Egyptian Journal of Animal Health

P-ISSN: 2735-4938 On Line-ISSN: 2735-4946
Journal homepage: https://ejah.journals.ekb.eg/

Overview of Carboxy-methyl cellulose Edible Films supported with propolis extracts as antimicrobial of Kariesh cheese

Yosra Samy Aleslamboly, Neven Mohamed and Sara Ragab

*Reference Lab for Safety Analysis of Food of Animal Origin, Animal Health Research Institute (AHRI), Agriculture Research Center (ARC) Giza, Egypt.

Received in 22/4/2025
Received in revised from 13/5/2024
Accepted in 1/6/2025

Keywords:

Kariesh cheese
Carboxy methyl cellulose
Propolis
microbial contamination
food safety
natural preservative. .

ABSTRACT

The purpose of this study is to evaluate the microbiological quality of Kariesh cheese which was collected from local markets and the efficacy of Carboxy-methyl cellulose (CMC) Edible Films supported with Propolis in enhancing its safety and shelf life. Fifty Kariesh cheese samples from Giza markets were analyzed for microbial contamination, including total *coliform* group counts, *E. coli, S. aureus,* yeast and mold, using standard analytical methods. Kariesh cheese was treated with 1% (T1) and 2% (T2) CMC with Propolis, stored at 4°C, and analyzed at zero time and every 7 days for 28 days for *coliform* group counts and yeast count. A control group was included for comparison. The results showed that market samples recorded high microbial contamination, with mean counts of 1.7 ± 0.14 (*coliform* group), 2.1 ± 0.12 (*E. coli*), 2.3 ± 0.12 (*S. aureus*), 2.7 ± 0.12 log CFU/g (yeast) and 1.6 ± 0.06 log CFU/g (mold). Treated samples showed a dose-dependent decrease in microbial growth. By Day 28, the control group exhibited the highest *coliform* group counts at 2.7 ± 0.38 log CFU/g, while the T1 treatment group's count was reduced to 1.4 ± 0.12 log CFU/g, and the T2 group showed the lowest count at 1.2 ± 0.06 log CFU/g. Similarly, yeast counts progressively declined in treated groups, with T1 decreasing to 2.2 ± 0.17 log CFU/g and T2 reaching the lowest level of 1.9 ± 0.12 log CFU/g by the end of the storage period. These results CMC with Propolis effectively inhibits microbial growth in a concentration-dependent manner throughout the storage duration. CMC with Propolis preserved sensory qualities, with no adverse effects reported. It was concluded that Kariesh cheese from local markets showed low microbiological quality, posing health risks. CMC with Propolis effectively reduced microbial contamination and maintained sensory attributes, highlighting its potential as a natural preservative to enhance the safety and shelf life of traditional dairy products.

Corresponding author: Yosra Samy Aleslamboly, Reference Lab for Safety Analysis of Food of Animal Origin, Animal Health Research Institute (AHRI), Agriculture Research Center (ARC) Giza, Egypt.
Email address: Yosrasamyy@gmail.com
DOI: 10.21608/ejah.2025.432116

INTRODUCTION

Cheese plays a significant role in the human diet, around the globe, it is common to see one or more varieties of cheese served at breakfast **(Sahar et al. 2023).**

Kariesh cheese is among the most popular traditional soft cheeses in Egypt, largely favored because of its affordability, high nutritional value, and distinct flavor **(Nyamakwere et al. 2021).** It is produced primarily through artisanal methods, often involving unpasteurized milk, making it highly susceptible to microbial contamination (**Awad, 2016; Nyamakwere et al. 2021 and Alnakip et al. 2023**). The microbiological safety of Kariesh cheese has become a significant public health concern, as studies have shown that it frequently serves as a vector for foodborne pathogens, including *coliform* bacteria, *Escherichia coli* (*E. coli*), *Staphylococcus aureus (S. aureus*), and various yeast and mold species (**EI-Tahan et al. 2004; Salem et al. 2016**). These microorganisms not only reduce the shelf life and quality of the cheese but also pose serious health risks to consumers, particularly in cases of inadequate hygienic practices during production and handling (**Allam et al. 2017; Kandil, 2023**).

It is well-established that microbial contamination in soft cheeses is a multifactorial issue, influenced by production processes, storage conditions, and environmental exposure (**Falih et al. 2024**). Total *coliform* group counts are commonly used to identify fecal contamination and poor hygiene during manufacturing (**Wanjala et al. 2018**). Similarly, the presence of *E. coli* in dairy products indicates inadequate pasteurization or contamination during handling. (**Lilian et al. 2023**). Yeast and mold contamination, on the other hand, often occurs due to improper storage and packaging, leading to spoilage and potential production of mycotoxins, which pose long-term health risks (**Awasti & Anand, 2020**). To address these concerns, synthetic preservatives such as sorbates and benzoates have long been employed to prolong shelf life of dairy products (**Anand & Sati, 2013**). However, there is growing consumer demand for natural and clean-label alternatives that can provide equivalent antimicrobial benefits without introducing chemical additives.

Recent studies have highlighted the antimicrobial potential of natural bioactive compounds, particularly Propolis, a resinous substance produced by honeybees (**Ratajczak et al. 2021**).

Propolis is contains a high concentration of phenolic compounds, flavonoids, and other bioactive substances which are characterized by their antibacterial, antifungal, and antioxidant properties (**Almuhayawi, 2020; Zulhendri et al. 2021; Al-Juhaimi et al. 2022 and Ożarowski et al. 2022;)**. Several studies have demonstrated its impact in inhibiting a wide range of microorganisms, such as foodborne pathogens and spoilage fungi. For instance, **(Paula et al. 2024)** showed that Propolis extracts significantly reduced microbial loads in soft cheeses, while **(Abarca et al. 2023)** reported its effectiveness against cheese contaminating fungi. Despite these promising results, the specific application of Propolis in Kariesh cheese, especially its ability to control *coliform* group, *E. coli, S. aureus,* and fungal contaminants during storage, remains underexplored (**El-Deeb & Omar, 2017; Saleh et al. 2020 and Mohamed et al. 2023**).

