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PHYSICOCHEMICAL AND MICROBIOLOGICAL QUALITY ATTRIBUTES OF SOME SYRIAN CHEESE VARIETIES PRODUCED IN EGYPT

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ABSTRACT

Due to the popularity and familiarity of Syrian cheese in Egypt, this study aimed to assess the sensory, chemical, and microbiological quality of Halloumi, Akawi, and Mudaffara cheese brands produced in Egyptian markets. 105 cheese samples (35 each of Halloumi, Akawi, and Mudaffara cheese) were randomly obtained from different dairy shops, hypermarkets, and online pages in the Giza and Cairo governorates. Sensory evaluation indicated a significant difference ($P<0.05$) between the overall mean of Halloumi cheese (85.60 ±0.76) and the other two types: Akawi 82.97 ±0.59 and Mudaffara 82.54 ±0.36. For the microbiological quality assessment, all samples were examined for the prevalence of total staphylococci, coagulase-positive staphylococci (CPS), coliforms, enterococci, salmonella species, aerobic spore formers, *Bacillus cereus*, anaerobic spore formers, yeasts, and molds. The highest mean value for total staphylococci ($67\times10^5\pm 25\times10^5$ CFU/g) was recorded by Akawi cheese samples. Suspected *E. coli* isolates were detected in 34.28%, 48.57%, and 28.57% of Halloumi, Akawi, and Mudaffara cheese samples, respectively. Aerobic spore formers were counted with high incidence in all examined samples, with an overall mean of $14\times10^3 \pm 1.0\times10^3$ CFU/g and a *B. cereus* overall mean of $21\times10^2 \pm 5.0\times10^2$ CFU/g. Anaerobic spore formers were found with low counts and an overall mean (13.5±4.2 MPN/g). Regarding the chemical composition, all parameters were insignificantly different between the three cheese types, except for salt% in Halloumi cheese, which was significantly ($P<0.05$) lower than other types. Therefore, standardized methods for manufacture, an integrated surveillance system and good manufacturing practice (GMP) during production were crucially recommended.

Key words: Syrian cheeses, Sensory, Enterococci, Aerobic spore formers, Salt.

INTRODUCTION

Cheese is a fermented milk-based solid dairy product, with approximately 750 cheese varieties, featuring a variety of flavors, textures and forms. Around 35 % of all milk is used for cheese production. Cheeses can be classified based on their method of coagulation (rennet-coagulated, acid-coagulated, and heat/acid-coagulated); ripening (internally bacterially ripened,

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mold-ripened, and surface-ripened), moisture content (soft, semi-hard and hard) and producing countries: United Kingdom (Cheddar), Italy (Parmesan and Mozzarella), France (Roquefort and Camembert), Germany, (Emmental), Greece (Feta), Egypt (Domiati, kareish and Mish) and Syria (Halloumi, Akawi, and Mudaffara) cheese (Fox *et al.,* 2017; Hayaloglu, 2017 and Khanal *et al.,* 2019).

Global cheese production is expected to reach 22.17 million metric tons by 2025. As compared to the 19.52 million a year in 2020, the market for cheese in Egypt has shown a positive compound annual growth rate (CAGR) of 9.85% from 2016 to 2021, with a sales value of 28,683.05 million in 2021, a 6.21% increase from the year before (Global data, 2023 and Statista, 2023).

After the civil war in Syria in 2011, UNHCR Egypt registered more than 153,000 Syrian refugees by the end of 2023 (UNHCR, 2023). They create job opportunities in various sectors, including food production and serving, especially cheese production, which continues to gain popularity in the Egyptian market. Several factors have contributed to the growing popularity of Syrian cheese in the Egyptian market, including the unique taste (tangy and salty) and texture (crumbly yet creamy), its affordability compared to other imported cheeses, the innovative marketing strategies of Syrian immigrants, and the increasing trend towards healthier food options (Hassan, 2021).

Some types of Syrian cheeses are plastic curd or "Pasta filata" cheeses that require plasticizing treatment of fresh curd in hot water, which gives the cheese its characteristic fibrous structure, high elasticity, and melting and stretching properties. Syrian cheeses are recognized as white brined cheeses with mild acidity, a salty taste, a white to yellowish color, a firm texture, and the ability to be easily sliced. The most popular Syrian cheeses in the Egyptian market are Halloumi, Akawi, and Mudaffara cheeses. Halloumi and Mudaffara cheeses are considered semi-hard to hard; Akawi cheese is semi-hard. They can be consumed fresh, grilled, or fried, but they are commonly used as a topping on pizza, bread, and pastries (Abou-Donia, 2005; Toufeili and Özer, 2006 and Tarabiya *et al.,* 2024).

The chemical compositions, sensory characteristics, and textural and functional properties of cheese are all important characteristics that determine the global quality and consumer perceptions. These properties are influenced by a number of factors, including milk composition, processing conditions, proteolysis, and pH (Sameen *et al.,* 2008 and Loudiyi & Aït-Kaddour, 2018).

Cheese contains many essential nutrients with unique health aspects. The protein in cheese is almost 100% digestible, which after proteolysis yields various bioactive peptides (BPs), similar to hormones that regulate the body. For lactose-intolerant individuals, cheese consumption is more comfortable than other dairy products. Furthermore, the digestibility of fat in different cheese varieties ranges between 88% and 94%, making it a vital source of saturated and essential fatty acids in the diet. The majority of cheese contains high amounts of vitamin A, riboflavin, vitamin B12, and minerals: calcium, phosphorus, and magnesium (O'Brien and O'Connor, 2017).

The microbiological quality of cheese is influenced by several factors, including the quality of raw materials, methods of production, applied hygienic measures during manufacture, packaging, and storage. These conditions can also lead to the growth of harmful microorganisms, which may pose a public health risk and cause economic problems due to a reduced shelf life of the cheese (Mohamed et al., 2019 and Mohamed et al., 2022).

Various bacteria are considered indicators to monitor the hygienic conditions in food, such as total aerobic mesophilic bacteria, coliforms, *Escherichia coli*, staphylococci, coagulase-positive *Staphylococcus aureus*, Salmonella species, *Clostridium perfringens, Bacillus cereus*, yeast, and mold (Mohamed *et al.,* 2019 and Compaore *et al.,* 2022).

Staphylococci are indicators of poor personal hygiene, and their presence may be referred to neglected hygienic measures. *S. aureus* is an important food-borne pathogen that has the ability to produce heat-resistant enterotoxins, which are potent emetic agents causing staphylococcal food poisoning. It is considered the third most important cause of food-borne diseases in the world (Mohamed *et al.,* 2019 and Compaore *et al.,* 2022).

The presence of coliforms in cheese indicates environmental and fecal contamination. Their observation with high levels in dairy products indicates product contamination post-pasteurization or inadequate pasteurization (Mohamed *et al.,* 2019). *E. coli* is one of the major significant bacteria, which has a bad effect on both humans and animals. It could also deteriorate raw milk and other milk products as a result of poor hygienic measures (Hussien *et al.,* 2019). Enterococci have been considered a more reliable index of environmental fecal contamination and sanitary quality than coliforms, especially in ripened cheese with high salt content, as most of them are quite salt-tolerant and relatively resistant to freezing (Boehm and Sassoubre, 2014).

Salmonella is a major food-borne pathogen that has caused several outbreaks of Salmonellosis worldwide. More than 2500 Salmonella serotypes are of public health concern. Two major groups are distinguished: typhoid salmonellosis [Salmonella enterica subsp. enterica serovar Typhi (*S. Typhi*) and Salmonella enterica subsp. enterica serovar Paratyphi (*S. Paratyphi*)] and non-typhoid salmonellosis (other Salmonella serovars). Salmonellosis is characterized by fever, diarrhea, nausea, abdominal pains, and vomiting (Elafify *et al.,* 2019).

Spore formers, either aerobic or anaerobic, are highly heat resistant and have the ability to cause defects in cheese, especially those held at elevated temperatures. Spore former counts are used as purchase specifications to specify the quality of cheese (Vidic *et al.,* 2020). *B. cereus* is an aerobic spore-forming bacterium, which has pathogenicity and spoilage-causing capabilities in the dairy industry. It is responsible for 2 food poisoning models: diarrheal and vomiting syndrome. Anaerobic spore formers cause blowing of semi-hard and hard cheeses during ripening, resulting in textural defects, off-flavors, and cheese loss, as it is not suitable for consumption (Adam *et al.,* 2021 and Porcellato *et al.,* 2023).

