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ANTIBACTERIAL IMPACT OF CURCUMIN NANOPARTICLES AGAINST SOME PATHOGENIC BACTERIA IN TALLAGA CHEESE

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ABSTRACT

The bacterial virulence and resistance to most antibiotics increased in the last decades and the public interest in traditional herbs has developed due to their confirmed medical properties and limited or no side effects. In the present study, the antibacterial activity of curcumin and its nanoparticles was investigated against *Staph. aureus*, *E. coli* and *Pseudomonas aeroginosa.* The prepared curcumin nanoparticles had the Z-average diameter of 103±32.12 nm and polydispersity index (PDI) of 0.152. In examining the freshly prepared nanoparticles by Transmission Electron Microscope (TEM) the spherical shape was confirmed, and the size was 47.83±5.45 nm and the flow of active functional groups was clarified by Fourier-transform infrared spectroscopy (FTIR). The minimum inhibitory concentration (MIC) of curcumin and its nanoparticles was 3.13% and 1.65%, on the examined bacteria, respectively. When curcumin and its nanoparticles were prepared in Tallaga cheese, a complete inhibition of the examined bacteria was recorded on the 4th day in samples supplemented with curcumin nanoparticles. However, the examined bacteria in the curcumin-free cheese samples reduced in count, but not completely inhibited. The overall acceptability (OAA) of samples with curcumin nanoparticles had no effect on the palatability or the color of cheese.

Key words: Tallaga cheese, curcumin, nanoparticles, sensory, microbial, antibacterial activity.

INTRODUCTION

Egypt is among the top two countries in Africa and the Middle East for both cheese production and consumption. Since cheese is a ready-to-eat item that is frequently eaten raw, it can cause significant food poisoning if it becomes infected with harmful microorganisms (Mohamed *et al.*, 2022). In Egypt, Tallaga cheese, known for its creamy, spreadable soft texture and minimal salty taste, is made from heated milk with a low concentration of salt and stored in the refrigerator for up to two weeks before consumption. This makes it the most popular local type of packaged or unpacked soft cheese (El-Kholy *et al.*, 2016; Ahmed *et al.*, 2023, Sobeih *et al.*, 2023).Various

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pathogenic bacteria, including *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus*, *Bacillus cereus*, and *Listeria* spp., which are possible sources of human infection and food poisoning, have been isolated from some traditional Egyptian cheeses (Hassanien *et al.,* 2021; Fathy *et al.,* 2023). Therefore, scientific and technological researchers have been increasingly interested in the study of new antimicrobial materials and new food sanitization methods that can extend shelf-lives and prevent food contamination by harmful microorganisms (Munir *et al.,* 2022).

Recently, there has been a global interest in functional foods, which are processed to contain important levels of biologically active components that offer health benefits beyond traditional foods. One such natural compound is curcumin, which can enhance the release of omega-3 fatty acids during digestion (Asl *et al.,* 2022). Curcumin is known for its unique anti-inflammatory, anti-oxidative, and antimicrobial properties (Buniowska-Olejnik *et al.,* 2023). It has demonstrated a wide range of promising therapeutic actions, including antibacterial activity against various bacteria by targeting the bacterial cell membrane, cell wall, protein, DNA, and other cellular structures, or by inhibiting bacterial growth through the quorum sensing (QS) system/pathway (Usman *et al.,* 2024). However, curcumin has low bioavailability and water solubility in the human body (Spanoudaki *et al.,* 2024).

So, transforming it to nano-emulsion or nanoparticles is a solution to overcome its low bio accessibility and low water solubility (Joung *et al.,* 2016). The nano sizing of curcumin particles advances a drug delivery system that can enhance its therapeutic translation, have better hydrophobicity, chemical stability, sustained release and adequate dispersibility of curcumin compared to its free form (Lebda *et al.,* 2022).

The present study was performed to transform curcumin into curcumin nano particles and evaluated their antibacterial effect on *Staph. aureus*, *E. coli* and *P. aeroginosa* in vitro and during the manufacture of Tallaga cheese.

MATERIALS AND METHODS

Materials:

Curcumin (98% purity) was purchased from Techno chemicals (TCI) (India) Pvt.Ltd, Tween* 80 (polyethylene glycol sorbitan monooleate) was bought from Sigma Aldrich from the molecular biology unit at Assiut University, and deionized water was collected.

