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Microbiological Characteristics of White Cheese (*Gibna bayda*) Manufactured under Traditional Conditions

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Authors' contributions

This work was carried out in collaboration between both authors. Author MOMA performed the statistical analysis and wrote the first draft of the manuscript. Author HEAO designed the study, managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript

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ABSTRACT

Aims: This study was conducted to evaluate the quality control of white cheese (*Gibna bayda*) processing in traditional plants. White cheese was manufactured using raw cow milk from two areas in North Kordofan (Riash and Cazgail).
Methodology: Samples were collected from four stages of cheese manufacture (raw milk, curd before and after pressing, cheese delivered to the market). Samples were collected in sterile plastic bags stored at 4℃ in ice box and transported to the laboratory of Kordofan University for analysis. Raw milk and cheese were microbiologically (total viable bacteria, *Staphylococcus aureus*, coliform bacteria, lactobacilli bacteria, yeasts and moulds) evaluated during processing stages.
Results: the results showed that all microorganisms tested were not significantly affected by the area in which cheese was manufactured. During the processing stages, coliform bacteria count

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was significantly (P<0.001) higher in curd before and after pressing (log 7.31 cfu/gm and log 7.30 cfu/gm respectively) compared to cheese delivered to the market. Yeasts and moulds count was significantly (P<0.05) higher in curd after pressing (log 4.08 cfu/gm). Total viable bacteria, *S. aureus* and lactobacilli counts were not significantly affected by the stage of cheese processing.
Conclusion: The microbiological count of raw milk was high except yeasts and moulds, and the quality of cheese deteriorated after curd pressing then slightly improved in cheese delivered to the market.

Keywords: Gibna bayda; microbiological; traditional plants; raw milk.

1. INTRODUCTION

Traditional white pickled cheese (*Gibna Bayda*) of the Sudan is a product made from raw milk to which salt (6-20%) has been added without the use of starter culture [1,2]. Cheese making in Sudan is a seasonal activity being manufactured during the rainy season where plenty of milk is available. The procedure of manufacturing white cheese in different areas in the country is similar with slight variations [3]. It is carried out by collection of milk from producers or sellers in iron or plastic barrels, and salting the milk at the rate of 5-20% but in winter, milk is heated to 38-40℃ prior to salting. Rennet tablets (1 tablet/45 L milk) are dissolved in tap water and added to milk, and the mixture is left undisturbed for 5–6 hr until coagulation occurs. The curd is then cut and transferred to moulds lined with cheese cloth and pressed overnight to drain whey which is collected to be used later for preservation. The curd is removed from the moulds, cut into small cubes and preserved in the whey in tins sealed with soldering or in plastic barrels tightly covered to prevent oxidation [4]. The microbiological quality of white cheese can be influenced by numerous factors such as the quality of milk, the use of pasteurization or thermization, various technological parameters, the level and type (s) of microbial contamination that occur throughout the manufacture and the storage of cheese [5]. Recent studies have shown that artisanal cheeses have different and typical microbial population dynamics related to the local processing technology and geographical origin [6].

Sulieman et al. [7] studied the impact of combination of lactic acid bacteria and yeasts in the fermentation of *Jibna-beida* and found that total bacteria and yeasts and moulds counts of *Jibna–beida* made with starter culture (combined starter of *Lactobacillus plantarum*, *Streptococcus thermophillus* and *Kluveromyces lactis*) were 2.85×10^5 and 5.0×10^2 cfu/g, respectively, coliform bacteria, *Salmonella* spp. and *Staphylococcus aureus* cells were not found. Due to the traditional method of manufacturing *Gibna bayda* in Sudan, it is necessary to evaluate the cheese manufactured under these conditions in order to suggest the accurate methods of improvement of the cheese. Therefore, this study was aimed to evaluate the microbiological quality of the cheese manufactured in traditional plants during the steps of manufacture until delivery to the market.