Yeast has a negative effect as a spoilage organism in cheese. The main defects caused by this spoilage yeast are fruity, bitter, or yeasty off-flavors, gas production, discoloration changes, and softening of texture. Also, presence of mold is undesirable, as it may influence the organoleptic characteristics of the cheeses. In addition, it can produce mycotoxins, which represent a potential health hazard (Mohamed *et al.,* 2019 and Awaad *et al.,* 2023b).

Although cheese is generally considered a safe food, because of the physicochemical and antagonistic properties of lactic acid bacteria, 0.4% of all foodborne outbreaks were related to contaminated cheese. In 1998-2011, out of 90 outbreaks attributed to cheese, 38 (42%) were due to cheese made with unpasteurized milk, 44 (49%) to cheese made with pasteurized milk, and the pasteurization status was not reported for the other eight (9%) (Gould *et al.,* 2014 and Choi *et al.,* 2016).

In light of these facts, the current study was planned to evaluate the sensory, microbiological, and chemical quality of the most common Syrian cheeses produced and sold in Egyptian markets.

MATERIALS AND METHODS

Collection of samples:
A total of 105 random Syrian cheese samples (500 g each) were collected from different dairy shops, hypermarkets, and online pages in the Giza and Cairo governorates, Egypt, from March to May 2023. Collected samples were transferred in an insulated icebox to the laboratory immediately to be examined for:

I.Sensory evaluation:
Sensory evaluation of Halloumi and Akawi cheese samples was conducted according to the score card designed by Sakr *et al.,* 2011 as follows: flavor (60) points, body & texture (30 points), saltiness (5 points), and appearance (5 points), with a total score of 100 points. While Mudaffara cheese samples were sensory evaluated according to the score card recommended by Bakheit and Foda (2012), in which the score for flavor (40 points), color (20 points), body & texture (20 points), acceptability (20 points), and total score (100 points). Five experienced sensory panelists (from both sexes in the age range of 25–55 years) were chosen from the Food Hygiene and Control Department staff members at the Faculty of Veterinary Medicine, Cairo University, Egypt. Samples under evaluation were cut, placed into white porcelain plates, and presented to the panelists randomly. Panel members were also instructed to report any defects or unpleasant flavor.

II. Microbiological analysis:

1- **Preparation of samples:** The collected samples were prepared following the guidelines of ISO 6887-1: 2017.

2- **Preparation of decimal dilution according to ISO 6887-5: 2020.**

Ten g of cheese were added to 90 ml of sterile sodium citrate 2% solution (HiMedia, R014) as a diluent, then homogenized using a stomacher (Lab-Blender 400) for 1 minute to make a 10^{-1} dilution. Further decimal dilutions were prepared in sterile peptone water according to ISO 6887-5: 2020. The samples prepared were subjected to the following examination:

a- **Determination of total staphylococci count (CFU/g)**: by the spreading technique using Barid Parker agar plates (HiMedia, MU043) according to APHA, 2015.

b- **Determination of coagulase-positive staphylococci (CPS) count (CFU/g):** suspected *S. aureus* colonies were emulsified in 0.5 ml reconstituted coagulase plasma with EDTA, and the coagulase-positive *S. aureus* count was determined according to APHA, 2015.

c- **Determination of coliform count (MPN/g):** the technique recommended by APHA, 2015 was performed using 3 fermentation tubes of Lauryl Sulphate Tryptose (LST) broth (HiMedia, M080).

d- **Isolation of *Escherichia coli*:** from each gassing Lauryl Sulphate tube, a loopful of suspension was added to a tube of *E. coli* broth and incubated at 45.5 ± 0.2°C for 24 ± 2 hours. From each gassing tube, streak a loopful to an Eosin Methylene Blue (EMB) agar plate (HiMedia, M317) according to APHA, 2015.

e- **Determination of enterococci count (CFU/g):** the technique recommended by APHA, 2015 was applied using KF Streptococcus (KF) agar medium (HiMedia, M1007).

f- **Isolation of salmonella species:** isolated on Xylose Lysine Desoxycolate (XLD) agar medium (HiMedia, M031) according to BAM, 2023.

g- **Determination of aerobic spore formers count (CFU/g):** the technique recommended by APHA, 2015 was conducted on the heat-shocked sample dilutions using standard plate count plates (Himedia, M091A)

supplemented with 0.1% soluble starch.

h- Determination of *Bacillus cereus* count (CFU/g): the organism was counted and isolated from the heat-shocked sample dilutions on Mannitol Egg Yolk Polymyxin (MYP) agar plates (HiMedia, M636) according to APHA, 2015.

i- Detection of anaerobic spore formers was carried out using the stormy fermentation test described by Cruickshank *et al.,* 1969, using 3 test tubes containing 10 ml of sterile skimmed milk, inoculated with one gram of cheese sample. Inoculated tubes were sealed with paraffin wax after heat treatment at 80ºC for 30 minutes, followed by incubation at 37ºC for five days. The results obtained were recorded.

j- Anaerobic spore former count (MPN/g): was carried out according to the technique recommended by APHA, 2004 by heat shocking 3 test tubes containing Reinforced Clostridial Broth (HiMedia, M443) and previously inoculated with 1 ml of each dilution before sealing with thioglycolate agar, followed by incubation at 37ºC for seven days. The MPN/g of each sample was calculated.

k- Yeast and mold count (CFU/g) was carried out according to APHA, 2015, using the pouring technique on Sabouraud Dextrose Agar plates (HiMedia, MH063), which were incubated at 25°C for five days.

III. Chemical analysis:

1- Preparation of samples: All samples were prepared for chemical analysis, according to AOAC (2019).

2- Chemical analysis: the techniques described by AOAC (2019) were carried out on the prepared cheese samples for determination of salt % by the Volhard method; Titratable acidity % by the titrimetric method; total solids % and moisture % by the evaporation method; and fat % by Gerber's method and Soxhlet method. Solids-not-fat% and the fat to total solid % was calculated.

IV. Statistical Analysis

The statistically analyzed data were expressed as mean ± Standard Error of Mean (SEM). Multiple comparisons of means were performed using the least significant difference at the significance level ($P<0.05$) using SPSS program version 26 (SPSS, 2019) for windows.

RESULTS

Table 1: Statistical analytical results of sensory evaluation of Syrian cheese samples (35 each)

Halloumi				Akawi				Mudaffara			
Parameters	**Min**	**Max**	**Mean ± SEM**	**Parameters**	**Min**	**Max**	**Mean ± SEM**	**Parameters**	**Min**	**Max**	**Mean ± SEM**
Flavor (60)	42	58.6	52.92± 0.63	**Flavor (60)**	41.80	57.80	51.04 ± 0.50	**Flavor (taste & odor) (40)**	30.2	36	32.33 ±0.23
Body and texture (30)	20	28.8	25.92 ±0.31	**Body and texture (30)**	21.60	27.20	24.12 ±0.21	**Body and texture (20)**	15.2	19.4	16.94 ±0.17
Saltiness (5)	3.40	4.50	4.0 ±0.04	**Saltiness (5)**	3.25	5	4.03 ±0.06	**Color (20)**	15.4	19.2	17.11 ±0.15
Appearance (5)	3.10	5	3.76 ±0.05	**Appearance (5)**	3.10	4.45	3.78 ±0.05	**Acceptability (20)**	15	17.8	16.14 ±0.11
Total score (100)	78.15	94.8	85.60 ±0.76 [b]	**Total score (100)**	73.05	90.15	82.97 ±0.59 [a]	**Total score (100)**	79	87	82.54 ±0.36 [a]

SEM: Standard Error of Mean

* Mean values of overall acceptability with different lowercase letter superscripts within the same row are significantly ($p<0.05$) different.

N.B.: Results in this table for each parameter are the average of the 5 panelists' evaluations in the score card.

