

Microbial Assessment of Biscuits, Chips, and UHT Milk in Hargeisa Somaliland

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Abstract The study was conducted to examine the microbial quality of two dried foods: chips and biscuits and UHT milk, which are very common among children and adults. Moreover, people from all age groups like and consume it. Chips, biscuits, and UHT milk are free from coliforms and *E. coli* due to proper handling during production. In the current study, forty samples were tested for microbiological quality analysis. Fifteen samples of three UHT milk brands, five samples from each brand, were analyzed to study the presence of coliforms and *E. coli*. No coliforms or *E. coli* were detected in all 15 UHT milk samples. Of the samples studied, all fifteen biscuit samples from three different brands were found not to be contaminated with coliforms and *E. coli*. All ten chip samples from the two brands were free from coliforms and *E. coli*. In conclusion, it can be said that either imported or locally manufactured UHT milk samples, chips, and biscuits collected from different shops, stores, and supermarkets are of high quality. One of the main findings of this analysis of UHT milk and chips was that one of the local industries applied good manufacturing practices, which made their product of high quality and similar to the imported UHT milk and chip samples. The government and relevant stakeholders are recommended to know the significance of food safety issues to avoid any possible foodborne diseases.

Keywords: TCC-Total Coliform Count, TEC-Total *Escherichia coli* Count, UHT- Ultra High Temperature, Sterilization, chromogenic coliform agar, chips, biscuits

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1. Introduction

Milk is a famous food for all ages of humans, especially for children, to support their growth and functions. It consists of essential nutritional constituents such as protein, fat, minerals, carbohydrates, and vitamins, all needed for the body's growth and maintenance. On the other hand, milk is a suitable medium for multiplying pathogenic microbes and transmitting chemicals and other impurities [1,2,3]. UHT processed milk is a milk which is treated between 130°C and 150°C for 2-4 seconds by the constant thermal flow treatment, and the product is quickly cooled to a temperature lower than 32°C, bottled in sterilized conditions in a prior hygienic packaging and sealed. The aim of the ultra-high temperature (UHT) process of milk is to attain commercial sterility via a shelf life of up to nine months. Commercial sterility means that UHT milk has no spore and viable microbes, which can multiply at room temperature [4,5,6,7,8].

Milk-borne infections are directly related to the use of low-quality milk. Therefore, the higher consumption of

unsterilized milk can cause a foodborne milk-associated infection outbreak [9]. Foodborne diseases account for 48 million infections per year in the United States of America, with *Salmonella* spp (nontyphoidal), Norovirus, *Campylobacter* spp, *Clostridium perfringens*, and *Staphylococcus aureus* ranking as the top five pathogens causing to domestically-acquired foodborne diseases [10].

Biscuits are snacks made from wheat flour, sugar, and hydrogenated fats. Adding a mixture of sodium biphosphate and sodium carbonate made biscuits lighter [11]. It is fortified with basic food supplements such as proteins, minerals, and vitamins [12]. Biscuits and other dried foods undergo contamination due to environmental conditions, humidity, production processing faults, water activity, and temperature [13].

Oval-to-round potatoes with a size range of 40–75 mm are ideal for food processing. The uniform distribution of the fewest amount of sugars on the surface of the chopped tuber is a very important feature. Refined products should not be made from potatoes that gather sugars in the vascular bundles, around the stolon, or in the top components [14]. Potato chips are considered the most eaten food in the world, especially by children and young

adults [15]. It is a sweet and highly edible vegetable with 75% water content. One hundred grams of cooked potato gives 86 kilocalories of energy comprising 20 g carbohydrate, 1.7 g protein, 1.8 g fibers, 17 mg vitamin C, 11 mg riboflavin, 1.2 mg niacin, 13 mg calcium, and traces of various other minerals and fibers [16]. Extremely high concentrations of acrylamide in commonly consumed foodstuff, such as potato chips, French fries, or cereals may pose a potential risk to human wellbeing. Because the typical eating of acrylamide-rich foods has increased, it is more likely that the compound will perform its impacts within the blood vessels. Swedish National Food Administration in April 2002 reached significant public concern since acrylamide was known to be a cancer-causing agent in rodents and is classified as a probable human carcinogen. Contaminated chips may lead to foodborne illnesses and some of the symptoms of foodborne infections often include aches, vomiting, fever, diarrhea, and abdominal pains [17,18,19]. Microbial contamination of ready-to-eat foods such as biscuits, salted nuts, and chips results from production, packaging, transportation, and storage [20].

In Somaliland and throughout Somalia, there is no properly functioning national food, drug, and cosmetics quality control laboratory that analyzes imported goods after ships dock at the port and materials are unloaded. There is a hypothesis in Somaliland that the quality of imported goods is poor, and the Somaliland quality control laboratory in Berbera does not regularly analyze. This research will prove how far the hypothesis about the quality of food items is true. The findings of this study will determine whether the above-mentioned food items are safe for human consumption. There are fewer published studies about the microbial quality of water and food items in Somaliland. Therefore, this research will be beneficial for academics and policymakers and will contribute information about food quality that may fill the wider literature gap in this area. The three food products that this study analyzed are some of the most commonly used foods in Hargeisa.

