. Therefore, the yogurt found in and around Bahir Dar city is categorized as poor grade since; it contains lower SPC [19] than the standards which was ≥7 log_{10} CFU/ml.

Coliform Count: The overall mean coliform count of yogurt produced in the area was 6.13±0.04 log_{10} CFU/ml (Table 1). This is higher than the acceptable level the standard of microbiological limit for the coliform count in yogurt is <2 log_{10} CFU/ml [19]. There was no significant difference between urban and peri-urban production system. Commonly, the presence of high numbers of coliforms in yogurt indicates that the milk might be contaminated with fecal materials, unclean udder and teats of cow's, inefficient cleaning of the milking containers, and poor hygiene of the milking environment. Similar results stated by Gabriel *et al*. [20] high level of CC commonly associated with manure or environmental contamination. Moreover, their presence in large numbers in yogurts shows that the products are potentially hazardous to the consumers‟ health. [21] also reported, higher (5.64 ±0.20 log_{10} CFU/ml) CC in Hawassa City, South Ethiopia. The mean counts of coliform bacteria in yogurt in the current study also failed to meet the internationally acceptable standard of 10 CFU/ml set for yogurt [22].

There was a significant difference (p<0.01) in coliform count among the yogurt sources. The CC of yogurt collected from urban farm owners, individual processers and cooperatives were 6.03±0.02, 6.13±0.08 and 5.84±0.22 log_{10} CFU/ml whereas, in peri-urban farm owners, individual processers and cooperatives were 6.09±0.07, 6.35±0.05 and 6.02±0.24 log_{10} CFU/ml, respectively. This result is higher than the finding of Sintayehu Yigrem and Haile Welearegay [21] who found 5.60, 5.55 and 5.64 log_{10} CFU/ml coliform count in the yogurt collected from individual farmer's individual processers while yogurt produced milk collected from single and multiple farms sources respectively. In the most part of the study area, raw milk was delivered to cooperatives and individual processers without any cooling system and poor transportation which might be the reason for the presence of highest coliform count in the study areas.

According to Azage Tegegne *et al*. [23] Cleaning of the udder before milking is essential to reduce the level of contamination. However, the present study revealed that significantly ($p<0.01$) higher coliform count (6.14±0.05 log_{10} CFU/ml) was identified in the yogurt sample processed from milk collected from the unwashed udder. This might be due to fecal contamination during milking of urban and peri-urban farm owners.

As the result indicated, the use of traditional (gourd) milking containers can be a potential source for the contamination of yogurt by bacteria because this is not suitable for proper cleaning and allows the multiplication of bacteria in milk contact surfaces during the interval between milking and processing. Hence, the yogurt produced from milked and processed by gourd had significantly ($p<0.05$) higher coliform count than milked and processed by the plastic container in the study area. As stated in the result 5.9±0.04 and 6.27±0.06 log_{10} CFU/ml coliform count were recorded from the yogurt processed from raw milk milked by washed and unwashed hand, respectively and there was significant at ($p<0.01$) difference between them.

***Staphylococcus aureus* count:** In the present study, the mean *staphylococcus* counts of yogurt in the study area were 6.09 ±0.04 log_{10} CFU/ml. Particularly in urban and peri-urban production system there were higher 6.03 ±0.06 and 6.15 ±0.05 log_{10} CFU/ml, respectively. There was no significant value between urban and peri-urban yogurt producers. In addition to this, both urban and peri-urban yogurts did not meet standard levels which are< 2 log_{10}CFU/ml) [19].