While numerous studies have shown the antimicrobial properties of Propolis in various food matrices (**Tosi et al. 2007; Pobiega et al. 2019 and Arief et al. 2022),** there is limited data on its use in traditional Egyptian dairy products, such as Kariesh cheese. The optimal concentrations of Propolis required to achieve effective microbial control without negatively impacting the sensory attributes of the product also remain poorly understood. This lack of data highlights the need for targeted research to assess the practical application of Propolis as a natural preservative in Kariesh cheese production and storage.

Carboxymethyl cellulose (CMC) is a key polysaccharide known for its ability to form edible coatings that are odorless, tasteless, safe, transparent, water-soluble, and stable. These coatings are especially effective at carrying active functional ingredients. Adding such functional substances to edible coatings is a modern approach in food preservation, helping to enhance the quality, safety, and shelf life of food products during storage. (**Panahirad et al. 2021**).

This study seeks to fill the identified gaps by evaluating the microbiological quality of Kariesh cheese samples collected from local markets and investigating the efficacy of Carboxy-methyl cellulose with Propolis treatments in controlling some microbial contamination during storage. Specifically, the study focuses on the impact of CMC with Propolis (1% and 2%) on *coliform* group counts and yeast levels. Microbiological analysis was performed using standardized methods, and the results were statistically analyzed to determine the significance of the observed effects. By assessing the dose-dependent antimicrobial efficacy of CMC with Propolis, this study seeks to provide a comprehensive evaluation of its potential used as a natural preservative for improving the safety and shelf life of Kariesh cheese.

MATERIALS AND METHODS

Samples collection

Fifty Kariesh cheese samples were randomly obtained from different local markets in Giza Government. As soon as possible, the samples were aseptically transported in an ice box to Food Hygiene department, Animal Health Institute to be examined microbiologically.

The Propolis employed in this work was obtained from Plant Protection Research Institute, Agriculture Research Center. While Carboxy methyl cellulose (CMC) was bought from Algomhoria Company-Cairo- Egypt.

Preparation of samples (ISO 6887-5: 2017):

Each 10-gram sample was thoroughly blended with 90 mL of sterile 0.1% buffered peptone water (BPW) using a sterile homogenizer at 2500 rpm for 2 minutes. This produce an initial 1:10 dilution. From this mixture, 1 mL was transferred to a tube containing 9 mL of fresh sterile BPW (0.1%) to prepare additional dilutions in a subsequent manner. Serial tenfold dilutions were prepared using sterile peptone water (0.1%), which were subsequently utilized for testing the specified parameters.

Preparation of Propolis Extract:

Four grams of finely chopped propolis sample were put into plastic tubes, macerated with 10 ml of 50% ethyl alcohol, vortexed for fifteen to twenty minutes, and then it was left to extract at four degrees Celsius for forty-eight hours. Periodically, the samples were vortexed to facilitate extraction. After filtering, the resulting ethanolic extracts were kept for further use. **(Tumbarski et al. 2021).**

Gel Preparation for use in Edible Films:

To prepare 1% gels for edible films, 4 grams of carboxymethyl cellulose (CMC) were dissolved in 400 milliliters of distilled water. The mixture was stirred using a magnetic stirrer at 800 rpm for 30 to 40 minutes until fully dissolved. The gel was then refrigerated at 4°C for 24 hours to allow any air bubbles formed during stirring to dissipate. Then, 10 milliliters of propolis extract dissolved in 50% ethanol was added to each 400 ml CMC gel and stirred again under the same conditions. This process resulted in the preparation of CMC gels containing propolis extract at concentrations of 1% and 2%.

Implementation of Edible Films:

Kareish cheese samples were divided into three groups for the experiment: Group 1 served as the control, Group 2 was coated with 1% CMC mixed with propolis, and Group 3 was coated with 2% CMC mixed with propolis. The coatings were applied using brushes and then left to dry. Each group of cheese was placed in separate plastic containers and stored at 4°C for 28 days. Throughout this period, yeast and coliform bacteria levels were measured at the beginning (day 0) and then again on days 7, 14, 21, and 28 to monitor any changes.

Microbiological analysis

Microbiological analysis was performed on all Kariesh cheese samples taken to determine the count of key microorganisms including total *coliform* group, *S. aureus*, *E.coli*, yeast and mold counts.

The methods were conducted as follow:

Coliform group counts according to FDA (2020):

Transfer 1 ml homogenized tested sample to sterile petri dish, then add 15 ml of Violet red bile agar (VRBA), after solidify add 10 ml VRBA over layer and incubate at 32ºC (dairy products) for 18-24 hours. Suspected colonies with a purplish - red color surrounded by a red zone of precipitated bile acid, take at least 10 colonies for confirmation by transfer each colony to a tube contain BGLB and incubate at 35ºC for 24-48hr and examined for gas production.

Enumeration of Escherichia _coli_ according to ISO 16649-2 (2001):

Transfer 1ml of each dilution into sterile petri dishes then pour 15-18 ml of molten Tryptone Bile X-glucoronide medium (TBX) (previously prepared and cooled at 44°C - 47° C in the water bath) to plates then mix and allow to set. Incubate plates at 44° C for 24 hr. The count is calculated from the number of typical blue or blue green colonies per plate.