Table 2: Statistical analytical results of microbiological examination of Syrian cheese samples (35 each)

Types of samples	Halloumi cheese					Akawi cheese					Mudaffara cheese					Overall
Microbiological analysis (CFU or MPN/g)	Positive samples		Min	Max	Mean ± SEM	Positive samples		Min	Max	Mean ± SEM	Positive samples		Min	Max	Mean ± SEM	Mean ± SEM
	No.	%				No.	%				No.	%				
Total Staphylococci count	35	100	30×10^2	40×10^6	$38\times10^5\pm 16\times10^5$	35	100	30×10^3	79×10^6	$67\times10^5\pm 25\times10^5$	35	100	20×10^2	18×10^6	$12\times10^5\pm 5\times10^5$	$39\times10^5\pm 10\times10^5$
Coagulase-positive Staphylococci count	32	91.43	90	30×10^4	$37\times10^3\pm 12\times10^3$	35	100	90	20×10^4	$32\times10^3\pm 9.0\times10^3$	28	80	2×10^2	90×10^4	$85\times10^3\pm 34\times10^3$	$49\times10^3\pm 11\times10^3$
Total coliforms count	35	100	21	21×10^6	$19\times10^5\pm 9\times10^5$	35	100	23	53×10^5	$10\times10^5\pm 2\times10^5$	35	100	2.0×10^2	75×10^5	$76\times10^4\pm 29\times10^4$	$12\times10^5\pm 3\times10^5$
Enterococci count	22	62.85	26×10^2	83×10^3	$24\times10^3\pm 5.0\times10^3$	10	28.57	7.0×10^2	12×10^4	$34\times10^3\pm 12\times10^3$	25	71.42	6.0×10^2	59×10^3	$15\times10^3\pm 2.0\times10^3$	$22\times10^3\pm 3.0\times10^3$
Aerobic spore former count	34	97.14	20×10^2	48×10^3	$13\times10^3\pm 2.0\times10^3$	34	97.14	23×10^2	48×10^3	$14\times10^3\pm 2.0\times10^3$	35	100	7.0×10^2	60×10^3	$15\times10^3\pm 2.0\times10^3$	$14\times10^3\pm 1.0\times10^3$
Bacillus cereus count	25	71.42	1.0×10^2	66×10^2	$12\times10^2\pm 3.0\times10^2$	31	88.57	1.0×10^2	30×10^3	$29\times10^2\pm 10\times10^2$	31	88.57	2.0×10^2	30×10^3	$20\times10^2\pm 9.0\times10^2$	$21\times10^2\pm 5.0\times10^2$
Anaerobic spore former count	28	80	4.0	93	15 ± 8.7	29	82.85	3.0	14	6.9 ± 1.2	28	80	4.0	93	15.9±7.7	13.5± 4.2
Total yeast count	35	100	36×10^3	46×10^7	$87\times10^6\pm 22\times10^6$	35	100	15×10^3	84×10^7	$91\times10^6\pm 29\times10^6$	35	100	33×10^2	31×10^7	$48\times10^6\pm 11\times10^6$	$75\times10^6\pm 13\times10^6$
Total mold count	16	45.71	4.0×10^2	20×10^4	$37\times10^3\pm 17\times10^3$	11	31.42	1.0×10^2	60×10^3	$14\times10^3\pm 6.0\times10^3$	12	34.28	1.0×10^2	20×10^3	$36\times10^2\pm 16\times10^2$	$20\times10^3\pm 7\times10^3$
Total yeast & mold count	35	100	38×10^3	46×10^7	$87\times10^6\pm 22\times10^6$	35	100	15×10^3	84×10^7	$91\times10^6\pm 29\times10^6$	35	100	4.0×10^3	31×10^7	$48\times10^6\pm 11\times10^6$	$75\times10^6\pm 13\times10^6$

SEM: Standard Error of Mean CFU: Colony Forming Units. MPN: Most Probable Number

Table 3: Statistical analytical results of chemical examination of Syrian cheese samples (35 each)

Types of samples	Halloumi cheese			Akawi cheese			Mudaffara cheese			Overall
Chemical analysis	Min	Max	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max	Mean ± SEM	Mean ± SEM
Salt %	2.44	4.84	4 ± 0.11^{b}	2.73	9.67	8.9 ± 0.33^{a}	7.25	9.71	9.28 ± 0.12^{a}	7.52±0.27
Titratable acidity %	0.07	0.76	0.4 ± 0.03^{a}	0.07	0.90	0.3 ± 0.03^{a}	0.14	0.72	0.4 ± 0.02^{a}	0.38±0.19
TS %	29	59.5	44.3 ± 1.2^{a}	19.5	55.5	43.3 ± 1.5^{a}	23	68.5	43.9 ± 2.1^{a}	44.07 ±1.08
Moisture %	40.5	71	55.7 ± 1.1^{a}	44.5	80.5	56.7 ± 1.5^{a}	31.5	77	56 ± 2.1^{a}	56.14±0.95
Fat %	9	25.31	15.9 ± 0.8^{a}	6.1	30.7	17.2 ± 1.1^{a}	6.5	27.4	15.1 ± 1.1^{a}	15.73±0.57
SNF%	10.19	40.56	28.5 ± 1.4^{a}	5.50	43.62	26.6 ± 1.8^{a}	4.40	59	27.4 ± 2.7^{a}	27.54±1.13
Fat to TS %	20.20	71.30	36.3 ± 2.2^{a}	14.02	73.26	39.2 ± 3^{a}	13.87	80.89	38.7 ± 3.8^{a}	38.02±1.69

SNF: Solids Not Fat TS: Total Solids SEM: Standard Error of Mean

*Mean values with different lowercase letter superscripts within the same row are significantly ($p < 0.05$) different.

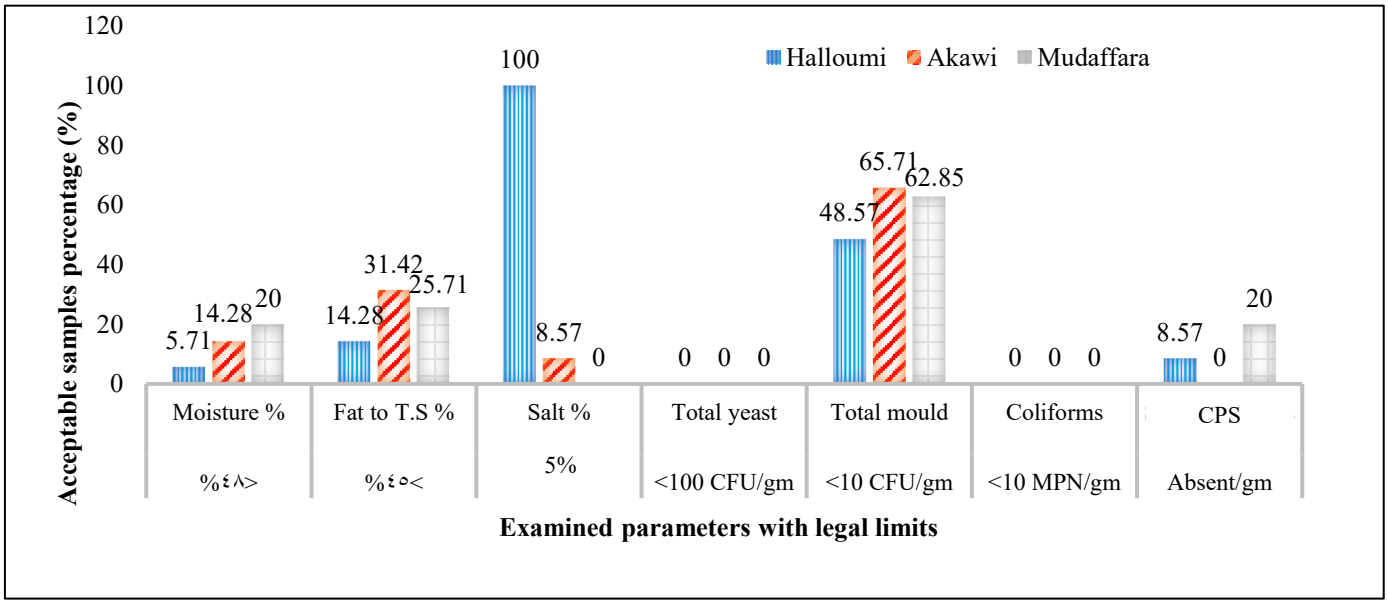
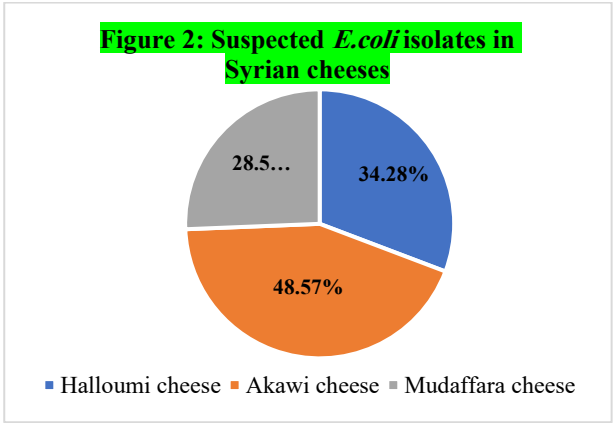