2. Objective of the Study

The objective of this research is to assess the microbial quality of biscuits, chips, and UHT milk in Hargeisa, Somaliland.

3. Materials and Methods

3.1. Study Area

The study site was Hargeisa. It is the largest and most densely populated city in Somaliland, with coordinates of 9.56°N and 44.077°E. It is a major hub for imported and locally manufactured goods. The production of standardized milk and chips in Hargeisa accounted for 30% of the total milk and chip production in Somaliland. Its population is estimated to be over 1.2 million people. This research was implemented in the microbiology lab of the University of Hargeisa, Science and Engineering Laboratory from December 2023 to February 2024.

3.2. Study Design

The study design of this research was a descriptive cross-sectional study intended to evaluate the microbial quality of biscuits, chips, and UHT milk sold in different shops, stores, supermarkets, and cafes.

3.3. Sample Collection

A sample size of 40 consisted of 5 samples for each biscuit, chip, and UHT milk imported and locally manufactured product from Turkey, Iran, Bahrain, Yemen, Saudi Arabia, and Somaliland. Samples for this study were three main products: milk, biscuits, and chips, which are most commonly used in Hargeisa. They were taken to the laboratory after the selection.

3.3.1. Sampling Technique

Multistage sampling, purpose, and convenience sampling methods were used. Firstly, imported and locally manufactured products: biscuits, chips, and UHT milk were purposefully chosen. Since accessibility of shops, stores, supermarkets, and cafes in Hargeisa was not possible during the study period, samples of locally manufactured and imported products were selected conveniently.

3.3.2. Sample Processing

For each dried food sample—chips and biscuits—10 g were weighed and mixed with 90 ml of sterile peptone water, and serial dilutions were prepared up to 10^{-5} . 1 ml of the diluted sample was spread on dried Chromogenic Coliform agar [13]. The same procedure was also used when simple and serial dilutions of UHT-processed milk were performed. Following the spread plate technique, all inoculated plates were incubated at 37°C for 18–24 hours. All culture media were prepared according to the manufacturers' specifications and sterilized at a temperature of 121°C for 15 minutes.

3.3.3. Enumeration of Coliform and *E. coli* Count

Total coliform and *E. coli* counts were done on chromogenic coliform agar by using the spread plate technique. Inoculated plates were incubated at 37°C for 18–24 hours. Pink or red colonies would be counted to find total coliform as cfu/g if coliform bacterial colonies grew on the culture medium. Dark blue or violet colonies would be counted if *E. coli* colonies appeared on the media. The total *E. coli* count is equivalent to the total fecal coliform count because *E. coli* is the predominant bacteria in fecal coliforms.

3.4. Data Analysis

Data were analyzed using Excel. Results from microbial quality test analysis would be compared with Somaliland and other international quality body's standard.

4. Results

Milk is a suitable food for human well-being. Dried foods such as chips and biscuits are snacks that are ready-to-eat foods that are consumed in the same state as they are

sold. UHT-processed milk, chips, and biscuits were examined for total coliform and *E. coli* counts. Results from this research would be useful for public institutions to follow up on the quality of commercial milk, biscuits, and chips. Microbial contamination of biscuits, milk, and chips can lead to food-borne infections. They should be analyzed microbiologically to prevent food-borne outbreaks.

The results of the bacterial load for the chips are shown in Table 1. Two of the most commonly used chips demonstrated the absence of both coliforms and *E. coli*. One of the two brand chips is locally manufactured and has the same microbial quality as the imported brand chip.

Table 1. Bacterial load of various chip samples

Product name	ID	TCC (CFU/g)	TEC (CFU/g)
	QL1	Absent	Absent
	QL2	Absent	Absent
	QL3	Absent	Absent
	QL4	Absent	Absent
Chips	QL5	Absent	Absent
	ALB1	Absent	Absent
	ALB2	Absent	Absent
	ALB3	Absent	Absent
	ALB4	Absent	Absent
	ALB5	Absent	Absent

TCC: Total Coliform Count TEC: Total Escherichia Coli Count

Table 2. Bacterial density of different UHT milk samples

Product name	ID	TCC (CFU/ml-1)	TEC (CFU/ml-1)
	AWL1	Absent	Absent
	AWL2	Absent	Absent
	AWL3	Absent	Absent
	AWL4	Absent	Absent
	AWL5	Absent	Absent
	MR1	Absent	Absent
UHT milk	MR2	Absent	Absent
	MR3	Absent	Absent
	MR4	Absent	Absent
	MR5	Absent	Absent
	LS1	Absent	Absent
	LS2	Absent	Absent
	LS3	Absent	Absent
	LS4	Absent	Absent
	LS5	Absent	Absent