Methods:

1-Preparation of nano-curcumin:

The nanocurcumin was prepared by using a wet milling process (patented process). Curcumin (100 mg) was dissolved in dimethyl sulfoxide (20 ml). 1 ml of this solution was added into boiling water (50 ml) dropwise with a flow rate of 0.2 ml/min under ultrasonic conditions, with an ultrasonic power of 100 W and a frequency of 30 kHz. After addition, the contents were sonicated for 10 min and then stirred at room temperature for about 20 min. The solution was concentrated under reduced pressure at 50ºC, and finally freeze-dried to obtain a yellowish-orange powder (Basniwal *et al.,* 2011).

2- Bacterial suspension preparation:

In this study, the following bacterial strains, *Staph. aureus* (ATCC: 29213), *E. coli* (ATCC: 9637) and *P. aeroginosa* (field strain) were obtained from Certified Food Lab at (AHRI), Giza, Egypt. They were cultured on selective broth and incubated, before being inoculated into selective agar according to (ISO 6888-1:2021) for *Staph. aureus*, (BAM, 2022) for *E. coli* and (Patel *et al.,* 2019) for *P. aeroginosa.* 2-4 pure colonies of each bacterial strain were inoculated into 5 ml saline. After vortex, the bacterial suspension was compared to a concentration of 0.5 McFarland Standard according to McFarland (1907), then diluted to be justified to 10^7.

3- Minimum inhibitory concentration (MIC), (Clinical and Laboratory Standard Institute, 2011):

This test was done to determine the lowest concentrations of curcumin, and its nanoparticles showed antibacterial effects against *Staph. aureus*, *E. coli* and *P. aeroginosa* by agar well diffusion method, 0.1 mL of previously prepared suspension was spread on solidified Mueller Hinton agar dishes with 4 mm diameter agar wells made by a sterile cork pourer. Each well was filled with 100 µL of different concentrations of curcumin and its nanoparticles (pure, 50, 25, 12.5, 6.25, 3.125, 1.6 and 0.8%, respectively), were inoculated directly into the well. After 24 hours of incubation at 37ºC, the various levels of inhibition zones were measured.

4- Manufacturing of Tallaga cheese to detect the antibacterial activity of curcumin and curcumin nanoparticles:

Tallaga cheese was manufactured according to (Mohamed *et al.,* 2021), who modified the traditional method to achieve the improvement in its quality; a slight modification was made to add the MIC concentration of nanoparticles. Whole fresh cow milk (80%) and skimmed buffalo milk (20%) were pasteurized for 30 minutes at 68ºC, then cooled to 38ºC (at this point we add an aliquot of 1 ml of each prepared bacterial suspension (*Staph. aureus. E. coli* and *P. aeroginosa*, 100 ml each), the initial count was determined. Then add $CaCl_2$ 0.2%, microbial rennet 0.3%. The cheese batches were separated into a negative control jar (free from treatment and pathogenic bacteria), 3 positive control jars (inoculated with *S. aureus. E. coli* and *P. aeroginosa* alone without treatment), three jars containing 3.13% of curcumin were added (according to MIC test) and the examined bacteria. Three jars of 1.56% of nanocurcumin particles with the examined bacteria. Coagulation completed in 75 minutes, salting in 3% brine for cheese and staying 45 minutes. All jars were put at 4ºC to make tenfold serial dilution till the end of the experiment. 25 g of cheese were added aseptically to 225 ml of 0.1% peptone water, and 0.1 ml was spread on EMB agar for *E. coli*, Baird Parker media for *S. aureus* and Pseudomonas CN media for p*seudomonas*. The plates were incubated at 37ºC for 24 hours. The experiment was done in triplicate.

5-Characterization of nanoparticles:

The prepared nanoparticles were diluted 1000 times by adding distilled water at a temperature of 25 degrees Celsius to evaluate the mean droplet size and polydispersity index (PDI) by using Zeta-Sizer (3000HS,Malven Instruments, Malven, United Kingdom). The size of particles was measured by a dynamic light scattering instrument (DLS) in the unit of Nanotechnology, Giza. Animal Health Research Institute, Egypt. Zeta-sizer® software (version 7) was used to gather and evaluate the data. All the experiment was done in triplicate. To identify the functional groups with their means of attachment at the fingerprint of the molecule, we prepared the sample using a suitable method, such as potassium bromide pellet method, and use Fourier-transform infrared spectroscopy (FTIR, NICOLET, iS10, Thermo Scientific) at the Chemistry Department at the Faculty of Science, Assiut University. The morphology of the prepared NEs was determined using TEM (JEOL-100CX II) at the Electronic Microscope Unit, Assiut University, Egypt. The sample was diluted with deionized water, and a small drop of NEs was dropped onto coated copper grids and negatively stained with uranyl acetate for 3 minutes. The excess liquid and prepared samples were dried using Whatman filter paper at room temperature.