Figure 1: Degree of acceptability of Halloumi, Akawi and Mudaffara cheese samples versus Egyptian Standard

for semi-hard cheese: ES: 1183/2005



DISCUSSION

Various Syrian cheeses, such as Halloumi, Akawi, and Mudaffara, are now available in Egyptian markets, with a high level of acceptance from Egyptian consumers. According to the Codex Standard for cheese, these cheeses are considered ripened cheeses, which have a white to yellowish color and a compact texture suitable for slicing, with none/few mechanical openings. These cheeses have been ripened and preserved in brine without rind. They are used either for direct consumption or for adding to other food recipes (Codex Alimentarius: 208-1999 and Tarabiya *et al.,* 2024).

Results of the sensory evaluation of examined Syrian cheese samples are presented in Table (1). The scores indicated a significant difference ($P<0.05$) between the overall mean of Halloumi cheese (85.60 ±0.76) and the other two types: Akawi 82.97 ±0.59 and Mudaffara 82.54 ±0.36). The high score of Halloumi cheese could be attributed to its rich flavor and body & texture mean scores. Nearly similar results were recorded by Sakr *et al.,* (2011), while lower ones were recorded by Kaminarides *et al.,* (2007) and El-Demerdash *et al.,* (2008). On the other hand, Atasever *et al.* (2003) noted higher scores for Halloumi cheese.

The mean scores of saltiness and appearance were nearly identical in Halloumi and Akawi cheese (4.0 ±0.04; 3.76 ±0.05 and 4.03 ±0.06; 3.78 ±0.05), respectively. Higher data were recorded by El-Demerdash *et al. (2008),* Sakr *et al.* (*2011*) and Moatsou *et al. (2019).*

Mudaffara cheese showed high scores with a mean value (16.14 ±0.11), which may be due to its production from non-pasteurized raw whole milk with a high percentage of

salt and rennet to obtain a firm coagulum that could be shredded and added to different recipes (Abdalla *et al.,* 2013). Similar scores were reported by El gabali *et al.,* (2022), while lower scores were reported by Farah and El Zubeir, (2019).

The quality of cheese is related to the quality of the raw materials, the conditions of hygienic production, and the method of production. As cheeses are highly nutritious, having a high-water content and nearly neutral pH that encourage the persistence and growth of various microorganisms (Hayaloglu, 2022).

Staphylococci are environmental microorganisms that may contaminate raw milk and its products directly or accidentally (Morar *et al.,* 2021). Staphylococci were found in all (100%) of the three cheese types examined. Akawi cheese samples had the highest Staphylococci count, ranging from 30×10^3 CFU/g to 79×10^6 CFU/g, with a mean value of $67\times10^5 \pm 25\times10^5$ CFU/g (Table 2). Lower counts were reported by Mansour *et al.* (2020), Ulusoy *et al.,* (2020) and Hussein *et al.* (2023).

S. aureus is a halophilic microorganism that can survive in white-brined cheeses with high salt content, even at low pH (El-kholy *et al.,* 2018). It could be recovered from 80%, 91.43%, and 100% of the examined Mudaffara, Halloumi, and Akawi cheese samples, respectively, with an overall mean of $49\times10^3 \pm 11\times10^3$ CFU/g (Table 2). Lower incidences were reported by Al-kotami *et al.* (2013) and Hussein *et al*. (2023). Similar counts were recorded by Al-kotami *et al.* (2013), while lower results were recorded by Elgaml *et al.* (2017) and Sheet *et al.* (2020). It is crucial to mention that *S. aureus* count is significant above 10^6 CFU/g, as it becomes able to produce enterotoxins with a concentration higher than 20–100 ng, at which the illness symptoms appear on the consumer (Schelin *et al.,* 2011).

Although the Syrian standard for this type of cheese (SASMO: 2179/2007) permits the presence of such a pathogen until a count of 10^2 CFU/g, its presence is considered illegal according to the Egyptian standard for semi-hard cheeses (ES: 1183/2005) as one of the foodborne pathogens. Therefore, only 8.57%, 0%, and 20% of the examined Halloumi, Akawi, and Mudaffara cheeses were considered acceptable according to Egyptian specifications, that may constitute a public health issue to the consumer (Figure 1).

Coliform bacteria are regarded as hygienic indicator organisms, since their presence in foods may indicate insufficient sanitary conditions and the presence of other enteric pathogens, in addition to economic losses, due to their capability for early blowing in white-brined cheeses (Bintsis and Papademas, 2002 and Halkman and Halkman, 2014). Coliforms were detected in all examined cheese samples (100%) with an overall mean of $12\times10^5\pm\ 3\times10^5$ MPN/g. Similar results were recorded by Al-kotami *et al.,* 2013, while lower results were given by Elgaml *et al.,* 2017; Mansour *et al.,* 2020 and Sheet *et al.,* 2020. The Egyptian standard for semi-hard cheeses (ES: 1183/2005) stated a total coliform count less than 10 MPN/g as acceptable. Therefore, none of the examined cheese samples were considered acceptable, that may be of concern to the Egyptian food safety authority (Figure 1).

E. coli is present in the intestines of humans and animals, and are released into the environment in fecal material. Its presence in raw milk and other milk products is indicative of poor hygienic measures. Also, its presence is considered a major health risk to consumers (Price and Wildeboer, 2017). Suspected *E. coli* isolates were detected in 34.28%, 48.57%, and 28.57% of Halloumi, Akawi, and Mudaffara cheese samples, respectively (Figure 2). Slik and Abou Ghorra (2007), Al-kotami *et al.*

(2013) and Hussein *et al.* (*2023*) could also isolate *E. coli* from Syrian cheese samples.

Enterococci group bacteria, a subgroup of fecal Streptococci, serve as a valuable bacterial indicator to determine the extent of fecal contamination and are more specific than coliforms (Boehm and Sassoubre, 2014). Enterococci were recovered with the highest incidence in Mudaffara cheese samples (71.42%), followed by Halloumi cheese samples (62.85%) and Akawi cheese samples (28.57%), with an overall mean of $22\times10^3 \pm 3.0\times10^3$ CFU/g (Table 2). The results obtained were lower than those reported by Atasever *et al.,* 2003. The presence of enterococci in examined cheese samples could be explained by the fact that some enterococci can survive even short-time pasteurization (72°C/15 seconds) or flash pasteurization (85°C/16 seconds) (Wierzchowska *et al.,* 2020).

In Egypt, milk originating from rural areas is often implicated in food-borne salmonella infection in humans. Lack of proper hygienic measures adopted during the manufacture of dairy products is the major reason for high incidences. However, few reports had surveyed the prevalence of Salmonella spp. in dairies in Egypt (Elafify *et al.,* 2019). In all examined samples, salmonella species failed to be detected. This result is aligned with Slik and Abou Ghorra, 2007, who failed to isolate any of the salmonella species organisms from Syrian cheese samples.

The dairy industry faces many problems associated with spore-forming bacteria. First, their presence is impossible to remove completely from milk. Second, their spores are highly hydrophobic and will attach to pipeline surfaces where they might multiply and sporulate again. The third problem is that spores are heat resistant; they could survive pasteurization or even ultra-high temperatures (UHT). Meanwhile, spore-forming bacteria greatly impact the quality, safety, and economy of cheese manufacture (Sobeih, 2009; Gopal *et al.,* 2015 and Montebello *et al.,* 2018).