Table 3. Bacterial density of different biscuit samples

Product name	ID	TCC (CFU/g)	TEC (CFU/g)
	T1	Absent	Absent
	T2	Absent	Absent
	T3	Absent	Absent
	T4	Absent	Absent
	T5	Absent	Absent
	HB1	Absent	Absent
	HB2	Absent	Absent
Biscuits	HB3	Absent	Absent
	HB4	Absent	Absent
	HB5	Absent	Absent
	ABW1	Absent	Absent
	ABW2	Absent	Absent
	ABW3	Absent	Absent
	ABW4	Absent	Absent
	ABW5	Absent	Absent

The results of the bacterial density for the UHT milk are displayed in Table 2. The three most commonly used UHT milk have shown zero growth of coliforms and *E. coli*. Two of the three UHT milk brands are imported, while the third UHT milk is locally manufactured and has the same microbiological quality as the imported UHT milk brand.

The findings of the bacterial load for the biscuits are presented in Table 3. Three of the most commonly used biscuits had zero growth of coliforms and *E. coli*. All three biscuit brands are imported and have similar microbiological quality.

5. Discussion

Food safety is an important issue all over the world, in particular in dairy chains, where most of the operations rely on human handling. The presence of coliforms and *E. coli* in milk is a prominent indicator of fecal contamination. However, this research showed that all 15 samples of UHT milk contained neither coliforms nor *Escherichia coli*. According to 2015 Gulf State Organization standards for foodstuffs, microbial analysis of all 15 UHT milk samples passed. Total coliform and *E. coli* counts are hygienic indicators demonstrating states of good manufacturing practices during milk production, as well as an assessment of microbial safety in milk [24]. A study that was conducted in Dhaka City, Bangladesh showed similar results to this research [21]. Another study about the microbial quality of UHT milk that was carried out in Iran also showed negative growth of coliforms after microbial analysis [22]. The findings observed with UHT milk in this research are comparable with the results of research in Kampala, Uganda, which found that the UHT milk had no detectable microbial contaminants [23].

Pasteurized milk should not contain any coliform bacteria, as though coliform bacteria can't live at the pasteurization temperature, but the presence of coliform in the pasteurized milk samples shows either a defect in the pasteurization process or post-pasteurization contamination, which includes contamination from packaging substances or defects in pipelines. A study that was conducted in India indicated that coliforms were found in pasteurized milk after four days of refrigeration. At the same time, microbial analysis of UHT milk indicated the presence of coliforms. These findings of coliform bacteria demonstrated that processed milk was not properly treated and may pose health risks to consumers [25]. Another study that was carried out in the Nairobi region found varying results of microbial analysis of pasteurized milk, but they were within the allowable limit [26].

No bacterial growth (coliforms and *E. coli*) was seen on all ten biscuit samples from two different brands, which are the most commonly used biscuits in Hargeisa. This indicated that the biscuits were made in a good hygienic situation, and sterile packaging materials were also used. According to GSO standards 2015, two brands of biscuits are safe for human consumption because the results are within the acceptable limit. The findings of this research are similar to the results of two studies that were conducted in either Brazil or Nigeria [27,28]. Another study that was also carried out in Nigeria about the quality

of biscuits found similar findings to this research, but there were slight differences. Most of the analyzed biscuits demonstrated zero coliform growth for the first two weeks after manufacture. Starting in the third week, some of the biscuit samples showed coliform multiplication [29]. Results from a study in Nigeria about the microbial profile of biscuits indicated that locally manufactured biscuits had zero coliforms on the day of production, but coliforms increased above the allowable limit during storage [30].

Microbiological analysis of two chip brands showed zero bacterial growth (coliform and *E. coli*). One of the two chip brands is locally manufactured but has the same microbial quality as the imported brand. The data in this research differed from a study done in Nigeria, but both results are within the acceptable range of coliforms (less than 100 CFU per gram) but no *E. coli* [31]. The data in this study varied from two other studies about the microbial quality of chips, which both contained coliforms and *E. coli* beyond an acceptable limit [32,33].

6. Conclusion

In summary, either imported or locally manufactured UHT milk samples, chips, and biscuits collected from different shops, stores, and supermarkets are of high quality. The above mentioned food products did not contain disease-causing microbes. Quality similarity of imported and locally manufactured UHT milk and chips were not expected. One of the main findings of this analysis of UHT milk and chips was that one of the local industries applied good manufacturing practices, which made their product of high quality and similar to the imported UHT milk and chip samples. The findings of this study also disproved the wrong hypothesis about quality of imported foods. Microbiologically analyzed foods were safe for human consumption. This study recommended the government and relevant stakeholders to know the significance of food safety issues to avoid any possible foodborne disease.

Conflict of Interest

The authors have no potential conflict of interest.

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