Enumeration of _Staphylococcus aureus_ according to ISO 6888-1, (2021):

The count was performed by plating 1 ml of the initial suspension (10^{-1} dilution) test sample on Baird Parker agar plate (d=140mm). Incubate at 34 °C to 38 °C for 24 h ± 2 h, then re-incubate for a total of 48 h ± 4 h. Suspected colonies were purified and subjected for further biochemical examination.

Enumeration of yeasts and molds according to ISO 21527-1: (2008):

It was performed by inoculation of 0.1 ml of tested sample on plate of Dichloran rose bengal chloramphenicol agar (DRBC). Followed by incubation at 25°C for 5 days. Count plates less than150 colonies and calculate the average.

Sensory analysis:

Organoleptic evaluation of coated kariesh cheese was performed in accordance with the protocol of **Bodyfelt and Potter, (2009).** Organoleptic examination was conducted on Kariesh cheese samples after zero time, 7, 14, 21 and 28 days of storage period by ten staff members of the Food Hygiene Department (Animal Health Research Institute, Agriculture Research Center Giza Egypt). The sensory attributes evaluated were the flavor (1-10 points), Body and texture (1-5 points) and Appearance and color (1-5 points).

Statistical analysis:

The data were analyzed through a one-way analysis of variance (ANOVA), with the experiment conducted in triplicate Before analysis, bacteriological counts were log-transformed. Statistical evaluation was carried out using the mixed procedure in SPSS software (version 20, IBM Corp.). Differences between means were determined using Fisher's least significant difference (LSD) test, and results were considered statistically significant at a confidence level of 95% ($\alpha = 0.05$).

RESULTS

The microbiological analysis of 50 Kariesh cheese samples collected from local markets in Giza Government revealed varying levels of contamination by total *E.coli* counts detected in 18% of samples and ranged from <1 to 2.6 Log CFU/g, with a mean of 2.1 ± 0.12 Log CFU/g. *S. aureus* was detected in 14% of samples, with counts ranging between <1 and 2.7 Log CFU/g with mean of 2.3 ± 0.12 Log CFU/g). Mold was detected in 22% of samples, with counts ranging between <1 and 1.9 Log CFU/g with mean of 1.6 ± 0.06 Log CFU/g). Among the analyzed microbes, yeast and *coliform* group exhibited the highest counts 100% of total samples, with values ranging from 1.5 to 4.6 Log CFU/g and a mean of 2.7 ± 0.12 Log CFU/g for yeast and values ranging from 1.0 to 3.5 Log CFU/g, with a mean of 1.7 ± 0.14 Log CFU/g for *coliform* group, indicating high contamination levels across the samples

Table 1. Statistical analysis of different microbial counts (log10cfu/g) of Kariesh cheese (n=50)

Type of microorganisms	Examined samples			Counts (log cfu/gm)		
	Total number	Positive Samples		Minimum value	Maximum value	Mean ±SE
		No.	%			
Total *Coliform*	50	50	100	1.0	3.5	1.7 ± 0.14
E.coli		9	18	<1	2.6	2.1± 0.12
S. aureus		7	14	<1	2.7	2.3 ± 0.12
Yeast		50	100	1.5	4.6	2.7 ± 0.12
Mold		11	22	<1	1.9	1.6 ± 0.06

Microbiological quality of Kariesh cheese samples collected from local markets in Giza, showing contamination levels of total *coliform* group, *S. aureus, E. coli*, yeast and mold. Yeast and *coliform* group exhibited the highest levels of contamination, highlighting the need for enhanced preservation measures.
CFU: colony-forming units; SE: standard Error.

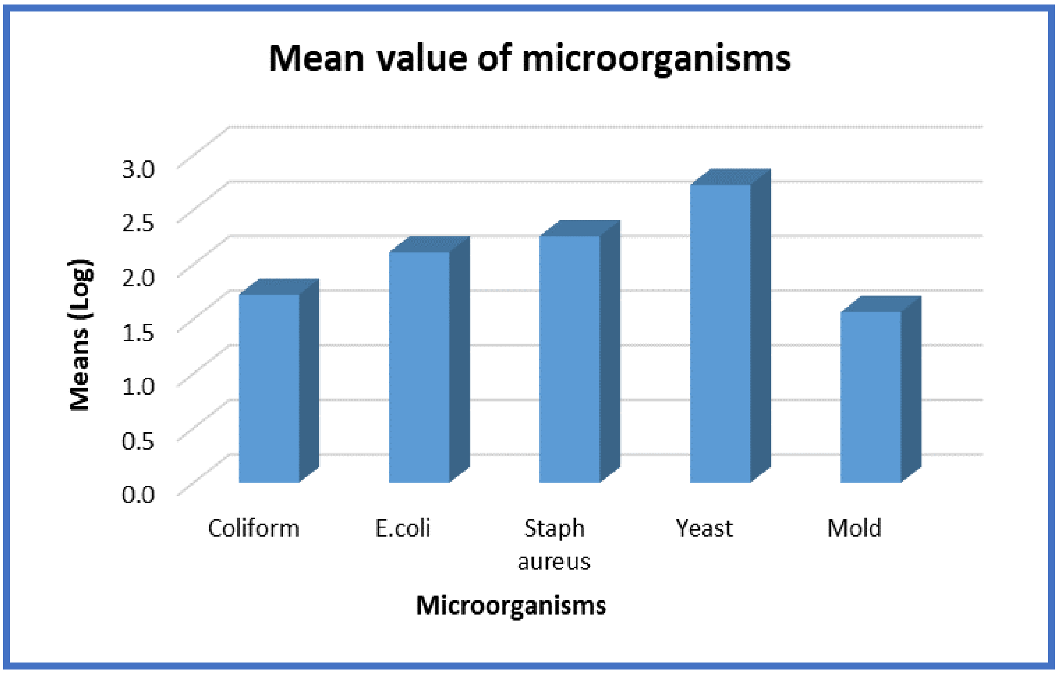

Figure (1) Comparison of microbial contamination levels in Kariesh cheese samples. The bar charts represent the mean count, expressed as Log (CFU/g). Yeast was the most prevalent contaminants, followed by *S. aureus, E. coli, coliform* group and Mold.