Aerobic spore formers were counted with high incidence, ranging from 97.14 to 100% in all the examined cheese samples, with an overall mean of $14\times10^3 \pm 1.0\times10^3$ CFU/g. The most encountered and problematic bacillus species in the dairy industry is *B. cereus*, which was isolated from Halloumi (71.42%), Akawi (88.57%), and Mudaffara (88.57%) cheese samples, with mean values of $12\times10^2 \pm 3.0\times10^2$, $29\times10^2 \pm 10\times10^2$ and $20\times10^2 \pm 9.0\times10^2$ CFU/g, respectively (Table 2). Mainly two types of disease syndrome are caused by *B. cereus*. Diarrheal syndrome is caused by an infective dose (10^4–10^9 cells/g) with production of heat-labile enterotoxins and an emetic type of illness; the dose is about 10^5–10^8 cells/g. Moreover, *B. cereus* can contribute to economic losses through reduced shelf life of final products and spoilage via spoilage enzymes like lipase, lecithinase, and protease (Tewari and Abdullah, 2015).

Anaerobic spore formers are commonly found in milk, as they are prevalent throughout the dairy farm environment. Most of them are saprophytes and normally grow in soil, silage, and water, and their presence in dairy products is indicative of manure and soil contamination (Özdemir *et al.,* 2010). Anaerobic spore formers were found in Halloumi, Akawi, and Mudaffara examined cheese samples with incidences of 80%, 82.85%, and 80%, respectively (Table 2). The high incidence of anaerobic organisms may be attributed to neglected hygienic measures during cheese production and handling.

In white-brined cheeses, fungi are not included as starter cultures and are frequently denoted as contaminants. They are found in raw milk, brine, air, production surfaces, cheese vats and cloths, curd-cutting knives, and other equipment. Their propagation in white brined cheeses

depends on numerous factors, such as the composition of milk, nutrient availability, interactions with coexisting micro-organisms, production, addition of preservatives such as potassium sorbate, and storage conditions (Geronikou *et al.,* 2020; Awaad *et al.,* 2020 and Awaad *et al.,* 2023a). Total yeast and mold were counted in all examined cheese samples (100%), with a minimum count of 4.0×10^3, a maximum count of 84×10^7 and an overall mean count of $75\times10^6 \pm 13\times10^6$ CFU/g (Table 2). A lower incidence was reported by Al-kotami *et al.* (2013), while the results of Sheet *et al.,* (2020) were aligned with our study. Al-kotami *et al. (*2013*),* Sheet *et al.* (2020) and Ulusoy *et al.* (2020) recorded lower counts for yeast and mold than our study. According to (ES: 1183/2005), total yeast count must not exceed 100 CFU/g. Therefore, all the samples examined were not compliant with the standards. While according to (ES: 1183/2005) total mold count must not exceed 10 CFU/g, therefore 48.57%, 65.71% and 62.85% were considered acceptable of the examined Halloumi, Akawi and Mudaffara cheeses, respectively (Figure 1).

Salt, acidity, total solids, moisture, and fat percentages were measured for all examined samples, and results were tabulated in Table (3). In most cheese varieties, salt enhances flavor, draws whey out of curd, and controls undesirable microorganisms (Guinee, 2004 and Metwally, 2006). Regarding the salt percentage in examined cheese samples, Halloumi cheese recorded the lowest mean value (4.0±0.11) with a significant difference ($P<0.05$), followed by Akawi (8.9±0.33) then Mudaffara (9.28±0.12). According to Hayaloglu, 2017 Halloumi cheese is salted by about 3% dry salt with or without brine, while Akawi and Mudaffara cheeses are salted in brine with 10 and 15% NaCl, respectively. It takes time for salt to penetrate evenly into the cheese, uniform salt distribution may not be possible in brined or surface-ripened cheeses (Mukhiddinov *et al.,* 2022) that could explain the variation in salt percentages between examined samples, especially for Akawi cheese (2.73-9.67%). Al-kotami *et al.,* (2013) and Elgaml *et al.,* (2017) reported salt percentages aligned with our results, while Slik and Abou Ghorra, (2007) reported higher results. Lower figures were found by Harfouch, (2013) and Hayaloglu & Karabulut, (2013). According to (ES: 1183/2005) for semi-hard cheese, salt% is about 5%. Therefore, all examined Halloumi cheese 100% and 8.57% of Akawi cheese were acceptable, while 100% of Mudaffara cheese samples were not acceptable (Figure 1).

Acidity percentage directly affects cheese moisture, mineral content, texture, and flavor development; besides it is the most important control factor for growth of spoilage and pathogenic organisms (McSweeney, 2007). Data presented in Table 3 showed no significant differences in the mean values of titratable acidity between the 3 cheese types. Nearly similar findings were recorded by Slik and Abou Ghorra, (2007) and Al-kotami *et al.,* (2013). However, Sakr *et al.,* (2011) reported higher figures. On the other side, Shenana, (2002); Abou-Donia *et al.,* (2005); Guven *et al.,* (2008), and Sbeeh & Harfouch, (2022) obtained lower values.

Roughly, cheese matured in brine has a moisture content that varies between 50 and 58% (El Soda *et al.,* 2011). Regardless of the cheese types, data presented in Table 3 showed no significance difference in the moisture percentages of the three types of examined Syrian chesses, with an overall mean 56.14±0.95. For Halloumi cheese, the mean value (55.7±1.1) was nearly similar to those obtained by Elgaml *et al.,* 2017 and higher than those obtained by Papademas, 2006. Regarding Akawi and Mudaffara cheese, the mean values for moisture content were 56.7±1.5 and 56±2.1, respectively. The obtained results were lower than those obtained by Gandhi &

Shah, 2016 and Sbeeh & Harfouch, 2022. According to (ES: 1183/2005) for semi-hard cheese, the moisture percentage should be less than 48%. Therefore, only 5.71, 14.28 and 20 % of the examined Halloumi, Akawi, and Mudaffara cheese samples, respectively, are considered acceptable (Figure 1).

Although Akawi cheese showed slightly higher fat content than Halloumi and Mudaffara cheese samples, there were non-significant differences between their mean values (Table 3). Similar figures were recorded by Slik and Abou Ghorra, (2007) and Al-kotami *et al.,* (2013), while higher percentages were recorded by Hayaloglu & Karabulut, (2013); Elgaml *et al.,* (2017) and Sbeeh & Harfouch, (2022).

Codex Standard for cheese (Codex Alimentarius: 208-1999) considers the fat to total solids percentage, as an essential composition and quality factors. This parameter is an essential requirement for evaluating the chemical composition of semi-hard cheeses in both Syrian (SASMO:289/2002) and Egyptian standards (ES: 1183/2005). The obtained results showed no significant difference in the mean value of Fat to T.S % of different cheese samples, where Halloumi cheese ranged from 20.20 to 71.30% with a mean value of 36.3±2.2%, for Akawi cheese 14.02 to 73.26% with a mean value of 39.2±3% and for Mudaffara cheese 13.87 to 80.89% with a mean value of 38.7±3.8%. Lower results were reported by Slik and Abou Ghorra, (2007) and Al-kotami *et al.,* (2013), while higher results were stated by Elgaml *et al.,* (2017) and Sbeeh & Harfouch, (2022). By comparing the results of the fat to TS % of the examined samples against Egyptian standards (ES: 1183/ 2005), 14.28%, 31.42% and 25.71% of Halloumi, Akawi, and Mudaffara cheese were considered accepted, respectively. The apparent variation among the results of fat to TS % in the examined cheese samples may be attributed to using raw milk from different sources with variable fat content, in addition to the lack of SOPs of manufacturing.

CONCLUSION

In this study, Syrian cheese (Halloumi, Akawi, and Mudaffara) samples sensory evaluation showed great overall acceptability. However, the microbiological analysis concluded with high incidence of contaminants with high counts, including some pathogenic bacteria. By analyzing the chemical composition of different cheese samples, great variations were found.

The detected low microbial quality of examined cheese samples encourages the use of different preservatives, modifying some processing steps and packaging strategies. Also, application of good manufacturing practice (GMP) during production, and maintenance of storage conditions till cheese consumption is necessary. HACCP system should be introduced in the Syrian cheese industry in Egypt to improve its quality and safety. As a newly introduced dairy product to the Egyptian market, a specific standard should be designed by the Egyptian organization for standardization, with continuous monitoring by authorities to guarantee its application.