Organoleptic analysis (Badmos and Abdulsalam, 2012):

Negative control samples containing 3.13% curcumin and 1.56% Nano- particles were examined by a panel of thirty (30) judges, who can detect the sensory characteristics of the cheese based on five attributes: taste, color, smell, texture and overall acceptability using a 9 points hedonic scale. The most acceptable cheese received 9 points, and the most unacceptable received 1 point.

Statistical analysis:
All experiments were carried out in triplicate. One-way analysis of variance was performed using the SPSS program (SPSS Inc., Chicago, IL, USA) to determine the statistical significance of differences within the samples. Results with $P < 0.05$ were considered statistically significant. The microbiological and cytotoxicity assay data were prepared using Excel software version 2017. The FTIR results were performed using Origin Lab 2021 for graphing and analysis.

RESULTS

Table 1: The MIC of curcumin and Nano-curcumin on inoculated bacteria.

Type of nano-curcumin	PDI	Size ± SD	Intensity %
Freshly prepared	0.152	103± 32.12 nm	100%

Table 2: Physical properties of formulated Nano-curcumin.

Concentrations %	Curcumin (mm)			Nano curcumin (mm)		
	E.coli	*P.aeroginosa*	*Staph.aureus*	*E.coli*	*P.aeroginosa*	*Staph.aureus*
100	14±1	23±0.9	12.5±0.5	24±1.1	29±0.8	20.5±1.6*
50	13.3±1.2	21.06±0.9	12.3±0.7	23±1.2	28.1±1	19.6±1.3
25	12±1	20.06±0.9	11.23±0.87	22±1	27±0.7	18.4±0.8
12.5	11±1	19.36±0.63	10.53±0.75	21±1	26±0.6	17.7±1
6.25	10.3±1.2	17.43±0.83	10.2±0.72	20±0.5	25±1	16.8±0.7
3.13	10±0.50	12.46±0.98	9.5±0.5	19±0.5	24±0.9	15±0.1
1.56	0	0	0	18.5±1	19±0.7	12±0.1
0.8	0	0	0	0	0	0

Data expressed as (mean ± SD) of three replicates.
* Significantly different ($P < 0.05$).

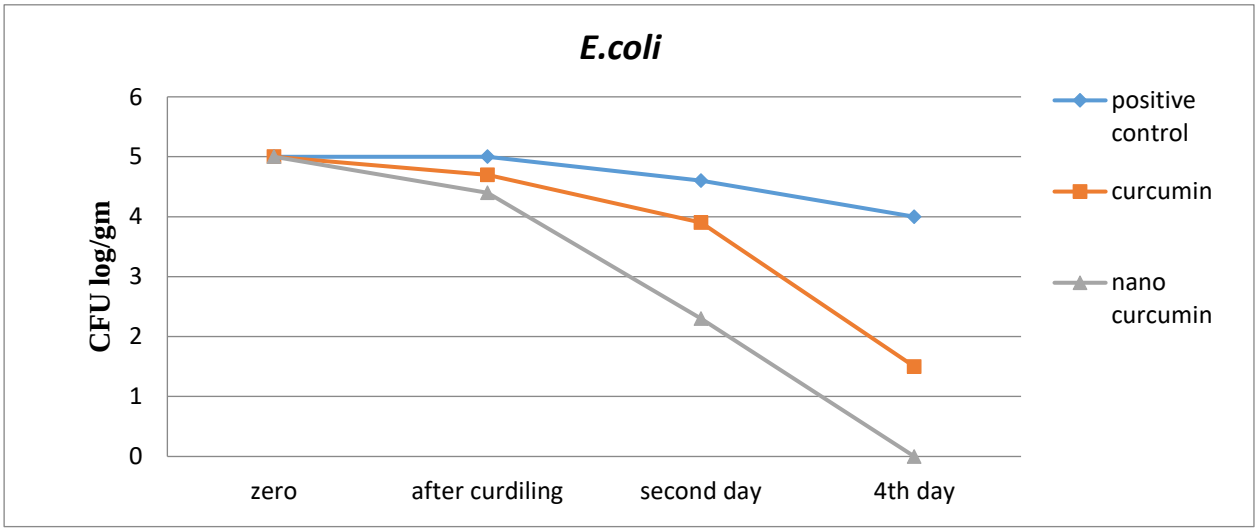

Figure 1: The efficacy of curcumin and Nano-curcumin against *E.coli* inoculated in cheese.

