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RESEARCH ARTICLE
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Physicochemical and Microbiological Evaluation of Locally Produced White Soft Cheese in Khabat District, Erbil Governorate.

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ABSTRACT

The purpose of this study was to evaluate the physicochemical and microbiological quality of Kurdish white soft cheeses locally produced in different places at Khabat District in Erbil governorate. A total of 20 samples of white soft cheeses were collected randomly from Khabat District markets. Physiochemically and microbiologically analyzed. Physicochemical analysis of the white soft cheese samples was determined as 6.01 for pH, 1.23 % total acidity, 53.82 % moisture content, 22.26 % protein content, 2.34 % ash, 15.69 % fat, 2.45 % salt (NaCl), 30.49 % solid non-fat, 46.18 % total solids on average, respectively. Microbiological examination data presented that the total aerobic count of white soft cheese samples ranged between 1.6×10^4 and 3.5×10^6 cfu/g, and coliform bacteria were detected in 18 out of 20 examined white soft cheese samples, ranging between 3.8×10^2 and 5.2×10^4 cfu/g. Escherichia coli were present in 17 examined cheese samples, ranging between 4×10^2 and 1.5×10^6 cfu/g. *Staphylococcus aureus* at the interval 4.1×10^3 and 2.6×10^5 cfu/g, while in all soft cheese samples, the *Salmonella spp*. was not detected. Also, yeasts and molds were present in all soft cheese samples at the interval 2.4×10^2 and 1.6×10^4 cfu/g. White soft cheese produced in Khabat District is incompatible with the Iraqi Standard and Specification.

***Keywords*:** Kurdish white soft cheese, Physicochemical composition, Microbiological, Quality, Khabat District.

INTRODUCTION

The most common form of cheese made in Kurdistan is white soft cheese. In Kurdistan, white soft cheese is produced from cow, goat or sheep milk or a mixture of them. Making the soft cheese can be summed up as heating the milk to roughly 40°C, coagulating it for 35–50 minutes with rennet, and then pressing it through cheese cloth. After manufacture, the soft cheese is typically devoured right away [1]. According to the Iraqi standards for white soft cheese (1-693: 2020), white soft cheese is described as un-ripened cheeses that are ready to consume immediately after processing. Milk and cheese have high nutritional value for human consumption as their protein and fat have a great biological value and contain all essential amino and fatty acids [2]. It is also regarded as a source of vitamins, minerals, including iron, calcium, and phosphorus. [3]. The shelf life of soft white cheese is extremely short, especially when refrigerated; several kinds of microbes can get into the cheese during production and handling. Because of their nutritional value, particularly their high protein and fat content, provides an ideal development environment for a wide range of microorganisms [4]. Around the world, soft white cheese is a popular food. In Iraq, it is usually consumed three to four weeks after production. Raw milk contains about 30% of undesirable micro-organisms in total microbial count, therefore, this problem suggests inflexible hygienic measures must be followed in cheese making [5]. Microbial contamination of soft white cheese can stem from multiple sources during production, including the floor, packaging materials, curd-cutting knives, cheese vat, cold storage room, cheese cloth and the air in the production area. [6] Presence of high levels of pathogenic microorganisms such as Coliform bacteria, being an indicator of process failures or post- pasteurization contamination [7]. Among all microorganisms' Enteric pathogens such as *Escherichia coli* and *Salmonella spp*. are frequently contaminating organisms, and are reliable indicator of fecal contamination generally in unhygienic conditions of milk, water, food and other equipment's [8]. *Staphylococcus aureus*, which produces enterotoxins, is another public health risk related to cheese intake worldwide [9]. The presence of Staphylococcus aureus in raw milk or its products may be attributed to inadequate heat treatment, unsanitary manufacturing and handling processes, the use of contaminated containers, and faulty transportation and storage conditions [10].

The objective of this study is to evaluate the physicochemical properties and microbiological quality of locally produced white soft cheese in Khabat District, Erbil Governorate, with a focus on identifying potential sources of microbial contamination and assessing the presence of pathogenic microorganisms that may pose health risks to consumers.

Materials and Methods

Sampling:

A total of 20 samples of local unpacked white soft cheese were collected from the retailers of different local markets in Erbil city (Khabat District) during March to May 2024. The samples were labelled and placed into clean, dry and sterilized sealable plastic bags and transported quickly to an insulated ice box to the laboratory. The samples were divided into two portions, one for physicochemical analysis and the other for microbiological examination, conducted on the same collection day.