REFERENCE

Abdalla, M.O.M.; Elsiddig, H.M.; Elhaj, N.M. and Suleiman, T.A. (2013): Chemical and microbiological evaluation of sudanese braided Cheese (Mudaffara). *U. of K.J. Agric. Sci*., 21(2): 253-268.

Abou-Donia, S.A. (2005): Egyptian Adopted Plastic Curd Cheese Varieties, Provolone, Mozzarella, Mudaffara and Halloumi: An Overview. *Alex. J. Fd. Sci. & Technol*, 2(2): 35-41. https://doi.org/10.21608/ajfs.2005.19615

Adam, A.H.; Aly, S.A. and Saad, M.F. (2021): Evaluation of microbial quality and safety of selected dairy products, with special focus on toxigenic genes of *Bacillus cereus*. *Mljekarstvo*, 71(4): 257-268. http://dx.doi.org/10.15567/mljekarstvo.2021.0405

Al-kotami, S.; Abou Ghorra, S. and Yaziji, S. (2013): Studying some chemical and microbial properties in Syrian Akawi cheese. *Damascus University Journal of Agriculture Sciences*. 29(3): 97-114.

AOAC "Association of Official Analytical Chemists" (2019): Official Methods of Analysis of AOAC International, 21st Ed. Rockville, MD: AOAC Int.

APHA "American Public Health Association" (2004): Standard Methods for Examination of Dairy Products. 17th Ed. Washington DC.

APHA "American Public Health Association" (2015): Compendium of Methods for the Microbiological Examination of Foods. 5th Ed. Washington DC.

Atasever, M.; Keleş, A.; Uçar, G. and Guner, A. (2003): Use of different salting techniques in Halloumi cheese: effect on sensory, microbiological and chemical properties. *Acta Alimentaria*, 32 (1): 7-14. https://doi.org/10.1556/aalim.32.2003.1.3

Awaad, S.S.; Moawad, A.A.; Abdel-Salam, A.B. and Sallam, S.S. (2020): Impact of raw materials and processing techniques on the microbiological quality of Egyptian Domiati cheese. *Int J Vet Sci*, 9(4): 505 - 510. https://doi.org/10.37422/IJVS/20.060

Awaad, S.S.; Moawad, A.A.; Sallam, S. and Abdel-Salam, A.B. (2023) a: Effect of Some Improving Processing Techniques on the Microbiological and Sensory Quality of Domiati Cheese. Egypt. J. Chem., 66 (6): 149-157.

Awaad, S.S.; Sherief, M.A.; Mousa, S.M.; Orabi, A. and Abdel-Salam, A.B. (2023) b: A comparative study on the antifungal effect of potassium sorbate, chitosan, and nanochitosan against *Rhodotorula mucilaginosa* and *Candida albicans* in skim milk acid-coagulated (Karish) cheese, Veterinary World, 16(9): 1991–2001.

Bakheit, A.M. and Foda, M.I. (2012): Sensory Evaluation and Antioxidant Activity of New Mudaffara Cheese with Spices under Different Storage Temperatures. *Research Journal of Applied Sciences*, 8(7): 3143-3150.

BAM "Bacteriological Analytical Manual" (2023): Chapter 5- Salmonella species. U.S. Food & Drug Administration Center for Food Safety & Applied Nutrition.

Bintsis, T. and Papademas, P. (2002): Microbiological quality of white-brined cheeses: A review. *Int J Dairy Technol*, 55(3): 113-120. https://doi.org/10.1046/j.1471-0307.2002.00054.x

Boehm, A.B. and Sassoubre, L.M. (2014): Enterococci as indicators of environmental fecal contamination. In: Gilmore, M.S., Clewell, D.B, Ike. Y, Shankar, N. *Enterococci: From Commensals to Leading Causes of Drug Resistant Infection*. Boston: Massachusetts Eye and Ear Infirmary. https://www.ncbi.nlm.nih.gov/books/NBK190421/

Choi, K.H.; Lee, H.; Lee, S.; Kim, S. and Yoon, Y. (2016): Cheese Microbial Risk Assessments - A Review. *Asian-Australasian journal of animal sciences*, 29(3): 307–314. https://doi.org/10.5713/ajas.15.0332

Codex Alimentarius (1999): Codex Stan 208-1999: Codex group standard for cheeses in brine. Codex Alimentarius, Rome, Italy.

Compaore, M.K.A.; Kpoda, S.D.; Bazie, R.B.S.; Ouedraogo, M.; Valian, M.; Gampene, M.L.; Yakoro, A.; Nikiema, F.; Belemlougri, A.; Meda, N.R.;

Meda, N.S.D.; Sanon, S.; Bande, M.; Hien, H.; Barro, N. and Kabre, E. (2022): Microbiological quality assessment of five common foods sold at different points of sale in Burkina-Faso. *PloS one*, 17(4): e0258435. https://doi.org/10.1371/journal.pone.0258435

Cruickshank, R.; Duguid, J.P. and Swain, R.H. (1969): Medical Microbiology 11th Ed. E.S. Livingston Limited Edinburgh, London.

El gabali, T.M; Jadain, O.A. and El Zubeir I.E. (2022): Effect of addition of Syrian thyme (*Thymus syriacus*) on physiochemical and sensory quality of Sudanese Mudaffara cheese during storage. *J Food Sci Technol* 60(2): 517–527 https://doi.org/10.1007/s13197-022-05634-7

El Soda, M.; Awad, S. and Abd El-Salam, M.H. (2011): Cheeses Matured in Brine, Editor(s): John W. Fuquay, *Encyclopedia of Dairy Sciences,* (2nd Ed.), Academic Press, pp. 790-794, ISBN 9780123744074. https://doi.org/10.1016/B978-0-12-374407-4.00092-3.

Elafify, M.; Darwish, W.S.; Al-Ashmawy, M.; Elsherbini, M.; Koseki, S.; Kawamura, S. and Abdel Khalek, A.E. (2019): Prevalence of Salmonella spp. in Egyptian dairy products: molecular, antimicrobial profiles and a reduction trial using d-tryptophan. *Journal of Consumer Protection and Food Safety*, 14(4): 399–407. https://doi.org/10.1007/s00003-019-01248-y.

El-Demerdash, M.E; Sonia, A.H. and Hashem, M.E. (2008): Study on producing Halloumi cheese from different types of milk. *Egyptian J. Anim. Prod.*, 45(2): 133-139. https://dx.doi.org/10.21608/ejap.2008.104507

Elgaml, N.; Moussa, M.A., and Saleh, A. (2017): Comparison of the properties of Halloumi cheese made from goat milk, cow milk and their mixture. *Journal of Sustainable Agricultural Sciences.* 43(2): 77-87. http://dx.doi.org/10.21608/jsas.2017.1065.1006

El-kholy, A.M.; Hassan, G.M.; Samia, A. and Mohamed E.A. (2018): "Impact of probiotics on *staphylococcus aureus* growth in some dairy products". *Assiut Veterinary Medical Journal*, 64(159): 21-32. https://doi.org/10.21608/avmj.2018.168973

ES: 1183 / 2005 "Egyptian Standards" (2005): General standard for semi-hard cheese. Egyptian Organization for Standardization.

Farah, N.A. and El Zubeir, I.E. (2019): Comparison on the acceptability of mudaffara cheese using black cumin and sesame seeds during storage. *Annals: Food Science & Technology*, 20(4): 721-727.

Fox, P.F.; Guinee, T.P.; Cogan, T.M. and McSweeney, P.L. (2017): Chapter 1-cheese: historical aspects. In: *Fundamentals of Cheese Science*, pp. 1-10, Boston, MA, USA: Springer. https://doi.org/10.1007/978-1-4899-7681-9_1

Gandhi, A. and Shah, N.P. (2016): Salt Reduction in a Model High-Salt Akawi Cheese: Effects on Bacterial Activity, pH, Moisture, Potential Bioactive Peptides, Amino Acids, and Growth of Human Colon Cells. *J Food Sci.*, 81(4): 991-1000. https://doi.org/10.1111/1750-3841.13260.