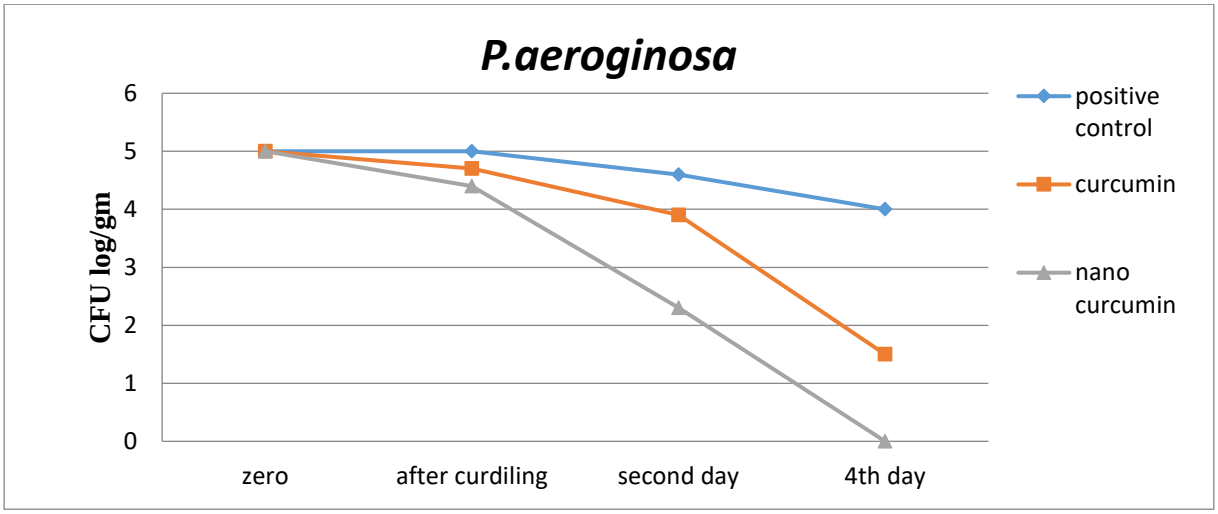

Figure 2: The efficacy of curcumin and Nano-curcumin against *P.aeroginosa* inoculated in cheese.

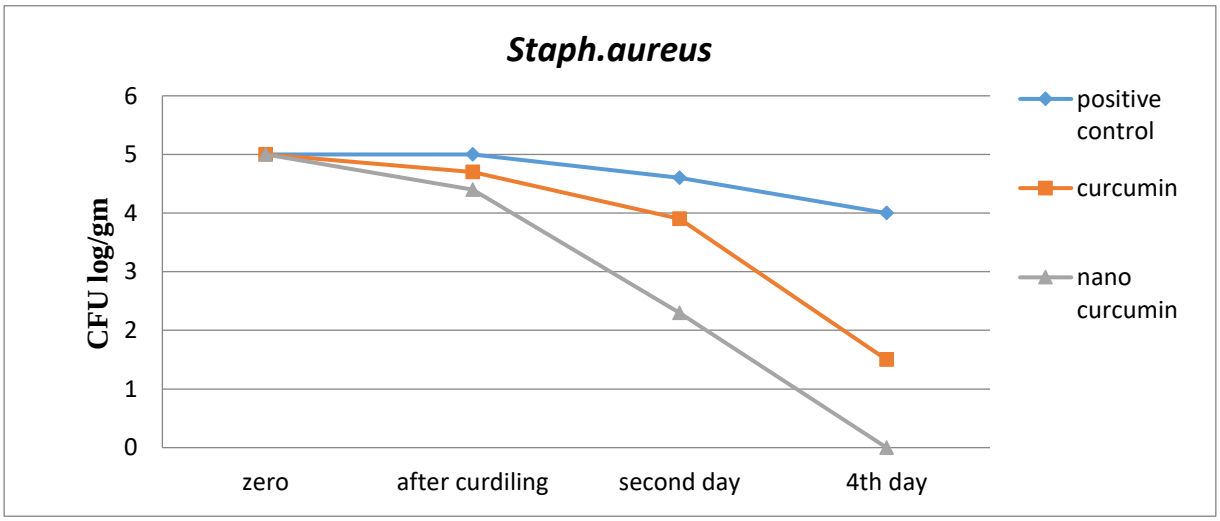

Figure 3: The efficacy of curcumin and Nano-curcumin against *Staph.aureus* inoculated in cheese.