Microbiological investigation of soft white cheese

Preparation of decimal dilutions (0.1% peptone water) for microbiological testing

A homogenate of each cheese sample was prepared by mixing 25 g of the sample with 225 ml of sterile 2% sodium citrate solution at 45°C in a pre-sterilized polyethylene bag. The mixture was homogenized to obtain appropriate decimal dilutions for microbiological analysis [11].

Total aerobic mesophilic count was performed using the pour plate method on Plate Count Agar (PCA), by ISO 4833-1 [12]. Plates were incubated at 30°C for 72 ± 3 hours, and results were expressed as colony-forming units per gram (cfu/g) of cheese.

Coliforms count: The coliform count was determined using the pour plate technique on to plates of violet red bile glucose agar (VRBG) as described in the International Standard, ISO 4832 [13]. Plates were incubated for 24 hours at 37°C.

***Staphylococcus aureus* count:**

Detection and Enumeration of Staphylococcus. aureus according to ISO 6888, [14] commonly by using the Baird-Parker agar plate. The Petri dishes were incubated at 37°C for 48 hours, and then Black colonies with a clear zone around were counted using a colony counter and recorded as CFU/g. Coagulase production, anaerobic utilization of glucose and mannitol, catalase test, and Gram stain were used for more assurance.

Yeast and Molds count.

Yeast and Molds count were done as described in the International Standard ISO, 6611, [15]. Dichloran rose Bengal chloramphenicol agar medium was used for enumerating yeast and mould. Petri dishes were incubated at 25°C for 5 days, and then colonies were counted using colony counter and recorded as cfu/gm.

***Escherichia coli* count**

E. coli, count was done as described in the International Standard, ISO, 16649-2, [16]. Tryptone Bile X-glucuronide agar (TBX) was used to enumerate *E. coli*, plates were incubated at 44^0C for 18-24 hours.

Detection of *Salmonella spp.*

Detection of *Salmonella spp* was detected by enrichment technique according to the procedure outlined in ISO, 6579, [17].

Cheese's gross composition tests:

Homogenized and grated soft white cheese samples was analyzed for titratable acidity, total solids, moisture and ash content (AOAC; No: 920.124, 990:21, 926.08, 942.05), [18], The protein content was determined using the Kjeldahl method according to ISO 8968-1, [19]. Salt (NaCl) content was estimated c according to ISO 5943-1, [20]. The pH meter was used to estimate the pH value of soft white cheese sample. Every sample was examined in parallel triplicate. [21]

Result and discussion

Physicochemical Analysis: -

Table 1 and Figure 1 present the chemical composition of Kurdish white soft cheese samples collected from the local market in Khabat District. All cheese samples were analyzed for (acidity, pH, moisture, protein, ash, fat, salt, S.N.F and total solid). From the presented data, the acidity percentage ranged between 0.75 and 2.12%. The pH value ranged from 5.03 to 6.95. Moisture content ranged between 50.78% and 57.68 %. Protein content ranged between 19.62% and 23.96%. Ash content ranged between 1.86 and 3.22 %. Fat content ranged between 12.5% and 18.50 %. Salt content ranged between 1.7 and 3.6%. S.N.F content ranged between 26.23 and 34.31%. Total solid content ranged between 42.23% and 49.22%.

The estimated means of total acidity, pH, and moisture were 1.23%, 6.01, and 53.82%, respectively Figure 1 these results nearly similar to the findings stated by [22] and [23] who documented mean total acidity, pH and moisture of (1.47), (6) and (56.5) respectively. The protein, ash and fat content revealed values of (22.26%), (2.34%) and (15.69%) respectively (Figure 1). [24] documented that the averages of protein, ash and fat content revealed values of (20.29%), (2.34%) and (15.01%). My results present that the average of Salt, S.N.F and total solid were (2.45%), (30.49%) and (46.18%) respectively. These values were similar to those reported for white soft cheese samples by [25], as shown in Figure 1. On the other hand, the evaluated mean of twenty samples indicated that it conformed to the Iraqi standard specification and criteria issued under the (No. 1/ 693: 2020) [26] and [27] for chemical composition of cheese, as shown in Figure 1.