The *staphylococcus aureus* counts of urban farm owners, individual processers and cooperatives were 6.02±0.11, 6.08±0.08 and 5.76±0.04 log_{10} CFU/ml. On the contrary in peri-urban farm owners, individual processers and cooperatives were 6.11±0.05, 6.22±0.1 and 6.09±0.06 log_{10} CFU/ml, respectively. These results are higher than another study conducted by Sintayehu Yigrem and Haile Welearegay [21] the overall mean count of *Staphylococcus aureus* (5.91 log_{10} CFU/ml) was also identified in Hawassa City. Abdalla and Ahmed [24] also reports lower Staph*ylococci* count than the present results in the Sudanese fermented milk product which was 3.63 log_{10} CFU/ml. The high count of staphylococcus aureus bacteria is due to poor personal hygienic practices. On the other hand, the present study revealed that higher *Staphylococci* count (6.08±0.08 log_{10} CFU/ml) was identified in the yogurt sample processed from milk collected from the unwashed udder. This might be due to fecal contamination and poor personnel hygiene during milking of urban and peri-urban farm owners. However statically difference was not observed.

As indicated in Table 1. The yogurt processed by plastic, aluminum, gourd and clay, containers were6.05±0.05,5.97±0.12, 6.35±0.04 and 6.07±0.08 log_{10} CFU/ml, respectively. Yogurt processed by gourd equipment's had significantly ($p<0.05$) higher staphylococcus aureus count than processed by Aluminum, plastic and clay containers in the study area. In the present study, a staphylococcus aureus counts 5.94±0.08 and 6.27±0.04 log_{10} CFU/ml was found in the yogurt sample produced from milk milked through washed hand and unwashed hand of farm owners, respectively and significant difference also observed between them. These results are higher than another study conducted in Egypt revealed that a *Staphylococci* count was 3.93 log_{10} CFU/ml [25].

Table 1. Microbiological counts and PH of traditionally produced yogurt in and around Bahir Dar city

Parameters	N	SPC (log_{10}CFU/ml)	CC (log_{10}CFU/ml)	S. aurous (log_{10}CFU/m	LABC (log10CFU/ml	YMC (log CFU/ml) 10	pH
Production systems							
Urban	28	6.3±0.07^{a}	6.06±0.05^{a}	6.03 ±0.06^{a}	6.16±0.09^{a}	6.26±0.09^{a}	4.15±0.03^{a}
Peri-urban	32	6.4±0.05^{a}	6.19±0.05^{a}	6.15 ±0.05^{a}	6.41±0.07^{b}	6.45±0.12^{a}	4.17±0.03^{a}
Over all mean	60	6.3±0.04	6.13±0.04	6.09 ±0.04	6.3±0.06	6.26±0.13	4.16±0.02
Sources of yogurt							
Urban Farm Owner	11	6.06±0.13^{ac}	6.03±0.02abcdf	6.02±0.11^{a}	6.04±0.16abcf	6.62±0.1^{a}	4.09±0.04^{a}
Individual processer	15	6.56±0.03bcef	6.13±0.08abcdf	6.08±0.08^{a}	6.32±0.12abcdf	6.07±0.12bcef	4.19±0.03^{a}
Cooperatives	2	6.09±0.34^{acd}	5.84±0.22abcdf	5.76±0.04^{a}	5.66±0.38abcf	5.78±0.02cbef	4.15±0.15^{a}