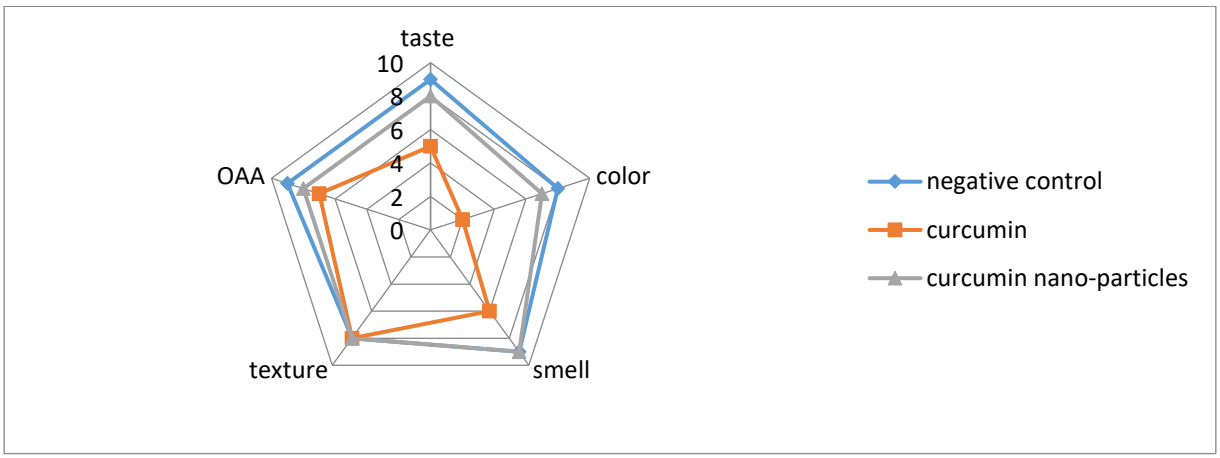

Figure 4: Organoleptic of curcumin and curcumin nano-particles in laboratory manufactured white cheese.

OAA: Over All Acceptability

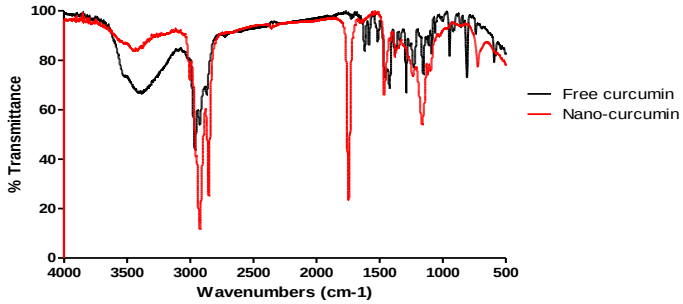

Figure 2: FTIR of curcumin and nano-curcumin.

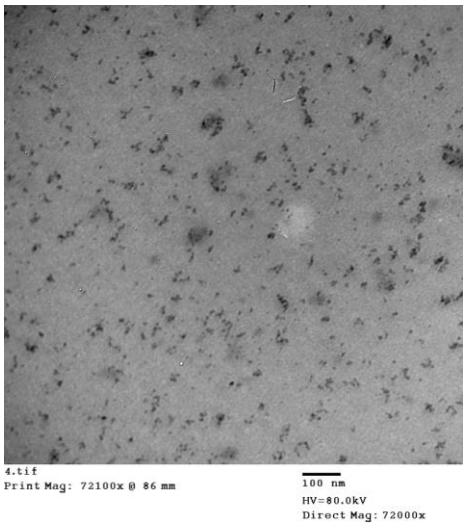

Figure 3: TEM of curcumin and curcumin nanoparticles showed nano-sphere and without any aggregation with average size 47.83±5.45nm.

DISCUSSION

Many studies devoted to the antibacterial activity of curcumin against gram positive bacteria and gram negative bacteria pathogenic or non-pathogenic in soft cheese and the antibacterial activity of curcumin was related to the presence of compounds belonging to flavonoids and terpens particularly to borneol, cymene, cuparene, p-tolymethyl-carbinol, curcumin and careen (Thongson *et al.*, 2005).