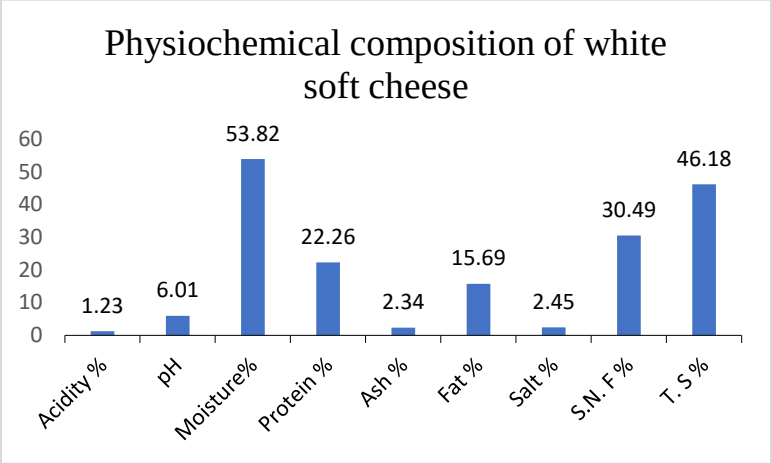

Figure 1: (Acidity, pH, moisture, protein, ash, fat, salt, solid non-fat, total solids) for twenty white soft cheese samples collected from Khabat District in Erbil governorate.

Table 1. Physicochemical composition analysis of local white soft cheese samples in Khabat District

No.	Acidity	pH	Moisture	Protein	Ash	Fat	Salt	S.N. F	T. S
1	0.93%	6.28	54.3%	20.14%	2.91%	15.90%	3.05%	29.85%	45.70%
2	1.00%	6.1	57.68%	22.18%	1.96%	13.85%	2.16%	28.38%	42.23%
3	1.06%	6.03	55.02%	21.43%	2.03%	16.10%	2.30%	28.88%	44.98%
4	0.84%	6.75	53.19%	23.96%	3.22%	12.50%	3.11%	34.31%	46.81%
5	1.87%	5.72	57.03%	21.04%	2.01%	16.65%	1.90%	26.32%	42.97%
6	0.96%	6.8	52.68%	24.11%	2.54%	14.30%	2.20%	33.02%	47.32%
7	0.99%	5.58	50.79%	23.08%	2.70%	17.64%	2.60%	31.57%	49.21%
8	0.75%	6.25	54.77%	20.30%	2.42%	15.66%	3.10%	29.57%	45.23%
9	1.76%	5.46	52.45%	21.18%	2.04%	18.20%	1.90%	29.35%	47.55%
10	1.26%	5.77	57.04%	21.98%	1.86%	13.45%	2.11%	29.51%	42.96%
11	1.15%	5.96	50.78%	24.10%	2.01%	16.70%	2.30%	32.52%	49.22%
12	0.83%	6.95	51.14%	21.36%	2.40%	17.95%	3.12%	30.91%	48.86%
13	1.06%	5.9	53.06%	21.84%	2.40%	15.89%	2.60%	31.05%	46.94%
14	0.92%	5.78	54.24%	22.55%	1.97%	14.21%	2.30%	31.55%	45.76%
15	2.12%	5.24	51.61%	23.23%	2.03%	17.17%	1.70%	31.22%	48.39%
16	1.09%	5.89	53.11%	19.62%	3.07%	18.50%	2.20%	28.39%	46.89%
17	1.07%	6.34	56.12%	22.12%	2.23%	13.43%	2.30%	30.45%	43.88%
18	2.04%	5.03	52.46%	23.16%	2.80%	17.30%	1.80%	30.24%	47.54%
19	1.90%	5.83	53.22%	24.01%	2.23%	14.84%	2.70%	31.94%	46.78%
20	0.92%	6.51	55.61%	23.71%	1.90%	13.59%	3.60%	30.80%	44.39%
Mean	1.23%	6.01	53.82%	22.26%	2.34%	15.69%	2.45%	30.49%	46.18%

Microbiological Examination: -

In this study, Kurdish white soft cheese samples were examined for their microbiological quality. The safety and quality of white soft cheese are severely related to its microbial content. The microbial counts of cheese samples are revealed in Table 2. The total aerobic count ranged between 1.6×10^4 and 3.5×10^6 cfu/g (Table 2). obtained results of white soft cheese, nearly similar results were reported by [28] and [29]. Results indicated that all of the examined cheese samples were highly contaminated with total aerobic count microorganisms. These results are higher than the Indian microbiological criteria for soft cheese (FSSAI: 2011). Indian standards for total plate counts are $5x10^5$ per g [30], which reflects the general lack of hygienic conditions, especially during production, handling, cheese marketing and bad storage, cross-contamination and post-heat treatment contamination [31].