Parameters	N	SPC (log$_{10}$CFU/ml)	CC (log$_{10}$CFU/ml)	S. aurous (log$_{10}$CFU/m	LABC (log10CFU/ml	YMC (log CFU/ml)	pH
Peri-Urban							
Farm Owner	16	6.33±0.09^{cd}	6.09±0.07abcdef	6.11±0.05^{a}	6.46±0.11^{d}	6.98±0.14^{d}	4.15±0.03^{a}
Individual processer	13	6.57±0.05^{be}	6.35±0.05^{e}	6.22±0.1^{a}	6.43±0.07^{e}	5.99±0.1bcef	4.18±0.06^{a}
Cooperatives	3	6.18±0.17abcdef	6.02±0.24abcdef	6.09±0.06^{a}	6.01±0.34abcdef	5.67±0.05^{bcef}	4.26±0.07^{a}
Hygiene of cow's udder Washed udder	8	5.93±0.17^{a}	5.87±0.06^{a}	6.05±0.07^{a}	6.25±0.19^{a}	6.58±0.18^{a}	4.11±0.06^{a}
Unwashed udder	19	6.34±0.07^{b}	6.14±0.05^{b}	6.08±0.08^{a}	6.3±0.12^{a}	6.94±0.11^{a}	4.13±0.03^{a}
Processing container Plastic	28	6.27±0.08^{abd}	6.12±0.05abcd	6.05±0.05^{abd}	6.20±0.09^{a}	6.44±0.09^{acd}	4.15±0.03^{a}
Alumunim	8	6.38±0.1abcd	5.9±0.05^{ab}	5.97±0.12^{abd}	6.06±0.21^{a}	5.71±0.6^{b}	4.15±0.05^{a}
Gourd	11	6.54±0.06^{bcd}	6.26±0.07^{acd}	6.35±0.04^{c}	6.49±0.07^{a}	6.32±0.47^{acd}	4.18±0.06^{a}
Clay	13	6.46±0.06abcd	6.19±0.08^{acd}	6.07±0.08^{abd}	6.46±0.09^{a}	6.65±0.24^{acd}	4.18±0.04^{a}
Personnel hygienic status Washed hand	16	6.12±0.12^{a}	5.91±0.04^{a}	5.94±0.08^{a}	6.23±0.15^{a}	6.71±0.11^{a}	4.09±0.03^{a}
Unwashed hand	11	6.37±0.08^{a}	6.27±0.06^{b}	6.27±0.04^{b}	6.38±0.14^{a}	7.01±0.17^{a}	4.17±0.04^{a}

Means followed by different superscript letters within a column are significantly different, N=number of respondents, SE=standard errors, SPC=standard plate count, CC=coliform count, S. aurous= *Staphylococcus aureus*, LABC= Lactic acid bacteria count YMC= yeast and mold count PH= power of hydrogen

Lactic Acid Bacterial Count (LABC): Yogurt has received wide-ranging microbiological works and it has been found that lactic acid bacteria and standard plate count dominate all other microorganisms followed by YMC. Similar result is reported by Scott and Sullivan [26] because of these organisms are acid-tolerant as compared to the other groups. In the collected yogurt sample, it was found that 6.3 and 6.16 log CFU/ml of LABC in peri-urban and urban production system, respectively. The overall mean of LABC was 6.3±0.06 log$_{10}$ CFU/ml. This could be explained by the general observation that lactic acid bacteria are acid tolerant and responsible for the fermentation of raw milk used in the production of yogurt. In this result there was no significant difference between urban and peri-urban yogurt samples. In contrast to the present study, Cisse *et al.* [27] reported higher LABC (7.72 log$_{10}$ CFU/ml) in yogurt collected from Burkina Faso. Another study held by Kidist Fikr *et al.* [28] also reported 9.6 log$_{10}$ CFU/ml LABC in traditionally produced yogurt in Addis Ababa.

Yogurt samples collected from different sources had various LABC (Table 1). Peri-urban farm owners significantly higher ($p<0.05$) LABC than urban farm owners and urban cooperatives. Beside this, peri-urban farm owners significantly higher($p<0.05$) LABC than urban farm owners and urban cooperatives. These results were lower than Kidist Fikr *et al.* [28] finding which was 9.6log10CFU/ml in Addis Ababa. Tankoano *et al.* [29] also reported higher (8.17 log$_{10}$ CFU/ml) LABC in Burkina Faso.

Based on this result significant difference was not observed in yogurt produced from milked and processed by plastic, gourd, clay and aluminum containers and also no statistically significant difference in LABC was observed by other factors. Generally, in the study area, the collected samples did not fulfill the Brazil standards that are yogurts produced in Brazil must contain at least 10^7 (7 log$_{10}$ CFU/ml) of LAB. This might be due to unable to use starter culture during processing and improper handling of yogurt during production.