Coliform group counts in Kariesh Cheese Treated with CMC mixed with Propolis

The effect of CMC mixed with Propolis treatment on *coliform* group counts in Kariesh cheese samples during a 28-day storage period is summarized in Table 2 and visually represented in Figures 2. On Day zero, *coliform* group counts were similar across all groups, with values of 1.8 ± 0.06 log CFU/g for the control group, 1.7 ± 0.06 log CFU/g for T1 (1% CMC Propolis), and 1.5 ± 0.10 log CFU/g for T2 (2% CMC Propolis). However, differences became apparent as storage progressed.

By Day 7, *coliform* group counts in the control group increased to 2.0 ± 0.06 log CFU/g, while the T1 and T2 treatments maintained lower counts of 1.5 ± 0.06 and 1.3 ± 0.12 log CFU/g, respectively. Significant differences (P < 0.05) were observed from Day 14 onward, with the control group showing consistently higher counts compared to the Propolis-treated samples. By Day 28, the control group had the highest *coliform* group counts (2.7 ± 0.38 log CFU/g), followed by T1 (1.4 ± 0.12 log CFU/g), while T2 had lowest count detection (1.2±0.06 log CFU/g).

Table 2. *Coliform* group counts (mean ± SD log cfu/g) in Kariesh cheese samples treated with different concentration of CMC mixed with Propolis during storage period

Storage Period	Control	T1 (1%)	T2 (2%)
Day Zero	$1.8^{a} \pm 0.06$	$1.7^{b} \pm 0.06$	$1.5^{c} \pm 0.10$
Day 7	$2.0^{a} \pm 0.06$	$1.5^{b} \pm 0.06$	$1.3^{c} \pm 0.12$
Day 14	$2.3^{a} \pm 0.25$	$1.5^{b} \pm 0.12$	$1.3^{c} \pm 0.06$
Day 21	$2.5^{a} \pm 0.26$	$1.5^{b} \pm 0.17$	$1.3^{c} \pm 0.10$
Day 28	$2.7^{a} \pm 0.38$	$1.4^{b} \pm 0.12$	$1.2^{c} \pm 0.06$

The statistical analysis of *coliform* group counts (mean ± SD, log CFU/g) in Kariesh cheese samples treated with different concentrations of CMC with Propolis (T1: 1%, T2: 2%) during the storage period. Over time control samples showing consistently higher counts compared to CMC mixed with Propolis treated samples. Means in the same row bearing different superscript letters (a, b, c) represent significant differences (P<0.05).
CFU/g: colony-forming units per gram
SD: standard deviation.

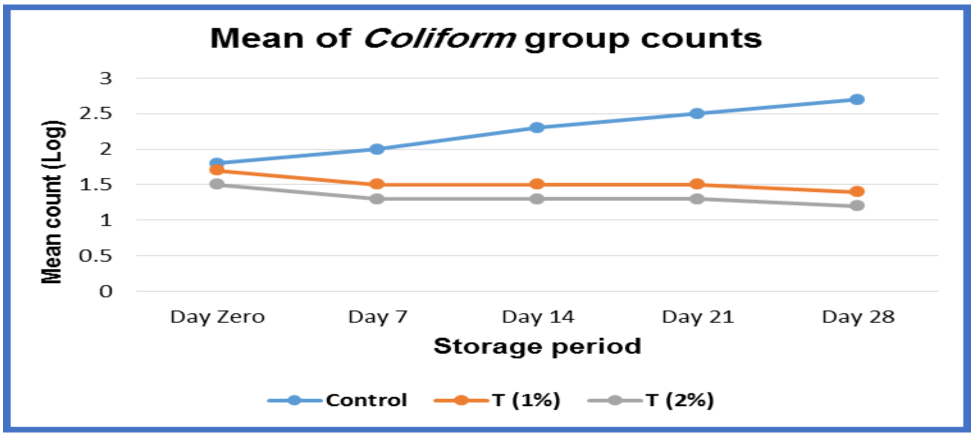

Figure (2) Reduction in *coliform* group counts in Kariesh cheese treated with different concentrations of CMC mixed with Propolis during storage. The line plot graph highlights the dose-dependent antimicrobial effect of Propolis. The blue line represents the control group, the orange line represents T1 (1% CMC with Propolis Propolis), and the gray line represents T2 (2% CMC with Propolis Propolis). *Coliform* group counts in Propolis-treated samples (T1 and T2) decreased progressively over time, while the control group exhibited a consistent increase, highlighting the antimicrobial effect of CMC mixed with Propolis during storage

Yeast Counts in Kariesh Cheese Treated with CMC mixed with Propolis

The impact of CMC with Propolis treatment on yeast counts in Kariesh cheese throughout a 28-day storage period is presented in Table 3 and illustrated in Figures 3. At Day 0, the yeast count was 2.5 ± 0.15 log CFU/g for the control group, 2.4 ± 0.10 log CFU/g for T1 (1% Propolis), and 2.3 ± 0.12 log CFU/g for T2 (2% Propolis). These initial counts were comparable, with T2 showing a slightly lower baseline.