Geronikou, A.; Srimahaeak, T.; Rantsiou, K.; Triantafillidis, G.; Larsen, N. and Jespersen, L. (2020): Occurrence of yeasts in white-brined cheeses: methodologies for identification, spoilage potential and good manufacturing practices. *Frontiers in microbiology*, 11:582778. https://doi.org/10.3389/fmicb.2020.582778

Global data (2023): Egypt Dairy & Soy Food – Market Assessment and Forecasts To 2026. Egypt Cheese https://www.globaldata.com/store/report/egypt-cheese-market-analysis/

Gopal, N.; Hill, C.; Ross, P.R.; Beresford, T.P.; Fenelon, M.A. and Cotter, P.D. (2015): The prevalence and control of bacillus and related spore-forming bacteria in the dairy industry. *Frontiers in microbiology*, 6:1418. https://doi.org/10.3389/fmicb.2015.01418

Gould, L.H.; Mungai, E. and Behravesh, C.B. (2014): Outbreaks attributed to cheese: differences between outbreaks caused by unpasteurized and pasteurized dairy products, United States, 1998-2011. *Foodborne pathogens and disease*, 11(7): 545–551. https://doi.org/10.1089/fpd.2013.1650

Guinee, T.P. (2004): Salting and the role of salt in cheese. *International Journal of Dairy Technology*, 57(2-3): 99-109. https://doi.org/10.1111/j.1471-0307.2004.00145.x

Guven, M.; Cadun, C.; Karaca, O. and Hayaloglu, A.A. (2008): Influence of rennet concentration on ripening characteristics of Halloumi cheese. *Journal of Food Biochemistry*, 32(5): 615 - 627. http://dx.doi.org/10.1111/j.1745-4514.2008.00187.x

Halkman, B.D. and Halkman, A.K. (2014): Indicator organisms, In Batt, C. A. and Tortorello, M L. *Encyclopedia of Food Microbiology, (*2nd Ed.), Academic Press, pp. 358-363. https://doi.org/10.1016/B978-0-12-384730-0.00396-7

Harfouch, M. (2013): Chemical and physico-chemical characterization of some Syrian traditional cheeses and its comparison with some similar international kinds. *Tishreen University Journal -Biological Sciences Series*, 35(7): 31-49 http://journal.tishreen.edu.sy/index.php/bioscnc/article/view/536

Hassan, M.A. (2021): The insertion of syrian refugees in the Egyptian labor market: with special focus on food and restaurants sector [Master's Thesis, the American University in Cairo]. AUC Knowledge Fountain. https://fount.aucegypt.edu/etds/1635

Hayaloglu, A.A. (2017): Chapter 39 - Cheese varieties ripened under brine. In: McSweeney, P.L.H., Fox, P. F., Cotter, P. D. and Everett D. W. *Cheese* (4th Ed.), Academic Press, pp. 997-1040, ISBN 9780124170124. https://doi.org/10.1016/B978-0-12-417012-4.00039-9

Hayaloglu, A.A. (2022): Microbiology of Cheese, In: McSweeney, P.L.H. and McNamara, J. P. *Encyclopedia of dairy sciences* (3rd Ed.), pp. 225-237, Elsevier, Academic Press, London, UK https://doi.org/10.1016/B978-0-12-818766-1.00272-5

Hayaloglu, A.A. and Karabulut, I. (2013): Characterization and Comparison of Free Fatty Acid Profiles of Eleven Varieties of Turkish Cheeses. *International Journal of Food Properties*.16(6): 1407-1416. http://dx.doi.org/10.1080/10942912.2011.587626

Hussien, H.; Elbehiry, A.; Saad, M.; Hadad, G.; Moussa, I.; Dawoud, T.; Mubarak, A. and Marzouk, E. (2019): Molecular characterization of Escherichia coli isolated from cheese and biocontrol of Shiga toxigenic E. coli with essential oils. *Italian journal of food safety,* 8(3): 162-167. https://doi.org/10.4081/ijfs.2019.8291

Hussein, N.D.; Hassan, J.W.; Osman, M.; El-Omari, K.; Kharroubi, S.A.; Toufeili, I. and Kassem, I.I. (2023): Assessment of the microbiological acceptability of white cheese (Akawi) in lebanon and the antimicrobial resistance profiles of associated *Escherichia coli*. *Antibiotics*. 12(3): 610.

https://doi.org/10.3390/antibiotics12030610

ISO 6887-1:2017 "International Organization for Standardization" (2017): Microbiology of the food chain — Preparation of test samples, initial suspension and decimal dilutions for microbiological examination, Part 1: General rules for the preparation of the initial suspension and decimal dilutions. 1st Ed. ISO, Geneva, Switzerland

ISO 6887-5:2020 "International Organization for Standardization" (2020): Microbiology of Food chain: Preparation of Test Samples, Initial Suspension and Decimal Dilutions for Microbiological Examination, Part 5: Specific Rules for the Preparation of Milk and Milk Products. 1st edition. ISO, Geneva, Switzerland.

Kaminarides, S.; Stamou, P. and Massouras, T. (2007): Changes of organic acids, volatile aroma compounds and sensory characteristics of Halloumi cheese kept in brine, *Food Chemistry*, 100(1): 219-225. https://doi.org/10.1016/j.foodchem.2005.09.039

Khanal, B.K.S.; Pradhan, M. and Bansal, N. (2019): Cheese: Importance and introduction to basic technologies. *J Food Sci Technol Nepal*, 11: 14-24. http://dx.doi.org/10.3126/jfstn.v11i0.29666

Loudiyi, M. and Aït-Kaddour, A. (2018): Evaluation of the effect of salts on chemical, structural, textural, sensory and heating properties of cheese: Contribution of conventional methods and spectral ones. *Crit Rev Food Sci Nutr.,* 59(15): 2442-2457. https://doi.org/10.1080/10408398.2018.1455637

Mansour, A.M.; Ishlak, A.M. and Toweir, M.A. (2020): Study bacteriological quality of white cheese in Benghazi markets, Libya. *Syrian Journal of Agricultural Research – SJAR,* 7(5): 438-448.

McSweeney, P.L. (2007): Analysis of cheese, In Woodhead Publishing Series in Food Science, Technology and Nutrition, Cheese Problems Solved, *Woodhead Publishing*, pp. 166-175, ISBN 9781845690601, https://doi.org/10.1533/9781845693534.166

Metwally, B.N. (2006): Hygienic quality of soft cheese marketed in Cairo. M.Sc. thesis, Faculty of Veterinary Medicine, Cairo University.

Moatsou, G.; Zoidou, E.; Choundala, E.; Koutsaris, K.; Kopsia, O.; Thergiaki, K. and Sakkas L. (2019): Development of Reduced-Fat, Reduced-Sodium Semi-hard Sheep Milk Cheese. *Foods*. 8(6):204. https://doi.org/10.3390/foods8060204

Mohamed, S.M.A.; Abdou, M.A.; Elbarbary, A.H. and Elbaba, H.A. (2019): Assessment of microbiological quality in some cheese varieties in Egypt. *Benha Veterinary Medical Journal,* 36(1): 164-174. https://doi.org/10.21608/bvmj.2019.103408

Mohamed, E.; Amin, W.; Mohamed, M. and Nan, M. (2022): Incidence of coliforms in white soft cheese with special reference to *E. Coli*. *Assiut Veterinary Medical Journal*, 68(175): 97-105. https://doi.org/10.21608/avmj.2022.154405.1076

Montebello, K.; Spiteri, D. and Valdramidis, V.P. (2018): Identification and characterization of aerobic spore-forming bacteria isolated from Maltese cows' milk, *International Dairy Journal*, 84: 54-61, https://doi.org/10.1016/j.idairyj.2018.03.016.

Morar, A.; Ban-Cucerzan, A.; Herman, V.; Tîrziu, E.; Sallam, K.I.; Abd-Elghany,

S.M. and Imre, K. (2021): Multidrug resistant coagulase-positive *staphylococcus aureus* and their enterotoxins detection in traditional cheeses marketed in Banat Region, Romania. *Antibiotics*, 10(12): 1458. https://doi.org/10.3390/antibiotics10121458

Mukhiddinov, Q.A.; Rakhimov, A.M.; Saparov, Dj.E.; Aït-Kaddour, A. and Sultanova, S.A. (2022): Investigation of the process of molding, pressing and salting hard and soft cheeses. *IOP Conf. Ser.: Earth Environ. Sci*. 1076 012060. https://doi.org/10.1088/1755-1315/1076/1/012060

O'Brien, N.M. and O'Connor, T.P. (2017): In: McSweeney, P.L.H., Fox, P. F., Cotter, P. D. and Everett D. W. *Cheese* (4th Ed.), Academic Press, pp. 603-611, ISBN 9780124170124, https://doi.org/10.1016/B978-0-12-417012-4.00024-7.