Yeast and mold count: Yeast and mold are the primary contaminants of yogurt. Fungi growing in yogurt utilize some of the acids; this may favor the growth of putrefactive bacteria and other pathogenic microorganisms such as *staphylococcus aureus* [20]. The average yeast and mold count of yogurt produced in the study area was 6.26±0.13 log$_{10}$

CFU/ml which is lower than the finding of Zelalem Yilma *et al.* [30] who reported that the overall mean yeast and mold count of yogurt produced in Addis Ababa was 8.3 log$_{10}$ CFU/ml. The overall average YMC observed in the present study is beyond the acceptable standard set for yogurt (5 log$_{10}$ CFU/ml), which could potentially be injurious to human health [22]. Contamination of milk and its products by yeast and mould might originate from the air, feed, inadequately cleaned milk utensils and poor personal hygiene of milk handlers [20].

Yeast and mold count in urban and peri-urban production system were 6.26±0.09, 6.45±0.12 log_{10} CFU/ml, respectively. In addition to this urban farm owners, individual processers and cooperatives had 6.62±0.1 6.07±0.12 and 5.78±0.02 log_{10} CFU/ml whereas in puri-urban farm owners, individual processers and cooperatives were 6.98±0.14,5.99±0.1and 5.67±0.05 log_{10} CFU/ml. From this result peri-urban farm owners significantly higher (p<0.01) than all other yogurt producers. Urban farm owners had significant difference amongst with yogurt producers. On the contrary, Okonkwo [31] reported lower counts of yeasts and molds (5.58 log10CFU/ml) in samples collected from Burkina Faso, Northern Nigeria.

Furthermore, the yeast and mold count obtained from the aluminum container are significantly (p<0.01) lower than yogurt samples collected from other milking and processing containers (Table 1). However, there was no statistically significant difference observed between yogurt samples processed from milk collected from the washed udder and unwashed udder of urban and peri-urban farm owners. Therefore, sources of yogurt, milking and processing containers were the main determinant factor for greater yeast and mold count. Whereas urban and peri-urban farm owner milkers and udder hygiene had not statistically significant effect on yeast and mold.

Power of Hydrogen (pH): Although the PH is not an official parameter to verify the quality of yogurt it can be measured in order to allow additional information. The pH of the samples varied from 4.1 to 4.26 (with the overall mean of 4.16±0.02). The pH of all samples collected from in and around Bahir Dar city fulfill the standards of yogurt stated in [19] which was ≤4.5. This low pH could be attributed to the high acidity of yogurt, which has a bacteriostatic effect on contaminant bacteria in yogurt.

3.1.2. Microbiological count of industrially produced yogurt

In the study area only Agerie milk processing plant was taken to evaluate the microbial load of yogurt. In this yogurt 5.69±0.0,6.53±0.00 log_{10} CFU/ml SPC and LABC was observed (Table 2). This result lower than Kidist Fikr *et al*. [28] which was sample collected from mama and sholla yogurt in Addis Ababa. However, no yeast and mold count, Coliform count and *Staphylococcus aureus* bacteria detected. This might be due to good personal hygienic practices and through using pasteurized milk the bacteria devastated through heat and this product might be relatively safe for human consumption. The pH of Agerie yogurt fulfil the acceptable level of yogurt standards.

Generally, in the study area the microbial count of standard plate count and Lactic acid bacteria count were low. However, coliform count, yeast and mold count and *staphylococcus aureus* count of the traditionally produced yogurt was high and couldn't meet yogurt quality standards whereas industrially produced yogurt relatively fulfills the acceptable limits of some level of microorganisms such as coliform count, yeast and mold count, and *staphylococcus aureus* count.