Concerning the results shown in Table 2, it revealed that coliform counts were detected in 18 examined samples out of 20 samples in white soft cheese samples, ranging between 3.8×102 and 5.2×104 cfu/g, which were generally high and unacceptable in most samples. The limits proposed by Iraqi standards (2270/5:2006) must not exceed 1×10^3 cfu/g. [31]. The presence of coliform bacteria in cheese samples indicated the poor manufacturing conditions and direct or indirect faecal contamination of the milk. [33,34].

Results indicated that *Escherichia coli* were present in 17 examined cheese samples, ranging between 4×10^2 and 1.5×10^6 cfu/g, (Table 2). *Escherichia coli* could be detected in the analyzed sample of cheese, and this was in disagreement with the Iraqi Standards. According to the Iraqi standards (2270/5:2006), *Escherichia coli* should be absent in white soft cheese. The presence *Escherichia coli* in white soft cheese samples indicates an extensive deficiency of satisfactory sanitary practices during cheese processing and the faecal contamination of the raw milk. (Enteropathogenic *E. coli*) causes gastroenteritis in humans and other animals [35]. White soft cheese samples that gives coagulase positive for *staphylococcus aureus* only seven samples of 20 cheese samples gave positive results, data in Table 2 showed the detection of *staphylococcus aureus* at the interval 4.1×10^3 and 2.6×10^5 cfu/g, samples were highly contaminated with *staphylococcus* indicating mishandling and lack of sanitation during production, distribution and storage, in addition to the prevalence of *S. aureus* on human body parts like the skin, nose and hands may be the reason for the high frequency of the genus in the samples under examination.[36,37]. Similar results were found by [38,39]. When *Staph. aureus* counts more than 5 log cfu/g, they can create heat stable enterotoxins. These enterotoxins are commonly associated with outbreaks of food poisoning, which typically manifest rapidly (within one to six hours) and are typified by the presence of severe abdominal pain, diarrhea [40]. According to the limits proposed by Iraqi standards (2270/5:2006), counts of Staph. aureus in white soft cheese must not exceed 1×10^3 cfu/g. in this respect 1.5×10^4 of the examined cheese samples were not in agreement with the acceptable limits of *Staph. aureus* count. obtained results of examined cheese incompatible results were reported by [41]. Results suggest white soft cheese marketed in Khabat District in Erbil might be an important vehicle of transmission for pathogens, which, after consumption of defective cheese, can cause serious infections in the human body.

Salmonellae spp were absent in all cheese samples shown in Table 2; this result agrees with the findings of Aly et al. [42] and agrees with the Iraqi standards (2270/5:2006). Also, the results agree with Egyptian and Indian microbiological criteria for soft cheese (ES: 1008/11/2005 and FSSAI: 2011) [43,30], which should be absent. *Salmonella* spp bacteria were absent in all the cheese samples examined, maybe due to a high amount of salt (44).

Data shown in Table 2 revealed that contaminated yeasts and moulds were detected in all examined cheese samples at the interval 2.4×10^2 and 1.6×10^4 cfu/g. According to the Iraqi standards (2270/5:2006), all examined cheese samples were incompatible with the suggested viable yeasts and moulds count, which must not exceed 1×10^2. These results agree with those found by [45] and [46]. Numerous sources can lead to the contamination of white soft cheese with yeasts and moulds throughout the milk used, the environment, washing water, handling and packaging. This contamination negatively impacts the shelf life and quality of the cheese [47]. Its lipolytic and proteolytic properties result in product discolourations, bad tastes, and texture alterations. Additionally, certain yeast species can lead to gastrointestinal disorders, endocarditis and systemic infections that can sometimes be fatal [48]. Safety concerns were noted in addition to the quality issues brought on by mould infestation, since certain toxic mould species can release mycotoxins that can cause cancer in the general population [49]. Finally, the results are higher than Indian microbiological criteria for soft cheese (FSSAI: 2011). Indian standards for yeasts & molds counts are absent in 1g [30].

Table 2. Microbiological Examination of local white soft cheese samples in Khabat District.