In Table 1 the obtained results were better than (Raksha *et al.*, 2015) who reported that nano curcumin (NC) was found more effective (12 mm) against *P. aeruginosa*, whereas less effective (10 mm) against *Staph. aureus* and *E. coli* while, (Mahmoud and Thanaa, 2021) found that the MIC for curcumin nano-particles was ranged between 25-50 µg/mL according to the type of bacteria strain. While (Negahdari *et al.*, 2020) found that NC (60mg/ml) caused complete inhibition against *E. coli*, *Staph. aureus* and *E. faecalis*. This study aimed to detect the antibacterial activity of curcumin and its nanoparticles against *E. coli*, *P. aeroginosa* and *Staph. aureus* in vitro. Curcumin nano particles (CNPs) showed the best antibacterial activity against *P. aeroginosa* with an inhibition zone of 19±0.7 mm, 18.5±1mm for *E. coli* and 12±0.1 mm for *Staph. aureus*. While there was no inhibition zone for all examined bacteria at the same concentration (1.56%) of curcumin. It showed antibacterial effect at (3.13%) with inhibition zones 10±0.50, 12.46±0.98 and 9.5±0.5 mm, respectively. There was a significant inhibitory effect between curcumin and its nano particles ($P < 0.05$).

da Silva *et al*, (2016) showed higher antimicrobial activity against Gram negative

bacteria (*P. aeroginosa* and *Y. enterocolitica*), which might be attributed to a stabilizing effect of the formulation, based on generally regarded as safe (GRAS) additives, which to some extent modifies the properties of curcumin, in particular antibacterial ones.

The mechanism of curcumin's inhibition of antibacterial activity is that it inhibits the formation of biofilms by pathogenic microorganisms (Zheng *et al.*, 2020). Unlike many antibiotics, it does not kill the bacteria themselves and does not destroy their biofilm but inhibits the process of its formation due to numerous interactions with molecular targets and transduction pathways due to the antibacterial mechanism (Selvam *et al.*, 2019).

Figures 1, 2 and 3 clarified that there was a reduction in the counts of *E. coli*, *P. aeroginosa* and *Staph. aureus* inoculated in manufactured Tallaga cheese supplemented with curcumin and its NPs at refrigerator. A complete reduction (100%) occurred in *E. coli*, *P. aeroginosa* and *Staph. aureus* on the 4th day in samples supplemented with NPs, while the bacteria decreased but didn't disappear in samples with curcumin.

Curcumin nanoparticles exhibit higher antioxidant activities in vivo and in vitro than its native curcumin, and the increase in antimicrobial activity of NC than curcumin due to the increase in aqueous-phase solubility and simple dispersibility (Karthikeyan *et al.*, 2020).

It has been reported that curcumin nanoparticles showed higher antibacterial activity against *Staphylococcus aureus, Clostridium sporogenes, Escherichia coli, Klebsiella pneumoniae* and *Pseudomonas marginalis* strains when they added curcumin nanoparticles to processed cheese formula by ratio 2.5% and 5% (Mahmoud and Shalaby, 2021).

Bagale *et al.* (2023) showed complete antibacterial activity against *Staph. aureus* and *E. coli* with a concentration of 100 and 50 µg/mL from curcumin nanoparticles. When used in concentration (0.05 g/mL), the curcumin nanoparticles showed good antimicrobial activity for *Staph. aureus and E. coli* (12- and 18-mm zone inhibition diameters) and it maintained its overall sensory analysis and physicochemical properties, compared to the control sample.

Figure (4) illustrates the organoleptic evaluation of cheese samples treated with curcumin (3.1%), curcumin nanoparticles (CNPs) (1.56%), and a control sample during one week of storage at 4°C. The evaluation focused on several sensory attributes, including color, taste, smell, texture, and overall acceptability.

Color and Appearance

The CNP-treated cheese exhibited a faint-yellow color with a slightly good appearance. Importantly, there were no significant differences in color between the control and CNP-treated samples, suggesting that the addition of CNPs did not adversely affect the visual appeal of the cheese. In contrast, cheese treated with curcumin alone recorded lower scores for color, which might be due to the more pronounced yellow hue that can be less appealing to consumers (Bagale *et al.*, 2023).

Taste, Smell, and Texture

Throughout the cold storage period, the taste, smell, and texture of the CNP-treated cheese were comparable to the control sample. This indicates that the incorporation of CNPs at the tested concentration (1.56%) did not negatively impact the sensory characteristics of the cheese. Conversely, the cheese treated with curcumin alone was found to be less acceptable (Elsherif, and Al Shrief, 2021), particularly in terms of texture. This could be attributed to potential changes in the cheese matrix caused by the higher concentration of curcumin, which might have influenced the mouthfeel and overall texture.

Overall Acceptability

Overall acceptability scores remained consistent between the control and CNP-treated cheese samples during the storage period. This finding is significant, as it suggests that the introduction of curcumin in nanoparticle form at a lower concentration (1.56%) maintains the sensory qualities of the cheese, while potentially providing the added benefits of curcumin's bioactive properties. On the other hand, the cheese with curcumin alone recorded the lowest overall acceptability, particularly due to issues with color and texture, highlighting the advantage of using nanoparticles to enhance curcumin's integration into food products.