As storage progressed, significant differences ($P < 0.05$) were observed between the control and treated groups. By Day 7, the control group experienced a slight increase to 2.7 ± 0.20 log CFU/g, while T1 and T2 groups maintained lower counts at 2.3 ± 0.12 and 2.0 ± 0.21 log CFU/g, respectively. From Day 14 onwards, yeast counts in the control group continued to rise, reaching 3.2 ± 0.26 log CFU/g by day 28. In contrast, CMC with Propolis treated groups exhibited a progressive reduction, with T1 decreasing to 2.2 ± 0.17 log CFU/g and T2 showing the lowest count at 1.9 ± 0.12 log CFU/g by the end of the storage period.

Table 3. Yeast counts (mean ± SD log cfu/g) in Kariesh cheese samples treated with different concentration of CMC with Propolis during storage period

Storage Period	Control	T1 (1%)	T2 (2%)
Day Zero	2.5^{a} ± 0.15	2.4^{b} ± 0.10	2.3^{b} ± 0.12
Day 7	2.7^{a} ± 0.20	2.3^{b} ± 0.12	2.0^{b} ± 0.21
Day 14	2.9^{a} ± 0.21	2.3^{b} ± 0.06	2.0^{b} ± 0.06
Day 21	3.1^{a} ± 0.25	2.2^{b} ± 0.06	1.9^{b} ± 0.17
Day 28	3.2^{a} ± 0.26	2.2^{b} ± 0.17	1.9^{b} ± 0.12

Table shows yeast counts (mean ± SD, log CFU/g) in Kariesh cheese samples treated with Propolis (T1: 1%, T2: 2%) during storage. The control group had consistently higher counts, while Propolis-treated samples demonstrated significant declines ($P < 0.05$), with T2 exhibiting the lowest levels. Significant differences are indicated by different superscript letters (a, b). The treated samples

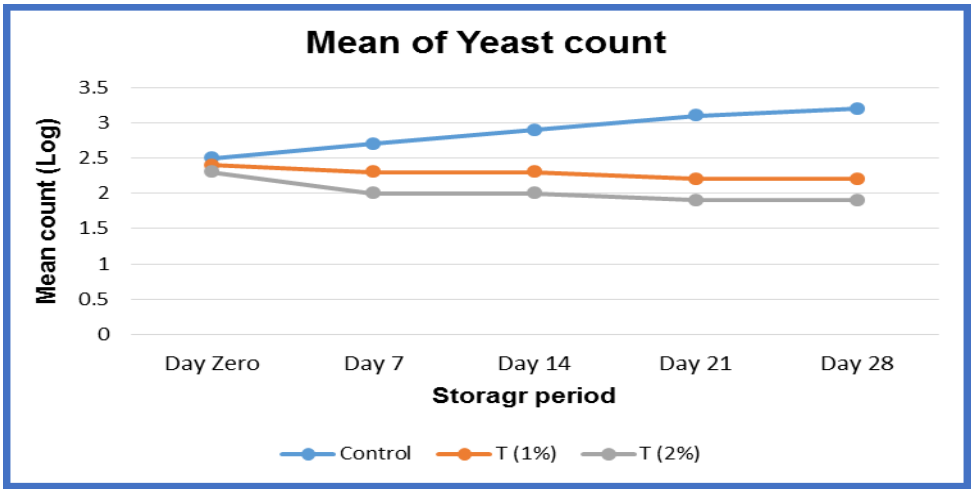

Figure (3) Reduction in Yeast counts in Kariesh cheese treated with different concentrations of CMC with Propolis during storage. The line plot graph highlights the dose-dependent antifungal effect of CMC with Propolis. The blue line represents the control group, the orange line represents T1 (1% CMC with Propolis), and the gray line represents T2 (2% CMC with Propolis). Yeast counts in Propolis-treated samples (T1 and T2) decreased progressively over time, while the control group exhibited a consistent increase, highlighting the antifungal effect of CMC with Propolis during storage

The sensory evaluation:

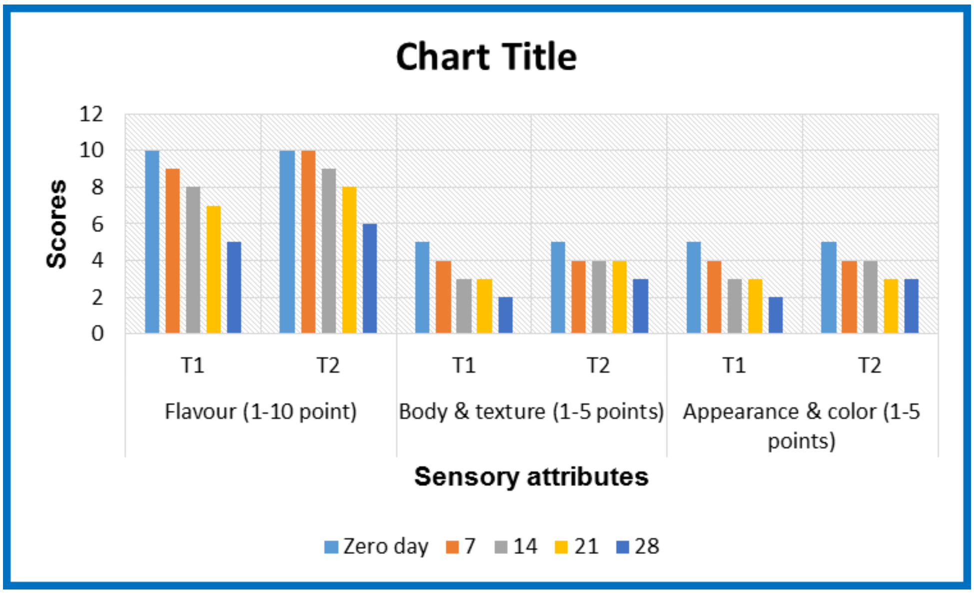

Figure (4) The bar chart represent sensory evaluation scores of two concentrations of Carboxy methyle cellulose with propolis treatment 1% (T1) and 2% (T2) across sensory attributes (Flavor (1-10 points), body and texture (1-5 points), appearance and color (1-5 points)) of Kariesh cheese, measured over five time points (Zero day, 7, 14, 21, and 28 days) of storage at 4ºC± 1. Overall all sensory attributes show slightly downward trend in scores as storage time increases. But generally T2 retains higher scores than T1 across all attributes and time points, suggesting better stability and quality retention