`No.	Total aerobic count cfu/g	Coliforms count cfu/g	*E. coli* cfu/g	*S. aureus* cfu/g	*Salmonella spp.* cfu/g	Yeast &Molds cfu/g
1	3.4×10^5	4.2×10^3	1.3×10^4	-	-	2.6×10^2
2	6.2×10^4	7.3×10^3	3.3×10^3	2.1×10^5	-	2×10^3
3	2.7×10^6	2.2×10^3	-	3.8×10^4	-	1.5×10^3
4	5.8×10^4	5.1×10^4	3.4×10^3	-	-	4.2×10^2
5	3.6×10^5	6.3×10^3	2.1×10^3	-	-	1.3×10^4
6	9.4×10^3	4.5×10^3	6.4×10^3	2.6×10^5	-	4.1×10^3
7	2.5×10^6	1.1×10^4	2.3×10^3		-	3.2×10^3
8	4.7×10^6	7.3×10^3	2.1×10^3	-	-	6.2×10^2
9	8.1×10^5	5.9×10^3	6.4×10^2	4.1×10^3	-	1.3×10^3
10	3.5×10^6	4.1×10^3	2.3×10^3	-	-	3.5×10^3
11	2.5×10^6	3.8×10^2	2.1×10^3	-	-	3.6×10^3
12	7.2×10^3	2.5×10^3	4×10^2	6.2×10^3	-	2.3×10^2
13	1.6×10^4	-	-	-	-	1.3×10^3
14	4.5×10^5	4×10^3	4.1×10^3	-	-	4.6×10^3
15	3.9×10^6	2.1×10^4	6.4×10^2	-	-	2.4×10^2
16	5.3×10^6	3.1×10^3	2×10^4	-	-	1.7×10^3
17	6.5×10^5	5.3×10^3	3.2×10^3	1.5×10^4	-	2×10^3
18	1.2×10^6	-	-	-	-	1.6×10^4
19	9.2×10^4	6.1×10^3	1.3×10^5	4.4×10^3	-	4.3×10^2
20	7.7×10^5	5.2×10^4	3.1×10^3	-	-	3.1×10^3

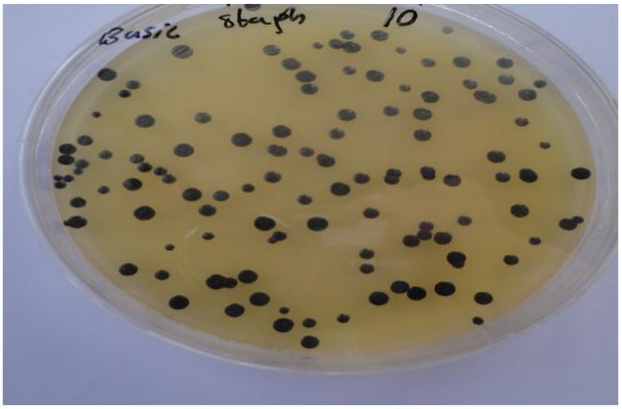

Figure2: *Staphylococcus. aureus* on Baird-Parker (BP) agar.

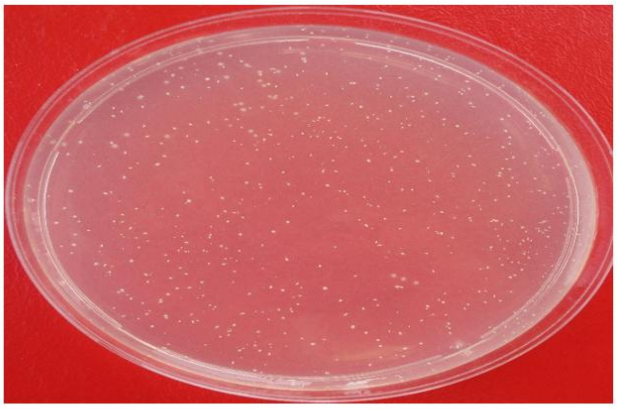

Figure3: Total aerobic on Plate Count (PC) agar.

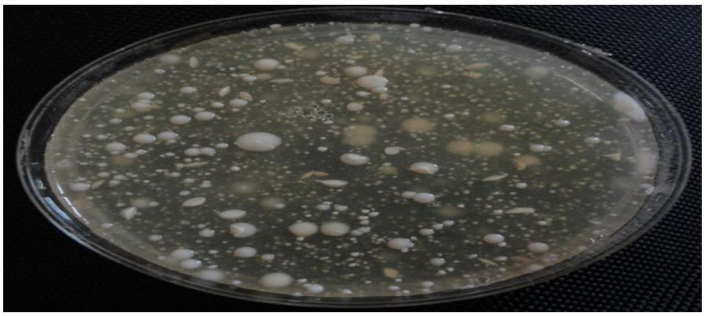

Figure4: Yeast and Molds on Dichloran Rose-Bengal Chloramphenicol (DRBC)agar.