The results presented in Figure 5 underscore the potential of using curcumin nanoparticles in cheese production. The CNPs do not only help in maintaining the sensory properties of the cheese, but also likely offer the health benefits associated with curcumin, such as its anti-inflammatory and antioxidant properties, without compromising consumer acceptability. The absence of significant differences in sensory attributes between the CNP-treated and control samples suggests that curcumin nanoparticles can be used effectively at lower concentrations to achieve the desired functional benefits while preserving the cheese's quality.

Moreover, these findings align with previous research, indicating that nanoparticle formulations can improve the bioavailability and stability of bioactive compounds in food products. The lack of impact on sensory properties also supports the feasibility of incorporating such functional ingredients into everyday foods without altering their consumer appeal (Ahmed *et al.,* 2023). In conclusion, the organoleptic evaluation of cheese samples treated with curcumin nanoparticles indicates that CNPs at a concentration of 1.56% do not adversely affect the sensory qualities of the cheese compared to the control. This is in contrast to cheese treated with curcumin alone, which showed lower acceptability scores, particularly in color and texture. These findings support the potential application of curcumin nanoparticles to enhance the nutritional and health benefits of cheese without compromising its sensory attributes, making it a promising strategy for functional food development.

This is where nanotechnology allows improvement of the functionality of various ingredients, decreasing the concentration of substances, modifying their solubility, and potentiating their effectiveness or controlling their release (Jafari and McClements, 2017). Sandikci *et al. (*2016) reported that 0.5% and 1% doses of curcumin used were seen to be of sensorily acceptable quality. In the light of its strong antimicrobial action, it was concluded that curcumin may be used instead of preservatives or in decreased doses, together with such substances in foods where color change is not important. The legal limit should be determined for curcumin as a preservative food additive and curcumin extracted from natural source materials must be used.

To make nano-curcumin more effective than its pure form, it is important to change particle size, surface charge, surface area, and hydrophobicity (Biswas *et al.*, 2014). So, the physicochemical properties of nano-curcumin (NC) are playing an important role (Karthikeyan *et al.*, 2020).

Characterization of the NC particles was done by Zeta-Sizer by means of droplet average diameter (DP) and PDI measurement, the results are illustrated in Table (2) the DPs was 103±32.12 nm while the PDI was 0.152 which indicates good stability of the prepared nano particles. High charged surfaces which resist droplet aggregation contribute greatly to the stability of nanoparticles (Rachmawati *et al.*, 2015; Elsherif *et al.*, 2024).

The Fourier Transform Infrared (FTIR) spectroscopy analysis of curcumin and its nanoparticles provides critical insights into the structural integrity and interaction of functional groups within these compounds. FTIR spectra are used to identify characteristic peaks that correspond to

various functional groups, which can reveal important information about the chemical structure and any modifications that occur during the formation of nanoparticles (Bakheet *et al.*, 2024). In the FTIR spectrum of pure curcumin, several characteristic peaks are typically observed: O-H Stretching: A broad peak around 3500-3200 cm^{-1}, indicating the presence of hydroxyl groups. C=O Stretching: A strong peak near 1625 cm^{-1}, corresponding to the carbonyl group. C=C Stretching: Peaks around 1600-1500 cm^{-1}, indicative of aromatic ring structures. C-O-C Stretching: Peaks near 1270 cm^{-1}, associated with ether linkages. These peaks confirm the presence of key functional groups in curcumin, such as hydroxyl, carbonyl, and aromatic rings, which are crucial for its biological activity. The FTIR spectrum of the curcumin nanoparticles shows several important features:

Shifted O-H Stretching: The broad peak for O-H stretching may shift and broaden, indicating hydrogen bonding interactions between curcumin and the emulsifying agents.

C=O Stretching: The carbonyl peak might shift or change in intensity, suggesting interactions or encapsulation within the nanoparticles matrix. C=C Stretching: Peaks corresponding to aromatic C=C stretching may exhibit slight shifts, indicating possible interactions with the nanoparticles components. New Peaks or Changes in Intensity: The appearance of new peaks or changes in intensity can suggest the formation of new bonds or interactions, confirming the successful formation of curcumin nanoparticles.