Özdemir, S.; Yangılar, F. and Ozdemir, C. (2010): Determination of microbiological characteristics of Turkish Karin Kaymagi cheeses packaged in different materials. *African Journal of Microbiology Research,* 4(9): 716-721.

Papademas, P. (2006): Chapter 4 - Halloumi cheese. In: Tamime, A. *brined cheeses*, pp. 117-138, Blackwell Publishing Ltd. https://doi.org/10.1002/9780470995860.ch4

Porcellato, D.; Hanne, K.; Finton, M.D.; La Rosa, S.L.; Duarte, V.D. and Skeie, S.B. (2023): Composition and fate of heat-resistant anaerobic spore-formers in the milk powder production line, *International Journal of Food Microbiology*, 402 ,110281, ISSN 0168-1605, https://doi.org/10.1016/j.ijfoodmicro.2023.110281.

Price, R.G. and Wildeboer, D. (2017): E. coli as an indicator of contamination and health risk in environmental waters. In: Samie, A. *Escherichia coli* - recent advances on physiology, pathogenesis and biotechnological applications InTech eBooks. https://doi.org/ DOI: 10.5772/67330.

Sakr, H.S.; Eman, F.M. and Neamah, R.A. (2011): Using Goat's milk in making three types of soft cheese. J. *Food and Dairy Sci*., Mansoura Univ., 2(5): 251–260. http://dx.doi.org/10.21608/jfds.2011.81950

Sameen, A.; Anjum, F.M.; Huma, N. and Nawaz, H. (2008): Quality evaluation of mozzarella cheese from different milk sources, *Pakistan Journal of Nutrition*, 7(6): 753-756. http://dx.doi.org/10.3923/pjn.2008.753.756

SASMO "Syrian Arab Standards and Metrology Organization" (2002): Chemical requirements for white cheeses No. 289 Ministry of Industry, Syria.

SASMO "Syrian Arab Standards and Metrology Organization" (2007): Microbial requirements for white cheeses No. 2179 Ministry of Industry, Syria.

Sbeeh, O. and Harfosh, M. (2022): Pasta Filata Cheesemaking (braided cheese) and Effect of The Manufacturing Method in Properties of The Cheese. *Damascus University Journal of agriculture sciences.* 38(4). https://journal.damascusuniversity.edu.sy/index.php/agrj/article/view/7404

Schelin, J.; Wallin-Carlquist, N.; Cohn, M.T.; Lindqvist, R.; Barker, G.C. and Rådström, P. (2011): The formation of *Staphylococcus aureus* enterotoxin in food environments and advances in risk assessment. *Virulence*, 2(6): 580–592. https://doi.org/10.4161/viru.2.6.18122

Sheet, I.; Sakr, S.; Al Hallak, N. and Al Khatib, A. (2020): Microbial quality assessment of selected Lebanese

dairy products and the antimicrobial resistance of bacterial isolates. *International Journal of Clinical Studies & Medical Case Reports*, 2(2), https://dx.doi.org/10.46998/IJCMCR.2020.02.000035

Shenana, M.E. (2002): Microstructure of full - and low fat Halloumi cheese. *Annals of agricultural scince.* 40(1): 359-368

Slik, S. and Abou Ghorra, S. (2007): Study of some chemical and microbial properties in Syrian Chelal and Halloumi cheeses. *Damascus University Journal of Agriculture Sciences*, 23(1):169-189.

Sobeih, A.M. (2009): Incidence of Aerobic Spore Formers in UHT Milk. *Assiut Veterinary Medical Journal*, 55(123): 1-11. https://doi.org/10.21608/avmj.2009.174922

SPSS "Statistical Package for the Social Sciences" (2019): Version 26. Armonk, NY: IBM Crop.

Statista (2023): Annual cheese production worldwide from 2015 to 2023. https://www.statista.com/statistics/1120911/cheese-production-worldwide/#:~:text=In%202022%2C%20global%20cheese%20production,tons%20of%20cheese%20that%20year.

Tarabiya, O.F.; Awaad, S.S.; Sallam, S.S. and Abdel-Salam, A.B. (2024): Customer Knowledge about purchasing perceptions, Safety and Quality Issues of Syrian Cheese in Egypt. *Journal of Advanced Veterinary Research*

Tewari, A and Abdullah, S. (2015): Bacillus cereus food poisoning: international and Indian perspective. *Journal of food science and technology*, 52(5): 2500–2511. https://doi.org/10.1007/s13197-014-1344-4

Toufeili, I. and Özer, B. (2006): Chapter 6 - Brined Cheeses from the Middle East and Turkey. In Tamime, A. *Brined Cheeses*, pp. 188-210. https://doi.org/10.1002/9780470995860.ch6.

Ulusoy, B.H.; Hecer, C. and Berkan, Ş. (2020): Investigation of Microbiological Hazards in Traditional Halloumi/Hellim Manufacturing Process. *Atatürk Üniversitesi Veteriner Bilimleri Dergisi,* 15(3):196-206. https://doi.org/10.17094/ataunivbd.742811

UNHCR "United Nations High Commissioner for Refugee" (2023): Refugee context in Egypt. https://www.unhcr.org/eg/about-us/refugee-context-in-egypt

Vidic, J.; Chaix, C.; Manzano, M. and Heyndrickx, M. (2020): Food Sensing: Detection of *Bacillus cereus* Spores in Dairy Products. *Biosensors*, 10(3): 15. https://doi.org/10.3390/bios10030015

Wierzchowska, W.C.; Zadernowska, A. and Solache, M.G. (2020): Ready-to-eat dairy products as a source of multidrug-resistant Enterococci strains: Phenotypic and genotypic characteristics. *Journal of dairy science*, 103(5): 4068–4077. https://doi.org/10.3168/jds.2019-17395

الصفات الفيزيائية والكيميائية والميكروبيولوجية لبعض أنواع الجبن السورية المنتجة في مصر

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نظرًا لتزايد شعبية الجبن السوري المنتج في مصر، تم إجراء هذه الدراسة علي ثلاثة أنواع لتقييم الجودة الحسية والكيميائية والميكروبيولوجية لبعض أنواع تلك المنتجات المعروضة في الأسواق المصرية. تم فحص ١٠٥ عينة من الجبن (٣٥ من: جبن الحلوم، العكاوي، والمضفرة) تم تجميعها بشكل عشوائي من محلات التجزئة، والهايبر ماركت، والصفحات الإلكترونية في محافظتي الجيزة والقاهرة. أشار التقييم الحسي إلى وجود فرق معنوي بين جبن الحلوم والنوعين الآخرين جبن العكاوي وجبن المضفرة. ولتقييم الجودة الميكروبيولوجية، تم فحص جميع العينات لمعرفة مدى انتشار المكورات العنقودية الكلية، والمكورات العنقودية الذهبية، والقولونيات، والمكورات المعوية، والسالمونيلا، والهوائيات المتجرثمة، والبكتريا العصوية الشمعية، واللاهوائيات المتجرثمة، والخمائر والعفن. حيث تم عزل ميكروب الأيشيريشا كولاي بنسبة ٣٤,٢٨٪، ٤٨,٥٧٪ و٢٨,٥٧٪ في عينات الجبن الحلوم والعكاوي والمضفرة، بينما لم يتم اكتشاف ميكروبات السالمونيلا في جميع العينات التي تم فحصها. لم تظهر نتائج الفحص الكيميائي وجود اختلاف معنوي باستثناء نسبة الملح في جبن الحلوم والتي كانت أقل معنويا من الأنواع الأخرى. وقد كانت معظم العينات المفحوصة غير متوافقة مع المواصفات القياسية المصرية للأجبان شبه الصلبة. لذلك، توصي هذه الدراسة بشكل كبير على أهمية اتباع أساليب تصنيع موحدة، ونظام مراقبة متكامل، وممارسات التصنيع الجيدة (GMP) أثناء عملية الإنتاج.

الكلمات المفتاحية: الجبن السوري، التقييم الحسي، المكورات المعوية، الهوائيات المتجرثمة، الملح.