DISCUSSION

The present study investigated the microbiological quality of Kariesh cheese and evaluated the antimicrobial efficacy of Propolis in reducing microbial contamination during storage. Kariesh cheese, a traditional soft cheese widely consumed in Egyptian cities and Arabian countries, has been previously reported to may carry several contaminants posing health risks (**Hamad, 2015**). Soft cheese is often regarded as a product with a limited and unpredictable shelf life. Many traditional cheeses are made under poor hygienic conditions, using various production techniques that vary depending on the region. (**Freitas and Malcata1999**).

The findings of this study confirm these concerns, as most were contaminated to varying degrees by total *coliform* group , *S. aureus, E. coli*, yeast and mold. Among these, yeast was the most prevalent contaminants, followed by *coliform* group and *E. coli.* The high levels of fungal contamination in traditional Egyptian dairy products due to poor storage conditions and exposure to ambient air during sale (**Pal, 2014 and Garnier et al. 2017**).

The total *coliform* group counts observed in this study (mean: 1.7 Log CFU/g) reflect moderate contamination levels. *Coliform* group are considered indicators of fecal contamination and poor hygienic practices during production. Additionally*, E. coli*, a specific *fecal coliform*, was detected in 18% of the samples, with a mean count of 2.1 Log CFU/g. The prevalence of *E. coli* in Kariesh cheese has been extensively documented by previous studies (**Ombarak et al. 2016; Hammad et al. 2022 and Sobeih et al. 2024**), which linked its presence to inadequate pasteurization and cross-contamination during handling.

The high yeast counts (mean: 2.7 Log CFU/g) observed in this study align with the results reported by (**Soliman & Aly, 2011 and Elshrawy et al. 2019**) which considered fungal contamination as a major issue in Kariesh cheese. The presence of these fungi not only reduces the shelf life of the product but also poses health risks. These findings highlight the urgent need for improved hygienic practices and the adoption of antimicrobial treatments to improve the safety and quality of Kariesh cheese.

The use of Propolis as a natural antimicrobial substance in this study demonstrated significant efficacy in reducing microbial contamination during storage. Both 1% and 2% concentrations of CMC mixed with Propolis significantly reduced *coliform* group counts, with the 2% treatment achieving the greatest reduction (mean: 1.2 ± 0.06 Log CFU/g). These results are in agreement with the findings demonstrated the antibacterial properties of CMC with Propolis against *coliform* group in dairy products (**Elkassas et al., 2023**). Propolis is rich in bioactive substances such as flavonoids and phenolic acids, which are known to damage bacterial cell membranes and prevent the growth of microbes. (**Almuhayawi, 2020; Nichitoi et al. 2021; Zulhendri et al. 2021 and Elkassas et al. 2023**).

Similarly, CMC with Propolis treatments were efficient in reducing yeast counts, with the 2% concentration achieving the most pronounced effect (mean: 1.9 ± 0.12 Log CFU/g). Previous studies have reported the antifungal efficacy of Propolis against fungi commonly contaminating dairy products, supporting this finding. (**Tumbarski et al. 2021 and Ibrahim & Alqurashi, 2022**).

The present study demonstrates that a 2% concentration is sufficient to significantly reduce fungal contamination in Kariesh cheese, suggesting its practical applicability in dairy products. The dose-dependent effects observed in this study further corroborate previous studies highlighted the concentration-dependent antimicrobial properties of Propolis (**Dantas Silva et al. 2017 and Vadillo-Rodríguez et al. 2021**).

Food preservation aims to inhibit and/or slow down spontaneous alternative processes. During production, processing, storage, and distribution, it is necessary to maintain stable environmental and chemical food storage parameters. Therefore, food must limit interaction with the external environment which could lead to deterioration and loss of initial characteristics (**Huang et al. 2021 and Antonino et al. 2024**).

The sensory profile of Kariesh cheese was marginally affected by the different propolis extract concentrations during storage period at (4± 1ºC) for 28 days. Using 2% of CMC with propolis gained the highest score, but overall the results are acceptable. The results are in agreement with **Tumbarski et al. (2021).**

The findings of this study also align with the broader trend toward using natural preservatives to enhance food safety. Unlike synthetic preservatives, Propolis is a natural product with additional health benefits, including antioxidant and anti-inflammatory properties (**Zulhendri et al. 2022**). Its use in dairy products aligns with consumer preferences for clean-label foods free from artificial additives. However, additional studies are required to refine and improve the use of propolis in cheese manufacturing, including its sensory impact, long-term stability, and cost-effectiveness.

CONCLUSION

This study emphasizes the effectiveness of CMC with Propolis as a natural antimicrobial substance that can enhance the microbiological quality and extend the shelf life of Kariesh cheese. The findings underscore the importance of adopting natural preservation methods to address the high levels of microbial contamination observed in traditional dairy products. Effectively reducing *coliform* group counts and yeast counts, so using CMC with Propolis could be an effective way to enhance both the safety and quality of Kariesh cheese. Further research is needed to explore its application on a commercial scale and evaluate its impact on sensory properties and consumer acceptance.

REFERENCES

Abarca RL, Vargas F, Medina J, Paredes JC, López BC, Ortiz PA, Vargas-Bello-Pérez E. 2023. Development and Characterization of Films with Propolis to Inhibit Mold Contamination in the Dairy Industry.