2. MATERIALS AND METHODS

2.1 Cheese Manufacture

Cheese was manufactured in Riash and Cazgail areas (traditional plants for *Gibna bayda* manufacture) which are located 20 km and 30 km, respectively from El Obeid city, North Kordofan State. Cheese was manufactured as follows: the temperature of milk was recorded (35℃), and then salt was added at the rate of 6-8 kg/50 L milk. Rennet powder was dissolved in 5 ml water and added to milk (1.5 g/50 L milk), stirred for 5 min and left undisturbed to develop a curd. After complete coagulation (3 hr), the coagulation time was recorded and the curd was scooped into wooden moulds lined with cheese cloth. The curd was pressed (about 5 kg weight) overnight. Next day the curd was removed from the moulds, and the whey was collected and boiled to remove cheese particles, which were used for the manufacture of *mish*, and the whey left after *mish* manufacture was used for cheese preservation. The cheese was cut into small cubes and immersed into the whey and packaged.

2.2 Sample Collection and Analysis

During manufacture of cheese till delivery to the market, the samples were collected as follows: raw milk; curd before pressing; curd after pressing; cheese delivered to the market. Milk (10 samples from each area) and cheese (10 samples from each stage) were collected in

sterile plastic bags stored in ice box, transported to the laboratory and stored at 4℃ till examination which was carried out immediately on arrival to the laboratory or within 24 hr. The experiment was carried out in triplicate.

2.3 Microbiological Examination

2.3.1 Preparation of sample dilutions

A representative sample of 11 g cheese was homogenized in 99 mL sterile peptone water to make 10^{-1} dilution, then serial dilutions of 10^{-2} – 10^{-7} were prepared [8].

2.3.2 Total viable bacteria count

Spread plate method on plate count agar medium was used, and the dishes were inverted and incubated at 25℃ for 48±2 hr [8].

2.3.3 Coliform bacteria count

MacConkey agar medium was used for the enumeration of coliform bacteria. The specified dilutions were deposited onto the medium and spread over the surface of the agar, the dishes were then inverted and incubated at 37℃ for 48±2 hr [9].

2.3.4 *Staphylococcus aureus* count

Baird Parker medium was used for the enumeration of *S. aureus*. The specified dilutions were deposited on to the solidified medium and spread over the surface of the agar, the dishes were then inverted and incubated at 37℃ for 48±2 hr [10].

2.3.5 Lactobacilli count

MRS medium was used for the enumeration of lactobacilli. The specified dilutions were deposited onto the solidified medium and spread over the surface of the agar, the dishes were then inverted and incubated at 37℃ for 48±2 hr [11].

2.3.6 Yeasts and moulds count

Yeast extract agar medium was used for the enumeration of yeasts and moulds. The specified dilutions were deposited on to the solidified medium and spread over the surface of the agar, the dishes were then inverted and incubated at 25℃ for 5 days [12].

2.4 Statistical Analysis

Statistical Analysis Systems (SAS, ver. 9) was used to determine the effect of area and processing steps on the microbiological characteristics of cheese using General Linear Model (GLM) procedure. Duncan multiple range test was used for separation of means at $P \leq 0.05$.

3. RESULTS

Although there was no significant variation ($P>0.05$) in the count of all microbes tested, the highest TVB and yeasts and moulds counts were found in Cazgail area (Log 7.97 cfu/g and Log 3.99 cfu/g, respectively), while slightly higher counts of coliform bacteria (Log 7.67 cfu/g), *S. aureus* (Log 3.98 cfu/g) and lactobacilli count (Log 6.31 cfu/g) were reported in cheese from Riash area (Table 1). TVBC and *S. aureus* started high (Log 7.97 and Log 4.01 cfu/g, respectively) in the milk then slightly decreased in the cured before pressing, followed by an increase in the curd after pressing, then decreased in cheese delivered to the market. Coliform bacteria count was significantly ($P<0.001$) higher in raw milk, then steadily decreased in curd before and after pressing and cheese delivered to the market. Lactobacilli count steadily increased from Log 5.29 cfu/g in milk to Log 6.33 cfu/g in cheese delivered to the market. Yeasts and moulds count reached the highest count (Log 4.08 cfu/g) in curd after pressing, and then decreased thereafter to Log 3.95 cfu/g when cheese was delivered to the market (Table 2). In cheese from Riash area, only coliform bacteria count significantly ($P<0.001$) decreased during processing and delivery to the market, while other microorganisms were not significantly ($P>0.05$) affected. However, TVBC was high in curd after pressing, while *S. aureus* count was high in curd before pressing, and the highest lactobacilli count was in cheese delivered to the market. The highest yeasts and moulds count was in curd before pressing (Table 3). In Cazgail area, coliform bacteria count significantly ($P<0.05$) decreased from raw milk till cheese delivery to the market, while lactobacilli and yeasts and moulds counts significantly ($P<0.05$) increased. Although no significant variation was found in TVBC and *S. aureus,* the count of both organisms decreased from raw milk till cheese delivery to the market (Table 4).