So, Figure (3) declared the use of FTIR to detect the functional groups, their attachment method and molecular fingerprinting. The inclusion of other functional groups and the differences in the peaks of NPs can be the main reasons for their nano properties, stability and antibacterial activity. Spectra were taken in the range of 1000 -4000 cm^{-1} peaks, which were observed at 3020 to 1700 for NC particles, while for curcumin peaks were 3500 and 3000. Among these, the absorption peak at 1626 cm^{-1} can be assigned for C=C stretching, 1452 cm^{-1} corresponds to C=H, and the absorption at 1146 cm^{-1} due to C–H stretching. The absorption peak at 1037 cm^{-1} might be due to C–N stretch. The absorption spectra of control might be attributed to the functional group, such as benzene ring, C–O–C bond, and aromatic C–H stretching. These findings are supported by many researchers (Yadav *et al.* 2009; Yen *et al.* 2010; Sav *et al.* 2012).

The FTIR analysis confirms that curcumin retains its key functional groups within the nanoparticles, ensuring its bioactive properties are preserved. The shifts and changes in peak intensity indicate successful manufacture and interaction with the nanoparticle's components, which can enhance curcumin's stability and bioavailability. This way of manufacture potentially addresses curcumin's inherent low bioavailability and poor water solubility, making it more effective for therapeutic applications.

Additionally, the observed interactions between curcumin and the nanoparticles matrix suggest improved dispersibility and sustained release properties. This can lead to better absorption and utilization in the body, maximizing the health benefits of curcumin. These findings support the potential of curcumin nanoparticles in functional food and therapeutic applications, offering a promising solution to improve the efficacy of this potent nutraceutical.

Figure (4) showed the TEM image, which was almost of nano-droplets spherical in shape, had approximately uniform shape and size (47.83±5.45nm), which provides more antibacterial activity. Our results were similar to Sandhuli *et al.* (2021) and Kabiriyel *et al.* (2023), who firstly synthesize nano-curcumin, using the natural turmeric rhizome as the raw material, offering a new insight into natural substances, such as turmeric and the result of TEM size is nearly half the result

of zeta-sizer. TEM images provide evidence of spherical and smooth surface morphology, and the size range between 100 and 200 nm. They also reported that there is no change between the chemical structures of curcumin and NC. The antimicrobial activity of nanoparticles with a size below 100 nm, it can disrupt the functions of the cell membrane by binding to the surface of cell membranes with a high affinity compared to larger nanoparticles (Negahdari *et al.,* 2020 and Wang *et al.,* 2017).

CONCLUSION

Based on earlier findings, it was shown that curcumin's physicochemical qualities are greatly enhanced upon its transformation into its nanoform, rendering nanocurcumin (NC) more potent than native curcumin. When compared to curcumin, NC's antibacterial activity against *P. aeruginosa*, *E. coli*, and *S. aureus* compared to curcumin was notably significant inhibitory effects observed.

Incorporating curcumin nanoparticles in cheese production demonstrated that NC at a concentration of 1.56% maintained the sensory qualities of cheese, such as color, taste, smell, texture, and overall acceptability, during one week of storage at 4°C. In contrast, cheese treated with curcumin alone showed lower acceptability scores, especially in color and texture.

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التأثير المثبط لمستحلب الكركمين النانوى على بعض البكتريا الممرضة في الجبن الثلاجة

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في العقود الاخيرة زادت ضراوة البكتيريا ومقاومتها لمعظم المضادات الحيوية. ولذلك تطور الاهتمام العام بالاعشاب التقليدية بسبب خصائصها الطبية المؤكدة واثارها الجانبية المحدودة او المعدومة. لذلك قمنا في هذه الدراسة بدراسة النشاط المضاد للكركمين وجزيئاته النانوية ضد كل من بكتيريا *Staph.aureus* و *E.coli* و *Pseudomonas.aeroginosa* *وقد كان لجزيئات الكركمين النانوية بقياسها بجهاز الزيتا حجما حوالي*nm 103±32.12 ومعامل تشتت 0.152 وعند فحص هذه الجسيمات النانوية بواسطة المجهر الالكتروني النافذ تم تأكيد عن الشكل الكروي وكان الحجم 47.83±5.45nm وتم توضيح تدفق المجموعات الوظيفية النشطة بواسطة التحليل الطيفي للاشعة تحت الحمراء . وكان الحد الادنى للتركيز المثبط (MIC) للكركمين وجسيماته النانوية 3.13% و ,1.65% على البكتيريا المفحوصة بينما عند اضافة جسيمات الكركمين النانوية للجبن الثلاجة تم تسجيل تثبيط كامل لجميع البكتريا المفحوصة في اليوم الرابع من بداية التجربة ولكن عينات الجبن التي تحتوي على الكركمين انخفض عدد البكتريا الممرضة ولكن لم يتم تثبيطها بالكامل وعند دراسة القبول العام للجبن المضاف اليه جسيمات الكركمين النانوية لم نلاحظ اي تاثير على استساغة الجبن او لونه.