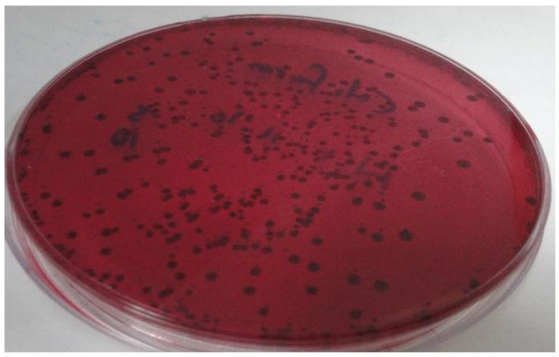

Figure 5: Coliforms on violet red bile glucose (VRBG) agar.

Conclusion

The current study evaluated the physicochemical and microbiological quality of Kurdish white soft cheese. The obtained results of the research, especially with considering to the variations in the chemical composition might be due to the different milk composition that impacts the chemical composition of the produced white soft cheese, further presented that there is a lack of a standardized method in processing white soft cheese production in Khabat District in Erbil. White soft cheese made from raw milk by the villagers might be a source of contamination, especially coliforms and *Staphylococcus aureus*. This highlights the need to perform good hygienic practices and effective inspection from production through the delivery chain to the consumer. Overall, the results attained in the research confirmed that the hygienic safety and quality of fresh soft cheese sold in Khabat District in Erbil is low and does not provide enough assurance in terms of public health. Thus, it is important to increase public awareness, pointing out that factories and households should be stimulated to follow the severe hygienic control measures. Moreover, to pasteurized milk should be used for the production of local soft cheese, with its preservation inside the brine.

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التقييم الفيزيائي الكيميائي والميكروبيولوجي للجبن الأبيض الطري المحلي المنتج في قضاء خبات، محافظة أربيل.

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الخلاصة
هدفت هذه الدراسة إلى تقييم الجودة الفيزيائية والكيميائية والميكروبيولوجية للأجبان الطرية البيضاء الكردية المنتجة محليًا في مناطق مختلفة من قضاء خبات بمحافظة أربيل. تم جمع عشرون عينة من الجبن الأبيض الطري بشكل عشوائي من الأسواق المحلية في القضاء، وأُجري لها تحليل شامل لتحديد الخصائص الفيزيائية-الكيميائية والميكروبيولوجية. أظهرت نتائج التحليل الفيزيائي-الكيميائي أن متوسط القيم المقاسة لعينات الجبن كانت على النحو الآتي: الرقم الهيدروجيني *(pH)*بلغ 6.01، الحموضة الكلية 1.23%، نسبة الرطوبة 53.82%، البروتين 22.26%، الرماد 2.34%، الدهون 15.69%، الملح 2.45%، المواد الصلبة غير الدهنية 30.49%، وإجمالي المواد الصلبة 46.18%.
اما الفحوصات الميكروبيولوجية فقد بينت ان العدد الكلى للبكتريا الهوائية تراوح بين $3.5x10^6$ - $1.6x10^4$ فى حين تراوح عدد البكتريا القولونية بين 3.8×10^2 - 5.2×10^4 وحدة/غم. كما تم الكشف عن وجود الاشريكية القولونية (*E. coli*) فى 17 عينة من اصل 20 ، بتعداد تراوح بين 1.5×10^6 - 4×10^2 وحدة /غم. و سجلت المكورات العنقودية الذهبية (*Staphylococcus aureus*) بتراكيز تراوحت بين 2.6×10^5 - 4.1×10^3 وحدة/غم. لم تسجل اي اصابة بالسالمونيلا في العينات المفحوصة. و بالمقابل، لوحظ وجود الخمائر و العفن في جميع العينات، بتعداد تراوح بين 1.6×10^4 - 2.4×10^2 وحدة/غم. استنادا الى هذة النتائج. يستنتج ان الجبن الطري الابيض المنتج محليا فى قضاء خبات لايتوافق مع المواصفات القياسية العراقية من حيث الجودة الميكروبيولوجية، مما يبرز الحاجة الى تحسين ممارسات التصنيع و النظافة خلال عمليات الانتاج و التوزيع لضمان سلامة المنتج و صحة المستهك..

الكلمات المفتاحية: الجبن الطري الأبيض الكردي، التركيب الفيزيائي والكيميائي، الميكروبيولوجي، الجودة، قضاء خبات.