Table 2. Microbiological counts and pH of industrially produced yogurt in the study area

Parameters	(log_{10} CFU/mg)
Power of hydrogen	4.1
Standard plate count	5.69
Coliform count	ND
Staphylococcus aurous	ND
Lactic acid bacteria count	6.53
Yeast and mold count	ND

ND= not detected

4. CONCLUSION AND RECOMMENDATIONS

In the study area, level of microorganisms was high. On the contrary, in Agerie yogurt coliform, yeast and mold and *staphylococcus aureus* count were not detected. However, low count of standard plate count and lactic acid bacteria were observed and thus, don't fulfill the yogurt microbial quality standards. Similarly, traditionally produced yogurt couldn't meet the desired yogurt microbial quality standards. The highest coliform, yeast and mold and staphylococcus counts were found in the study area. This indicates that the yogurt has been contaminated with fecal materials, unclean udder of cow's, inefficient cleaning of the milking containers, poor hygiene of the milking environment and milker's. The yogurt sample processed from milk collected from unwashed udder, gourd, and unwashed hand results in higher microbial count. However, relatively quality yogurt was gained in the Agerie milk processing. Generally, the quality of yogurt produced in the study area was below the acceptable level of most national and international yogurt quality standards which may have a great impact on public health, household economy and national growth. Hereafter, it needs serious consideration and action to improve the existing situation in the area.

Therefore, based on the results of this study the following recommendations were forwarded:

- Appropriate sanitary practices should be implemented in each production system starting from input up to the end product so as to produce quality yogurt.
- Yogurt producers should use utensils made from alumunim can for milking, processing and storing

of products.
- Setting national quality standards and quality control system is important to improve the yogurt quality.

Conflicts of Interest
The authors declare that they have no conflicts of interest.

5. REFERENCES
[1] Zelalem Y. 2012. Microbial properties of Ethiopian marketed milk and milk products and associated critical points of contamination: An Epidemiological perspective, Epidemiology Insights, ISBN: 978-953-51-0565-7.
[2] Abebe B., Zelalem Y and Ajebu N. 2013. Handling, Processing and Utilization of Milk and Milk Products in Ezha District of the Gurage zone, Southern Ethiopia. Journal of Agricultural Biotechnology and Sustainable Development. 5: 91-98.
[3] Jermen Mamo, Bulti Kumera and Mengistu Asmamaw. 2016. Evaluation of microbiological quality of raw yogurt, traditionally produced yogurt and homemade Ayib in North Shoa District, Amhara, Ethiopia. Pakistan Journal of Yogurt Sciences.26: 83-91.
[4] BoARD. 2016. Bureau of Agriculture and Rural Development (Board) Amhara Region, Statistics section. Bahir Dar, Ethiopia.
[5] CSA. 2017. Agricultural sample survey. Report on livestock and livestock characteristics. 2(583): 20-21. CSA, Addis Ababa, Ethiopia.
[6] IDF 50 and ISO/DIS 707, 2008. Milk and milk products –Guidance on milk sampling. 3rd ed. Institute of Research, Technology and Science, Bhopal, India. International Journal of Standards, New Delhi. 1- 10pp.
[7] Da Silva N., Taniwaki M., Junqueira C., Silveira N., do Nascimento M. and Gomes R. 2012. Microbiological examination methods of food and water: a laboratory manual. CRC Press. 68-70pp.
[8]Bioresource.2011.Availablefrom:http://technologyinscience.blogspot.com/2011/11/cfucolony-forming-unit-calculation.html#.XXmHWi5Kjcf [Accessed 11 September 2019].
[9] AOAC. 2010. International Journal of analytical science. Rapid Methods Adopted as AOAC Official Methods.
[10] Henning D., Flowers R., Reiser R. and Ryser E. 2004. Pathogens in yogurt and yogurt products. In: Wehr, H.M. and Frank, J.F (eds). Standard Methods for the Examination of Dairy Products. 17th edition. Washington, American Public Health Association. 103–151pp.
[11] APHA. 2001. Compendium of methods for the microbiological examination of foods. 4th ed., Washington, DC. Good-luxuriant. 50-100pp.
[12] Horwitz W. and Latimer, G. (eds) 2010. Official Methods of Analysis of AOAC International. 18th edition, revision 3. Gaithersburg, Maryland, AOAC International.
[13] Pitt J. and Hocking P. 2009. Growth and mycotoxin production by food spoilage fungi under high carbon dioxide and low oxygen atmospheres. International Journal of Food Microbiol. 132:2-3
[14] Cristina D., Florisvaldo D. and Ronaldo L. 2013. Quantification of lactic acid bacteria and bifidobacteria in goat milk-based Yogurts with added water-soluble soy extract. Journal of African food science. 7: 392-398.
[15] Masulli D. 2016. "Measuring PH of Yogurt." *Food Quality and Safety*.
[16] SAS (Statistical Analysis System). 2010. (Version 9.0) Informatica Power Exchange for SAS User Guide. USA.
[17] Glory L., Paul L., Tedonkeng P., and Jules-Roger K. 2017. Seasonal Microbial Conditions of Locally Made Yoghurt (Shalom) Marketed in Some Regions of Cameroon International Journal of Food Science. 16 pp.
[18] Ekram E. Mohammad and Ibtisam E. El-Zubeir. 2011. Chemical Composition and Microbial Load of Set Yoghurt from Fresh and Recombined Milk Powder in Khartoum State, Sudan. International Journal of Dairy Science, 6: 172-180.
[19] ANZFA. 2000. The Australia New Zealand Food Authority. *Microbiological Limits for Food* User guide. 22pp.
[20] Gabriel C., Lily G. and Igwe E. 2015. Microbiological load of yoghurt sold in Omoku schools, Rivers State, Nigeria African journal of microbiology research.9: 1960-1963.
[21] Sintayehu Y. and Haile W. 2015. Assessment of Microbial Quality and Safety of a Traditional Fermented Milk Irgo', Collected from Hawassa City, South Ethiopia. Journal of Food Process Technology. 6: 431.
[22] USDA. 2001. United States department of agriculture specifications for yogurt, non-fat yogurt and low-fat yogurt.
[23] Azage T., Berhanu G., Dirk H., Berhanu B. and Yoseph M. 2013. Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 31.