Foods, *12*(8), 1633.

Al-Juhaimi FY, Özcan MM, Mohamed Ahmed IA, Alsawmahia ON, Özcan MM, Ghafoor K, Babiker EE. 2022. Bioactive compounds, antioxidant activity, fatty acid composition, and antimicrobial activity of propolis from different locations in Turkey. *Journal of Apicultural Research*, *61*(2): 246–254.

Allam MG, Darwish AMG, Ayad EHE. 2017. Improve hygienic quality of Egyptian Karish cheese employing isolated antagonistic lactobacilli strains. *Annual Research & Review in Biology*, *19*(2), 1–13.

Almuhayawi MS. 2020. Propolis as a novel antibacterial agent. *Saudi Journal of Biological Sciences*, *27*(11): 3079–3086.

Alnakip MEA, El-Essely E, Bayoumi MA, Elsaid EE. 2023. Screening of Particular Food-borne Pathogens in Raw Buffalosâ€™ milk and some Popular Artisanal Egyptian Dairy Products. *Journal of Advanced Veterinary Research*, *13*(7): 1418–1424.

Anand SP, Sati N. 2013. Artificial preservatives and their harmful effects: looking toward nature for safer alternatives. *Int. J. Pharm. Sci. Res*, *4*(7):2496–2501.

Antonino C, Difonzo G, Faccia M, Caponio F. 2024. Effect of edible coatings and films enriched with plant extracts and essential oils on the preservation of animal-derived foods. J. Food Sci. 2024;(89):748–772

Arief II, Apriantini A, Jayanegara A, Budiman C. 2022. Antimicrobial activity of propolis extract and their application as a natural preservative in livestock products: A meta-analysis. *Food Science of Animal Resources*, *42*(2), 280.

Awad S. 2016. Microbial safety criteria and quality of traditional Egyptian Karish cheese. *African Journal of Microbiology Research*, *10*(22): 804–812.

Awasti N, Anand S. 2020. The role of yeast and molds in dairy industry: An update. *Dairy Processing: Advanced Research to Applications*, 243–262.

Bodyfelt F, Potter D. 2009. Creamed cottage cheese. In: The Sensory Evaluation of Dairy Products. (2nd Ed.), Clark, S.; M. Costello; M. Drake and F. Bodyfelt (eds.). pp. 167-190. Springer Science Business Media, LLC, New York, USA.

Dantas Silva RP, Machado BAS, Barreto G, de A, Costa SS, Andrade LN, Amaral RG, Carvalho AA, Padilha FF, Barbosa JDV, Umsza-Guez MA. 2017. Antioxidant, antimicrobial, antiparasitic, and cytotoxic properties of various Brazilian propolis extracts. *Plos One*, *12*(3), e0172585.

EI-Tahan MH, Sedik MZ, EI Tahan FH. 2004. MICROBIOLOGICAL QUALITY OF AND INCIDENCE PATHOGENIC BACTERIA IN SOME TYPES OF CHEESE. *Journal of Agricultural Chemistry and Biotechnology*, *29*(2): 879–889.

El-Deeb AM, Omar SA. 2017. Effect of Propolis Extract as a Natural Preservative on the Microbial Content of Kareish Cheese. *Journal of Food and Dairy Sciences*, *8* (7):295–302.

Elkassas WM, Yassin SA, Taksira DM. 2023. Effect of adding propolis on quality standards of raw milk and yoghurt. *Current Research in Nutrition and Food Science Journal*, *11*(1): 231–245.

Elshrawy T, Mohamed HA, Elbarbary HA, Salem RM, El-Diasty EM. 2019. Incidence of fungi in kareish cheese from raw milk and trial to control them. *Benha Veterinary Medical Journal*, *37*(1): 97–101.

Falih MA, Altemimi AB, ALKaisy QH, Awlqadr FH, Abedelmaksoud TG, Amjadi S, Hesarinejad MA. 2024. Enhancing safety and quality in the global cheese industry: A review of innovative preservation techniques. *Heliyon*.

Food and Drug Administration 2020. Bacteriological Analytical Manual, Chapter 4: Enumeration of Escherichia coli and the Coliform Bacteria.

Freitas AC, FX, Malcata. 1999. Technological optimization of picante cheese using microbiological, chemical and physical criteria. Journal of Food Engineering, (41): 163-175.

Garnier L, Valence F, Mounier J. 2017. Diversity and control of spoilage fungi in dairy products: An update. *Microorganisms*, *5* (3): 42.

Hammad AM, Eltahan A, Hassan HA, Abbas NH, Hussien H, Shimamoto T. 2022. Loads of coliforms and fecal coliforms and characterization of thermotolerant Escherichia coli in fresh raw milk cheese. *Foods*, *11*(3):332.

Hamad MNF, Effect of Adding Glucono-δ-Lactone, Different of Starters, Rennet on the Chemical Composition, Yield and Economic Study of Kareish Cheese. International Journal of Food Science and Nutrition Engineering 2015, 5(3): 130-140 DOI: 10.5923/j.food.20150503.04

Huang J, Hu, Z, Hu, L, Li, G, Yao, Q, Hu, Y. 2021. Pectin-based active packaging: A critical review on preparation, physical properties and novel application in food preservation. Trends in Food. Science and Technology,118 (PA): 167–178

ISO "International Organization for Standardization" 6887 -5, 2017. Microbiology of the 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

ISO "International Organization for Standardization" 6888-1:2021. Microbiology of the food chain — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) Part 1: Method using Baird-Parker agar medium.