Table 1. Microbiological characteristics of cheese manufactured in Riash and Cazgail

Microorganisms	Area in which cheese was manufactured		SE	*p*
	Riash	Cazgail		
Total viable bacteria count	7.93[a]	7.97[a]	0.791	0.7644
Coliform bacteria count	7.67[a]	7.52[a]	0.942	0.3952
Staphylococcus aurous	3.98[a]	3.83[a]	0.461	0.4076
Lactobacilli count	6.31[a]	6.23[a]	00755	0.2815
Yeasts and moulds count	3.87[a]	3.99[a]	0.464	0.2009

Means in the same row bearing similar superscripts are not significantly different (p>0.05)
NS = Not significant
SL= Significance level
SE = Standard error of means

Table 2. Microbiological characteristics of raw milk and cheese samples during processing till delivered to market

Microorganisms	Milk	Curd before pressing	Curd after pressing	Cheese delivered to market	SE	*P*
Total viable bacteria count	7.97[a]	7.87[a]	8.08[a]	7.85[a]	1.370	0.5869
Coliform bacteria count	8.04[a]	7.31[a]	7.30[b]	6.97[b]	1.268	<0.0001
Staphylococcus aureus	4.01[a]	3.95[a]	3.99[a]	3.58[a]	0.685	0.1436
Lactobacilli count	5.29[a]	6.19[a]	6.23[a]	6.33[a]	1.089	0.2616
Yeasts and moulds count	3.51[b]	4.03[a]	4.08[a]	3.95[a]	0.692	0.0119

Means in the same row bearing similar superscripts are not significantly different (p>0.05).
**** = p<0.001*
** = p<0.05*
NS = Not significant
SL= Significance level
SE = Standard error of means

Table 3. Microbiological characteristics of milk curd before and afterpressing and cheese delivered to the market from Riash area

Microorganisms	Milk	Curd before pressing	Curd after pressing	Cheese delivered to market	SE	*p*
Total viable bacteria count	7.68[a]	7.83[a]	8.17[a]	7.91[a]	1.864	0.4571
Coliform bacteria count	8.13[a]	7.21[b]	7.37[b]	7.10[b]	1.802	0.0004
Staphylococcus aureus	3.99[a]	4.09[a]	4.08[a]	3.60[a]	0.982	0.5186
Lactobacilli count	5.46[a]	5.91[a]	6.05[a]	6.36[a]	1.439	0.2756
Yeasts and moulds count	3.51[a]	5.97[a]	4.02[a]	3.83[a]	0.950	0.3318

Means in the same row bearing similar superscripts are not significantly different (p>0.05).
**** = p<0.001*
NS = Not significant
SL= Significance level
SE = Standard error of means

Table 4. Microbiological characteristics of milk, curd before and after pressing and cheese (*Gibna bayda*) delivered to the market from Cazgail area

Microorganisms	Milk	Curd before pressing	Curd after pressing	Cheese delivered to market	SE	*P*
Total viable bacteria count	8.14[a]	7.91[a]	7.98[a]	7.79[a]	1.979	0.4701
Coliform bacteria count	7.93[a]	7.39[b]	7.22[b]	6.77[c]	1.772	0.0312
Staphylococcus aureus	4.03[a]	3.74[a]	3.87[a]	3.55[a]	0.931	0.5324
Lactobacilli count	5.17[a]	6.37[b]	6.35[b]	6.29[b]	1.479	0.2508
Yeasts and moulds count	3.51[b]	4.08[a]	4.12[a]	4.04[a]	0.997	0.3425