Nairobi: ILRI.
[24] Abdalla M, Ahmed SAN. 2010. Evaluation of microbiological quality of Sudanese fermented dairy product 'mish' during storage. Advanced journals Food Science Technology. 2:155-158.
[25] El-Malt L., Abdel H. and Mohammed A. 2013. Microbiological evaluation of yoghurt products in Qena city, Egypt, Vet World 6:400-404
[26] Scott R. and Sullivan W. 2008. Ecology of fermented foods. Human Ecology Research. 15: 25-31.
[27] Cisse H., Jean U., Namwin S. François T. 2019. Assessment of safety and quality of fermented milk of camels, cows, and goats sold and consumed in five localities of Burkina Faso Veterinary World. 12: 295-304.
[28] Kidist F., Anteneh T. and Fassil A. 2015. Comparative Analysis of Microbial Load of Commercially Prepared and Traditionally Homemade Yogurt (Traditionally produced yogurt) Retailed in Addis Ababa Advances in Life Sciences. 5: 58-63.
[29] Tankoano A., Kabore D., Savadogo A., Soma1 A., Fanou-Fogny N., Compaore- Sereme D., Hounhouigan J. and Sawadogo-Lingani1 H. E 2016. Evaluation of microbiological quality of raw milk, sour milk and artisanal yogurt from Ouagadougou, Burkina Faso. 10:535-541.
[30] Zelalem Yilma, Emmannuelle G., Ameha S. 2011. A Review of the Ethiopian Dairy Sector. Ed. Rudolf Fombad, Food and Agriculture Organization of the United Nations, Sub Regional Office for Eastern Africa (FAO/SFE), Addis Ababa, Ethiopia, pp 81.
[31] Okonkwo O. 2011. Microbiological analyses and safety evaluation of nono: A fermented milk product consumed in most parts of Northern Nigeria. International Journal of Dairy Science. 6: 181-189.

Budget sources: This research was done by self-sponsor

Data availability

Currently, I'm not voluntary to share the data for privacy purpose