ISO "International Organization for Standardization" 16649-2 (2001). Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of beta-glucuronidase-positive Escherichia coli — Part 2: Colony-count technique at 44 degrees C using 5-bromo-4-chloro-3-indolyl beta-D-glucuronide

ISO "International Organization for Standardization" 21527-1:2008 Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of yeasts and molds Part 1: Colony count technique in products with water activity greater than 0,95

Ibrahim, MEED, Alqurashi RM. 2022. Antifungal and antioxidant properties of propolis (bee glue) extracts. *International Journal of Food Microbiology*, *361*, 109463.

Kandil STK. 2023. *Biocontrol of Pathogenic Bacteria in Egyptian Cheeses by Bacteriophages*. Harper Adams University.

Lilian A, Njue LG, Abong GO. 2023. Implementation of Good Manufacturing Practices in Milk Processing Companies in Nairobi County and Microbial Contamination of Milk and Milk Products. *Asian Food Science Journal*, *22*(12): 11–22.

Mohamed SHS, El-Aziz A, Al Towaijri SA. 2023. Prolong Shelf Life of Kareish Cheese: A review. *Egyptian Journal of Food Science*, *51*(1): 151–163.

Nichitoi MM, Josceanu AM, Isopescu RD, Isopencu GO, Geana EI, Ciucure CT, Lavric V. 2021. Polyphenolics profile effects upon the antioxidant and antimicrobial activity of propolis extracts. *Scientific Reports*, *11*(1): 20113.

Nyamakwere F, Esposito G, Dzama K, Raffrenato E. 2021. A review of artisanal cheese making: An African perspective. *South African Journal of Animal Science*, *51*(3): 296–309.

Ombarak RA, Hinenoya A, Awasthi SP, Iguchi A, Shima A, Elbagory ARM, Yamasaki S. 2016. Prevalence and pathogenic potential of Escherichia coli isolates from raw milk and raw milk cheese in Egypt. *International Journal of Food Microbiology*, *221*, 69–76.

Ożarowski M, Karpiński TM, Alam R, Łochyńska M. 2022. Antifungal properties of chemically defined propolis from various geographical regions. *Microorganisms*, *10* (2): 364.

Pal M. 2014. Spoilage of dairy products due to fungi. *Beverage and Food World*, *41*(7):37–38.

Panahirad S. 2021. Applications of carboxymethyl cellulose-and pectin-based active edible coatings in preservation of fruits and vegetables: A review. Trends in food science & technology. (110): 663-673.

Paula VB, Dias LG, Estevinho LM. 2024. Microbiological and Physicochemical Evaluation of Hydroxypropyl Methylcellulose (HPMC) and Propolis Film Coatings for Cheese Preservation. Molecules, 29(9): 1941.

Pobiega K, Kraśniewska K, Gniewosz M. 2019. Application of propolis in antimicrobial and antioxidative protection of food quality–A review. *Trends in Food Science & Technology*, (*83*): 53–62.

Ratajczak M, Kaminska D, Matuszewska E, Hołderna-Kedzia E, Rogacki J, Matysiak J. 2021. Promising antimicrobial properties of bioactive compounds from different honeybee products. *Molecules*, *26*(13): 4007.

Sahar SH, Mohamed Mahmoud Abd El-Aziz and Shouq A, Al Towaijri. 2023. Prolong Shelf Life of Kareish Cheese: A review Egypt. J. Food. Sci. Vol. 51, No.1, pp. 151 -163.

Saleh A, El-Malek A, Moussa M. 2020. Extended shelf life of Tallaga cheese by natural preservatives. *Journal of Productivity and Development*, *25*(1): 25–37.

Salem H, El-Attar L, Omran E. 2016. Microbiological assessment of some parameters of Kariesh cheese sold by supermarkets and street vendors in Alexandria, Egypt. *Journal of High Institute of Public Health*, *46*(2): 77–85.

Sobeih AMK, Elbarbary HA, Elattar SAM. 2024. Escherichia coli that Produces Shiga Toxins: Prevalence and Possible Risk in Soft Cheese. *Egyptian Journal of Veterinary Sciences*, 1–8.

Soliman NSM, Aly SA. 2011. Occurrence and identification of yeast species isolated from Egyptian Karish cheese. *Journal of Yeast and Fungal Research*, *2*(4): 59–64.

Tosi EA, Ré, E, Ortega ME, Cazzoli AF. 2007. Food preservative based on propolis: Bacteriostatic activity of propolis polyphenols and flavonoids upon Escherichia coli. *Food Chemistry*, *104*(3): 1025–1029.

Tumbarski YD, Todorova MM, Topuzova MG, Georgieva PI, Ganeva ZA, Mihov RB, Yanakieva VB. 2021. Antifungal Activity of Carboxymethyl Cellulose Edible Films Enriched with Propolis Extracts and Their Role in Improvement of the Storage Life of Kashkaval Cheese. *Current Research in Nutrition & Food Science*, *9*(2).

Vadillo-Rodríguez V, Cavagnola MA, Pérez-Giraldo C, Fernández-Calderón MC. 2021. A physico-chemical study of the interaction of ethanolic extracts of propolis with bacterial cells. *Colloids and Surfaces B: Biointerfaces*, (*200*):111571.

Wanjala WN, Nduko JM, Mwende MC. 2018. Coliforms Contamination and Hygienic Status of Milk Chain in Emerging Economies. *Journal of Food Quality & Hazards Control*, *5*(1).

Zulhendri F, Chandrasekaran K, Kowacz M, Ravalia M, Kripal K, Fearnley J, Perera CO. 2021. Antiviral, antibacterial, antifungal, and antiparasitic properties of propolis: A review. *Foods*, *10*(6): 1360.

Zulhendri F, Lesmana R, Tandean S, Christoper A, Chandrasekaran K, Irsyam, I., Suwantika AA, Abdulah R, Wathoni N. 2022. Recent update on the anti-inflammatory activities of propolis. *Molecules*, *27*(23): 8473.