Means in the same row bearing similar superscripts are not significantly different (p>0.05)
** = p<0.05*
NS = Not significant
SL= Significance level
SE = Standard error of means

4. DISCUSSION

The results of microbiological characteristics indicated that TVB and coliform bacteria counts were higher in milk and cheese indicating the unhygienic conditions under which milk was produced and cheese was processed. All micrograms under investigation were not significantly different in cheese produced in the two areas which means that the processing conditions are somewhat similar. Similar results were reported by Kamber and Celik [13] for TBC, while lower values were reported by the same authors for coliform bacteria count. The results are in disagreement with Ceylan et al. [14], and in line with Aissi et al. [15]. *S. aureus* count exceeded Log 3.5 cfu/gm indicating that cheese was produced either from milk of mastitic cows or contamination accrued during processing. These results are not in line with Aissi et al. [15] who did not find any colonies of *S. aureus* in local cheese marketed in Benin. However, the results of this study are in agreement with Vural et al. [16] who reported that 84.76% of Orgu cheese samples were positive for *Staphylococcus*. Lactobacilli count ranged between Log 6.31 cfu/gm in Riash area and Log 6.23 cfu/gm in Cazgail area. The results of lactobacilli count in this study are in accordance to the findings of Vural et al. [16] who reported an average of 3.4×10^6 cfu/gm of *Lactobacillus* spp. in Orgu cheese. The results of yeasts and moulds count were higher than those reported by Menendez et al. [17], Mennane et al. [18] and Vasek et al. [19]. Similar results were reported by Mennane et al. [20]. During processing to delivery to the market all microorganisms tested increased after pressing then decreased in population when cheese was delivered to the market. This might be due to unhygienic conditions which enabled the bacteria to grow, while the decrease in cheese delivered to the market might be due to the antagonistic effect of salt and lactic acid produced by natural microflora. However, lactobacilli count increased in number till delivery to the market. This might be attributed to the favourabale conditions for the natural flora to proliferate and increase in number. The result of TVBC was in agreement with Effat et al. [21] who reported that TVBC of all functional cheeses increased during the first 10 days of refrigeration period then declined reaching the lowest count at the end. Cetinkaya and Soyutemiz [22] reported that during manufacture of Kashar cheese, TVBC increased from Log 6.5 cfu/gm in raw milk to as high as Log 8.0 cfu/gm in the acidified curd then decreased during heat treatment of curd. Coliform bacteria count followed the same trend of TVBC. These results are in disagreement with Cetinkaya and Soyutemiz [22] who reported a peak coliform bacterial count in the coagulum, followed by decline till heat treatment of the curd. *S. aureus* count showed a peak in raw milk and curd after pressing, followed by a decline in cheese delivered to the market. Lactobacilli count showed an increase in raw milk till cheese delivery to the market. The results are in line with Sert et al. [23] and Effat et al. [21]. Higher count of lactobacilli could be attributed to the ability of the genus *Lactobacillus* to survive at high acidity [21]. Cetinkaya and Soyutemiz [22] reported that lactic acid bacteria on MRS agar medium steadily increased to a maximum during curd acidification and then declined when curd was heat treated. Yeasts and moulds count reached the maximum in curd after pressing then

declined in cheese delivered to the market. Similar results are reported by Cetinkaya and Soyutemiz [22] who reported that yeasts and moulds count reached the maximum in acidified curd followed by a decline in heat treated curd.

5. CONCLUSION

The microbial load of cheese from two areas was not significantly different. Coliform bacteria count was significantly higher in curd before and after pressing, while yeasts and moulds count was high in curd after pressing, and the rest of microbes were not significantly affected by the processing conditions. This investigation highlighted the problem of cheese manufacture under traditional conditions in Sudan which needs to be improved by legislations and laws that govern this industry to produce a safe product to the consumer.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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