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EFFECT OF CINNAMON AND TURMERIC NANOPARTICLES EXTRACT IN QUALITY CHARACTERISTICS OF GROUND BEEF DURING FREEZE STORAGE

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Abstract

The objective of this study was to evaluate the effect of adding different concentrations of cinnamon silver nanoparticles (CAgNPs) and turmeric silver nanoparticles (TAgNPs), in oxidative stability and quality characteristics of raw ground beef meat, stored at -18°C for 90 days. In current study, six different treatments of (CAgNPs) and (TAgNPs) were analyzed. T1 Positive control treatment (add water), T2 negative control treatment (without addition), T3 (turmeric 248.3ppm) T4 (turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm), and T6 (cinnamon 166.16 ppm). The treatments were stored for 30, 60and 90 days. Results were analyzed after the physical and chemical tests conducted. The results of present study were noted that:

- The addition of Cinnamon and turmeric nanoparticles extract to ground beef, meat during freeze storage period led to a significant increases ($P<0.05$) in moisture, protein and fat percentages as compared with control treatment.
- While these extracts showed a significant decrease ($P<0.05$) in Thiobarbituric acid (TBA) value as compared with control treatment.
- The addition of Cinnamon and turmeric nanoparticles extract to ground beef, meat during freezing storage revealed a significant increase ($P<0.05$) in pH value as compared with control treatment.
- The Cinnamon and turmeric nanoparticles extract treatments were recorded higher percentage in water holding capacity (WHC) in the meat, and significant decrease ($P<0.05$) Thaw loss in the meat.

This study concluded that the addition of Cinnamon and turmeric nanoparticles extract to ground, meat during freeze storage have achieved higher antioxidant efficiency through lower oxidation indicator such as thiobarbituric acid (TBA) value, increased pH value and improved water holding capacity (WHC) in the meat and decrease thaw loss in the meat.

Keywords: Cinnamon, turmeric, nanoparticles, antioxidant, ground freeze beef.

Introduction

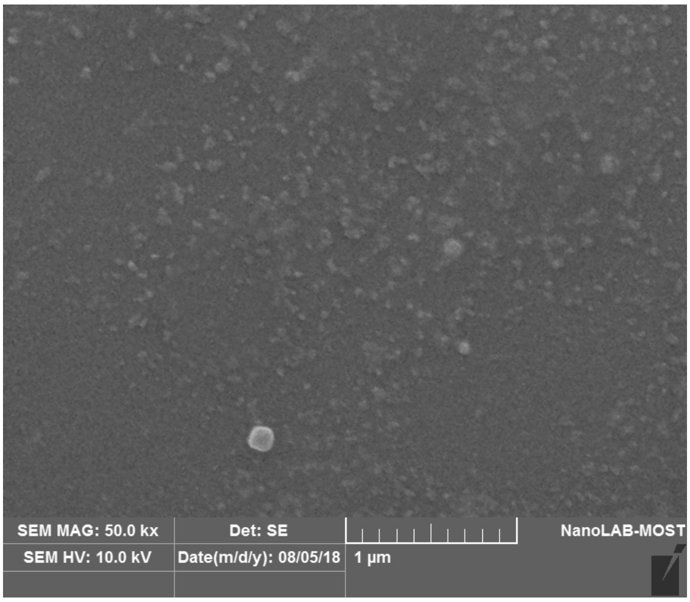
Red meat is a very important part of the human diet in all humane evolutions. When included as part of a varied diet, healthy, red meat provides a rich source of essential nutrient such as a high biological value protein, some of which are more bioavailable than in alternative food sources (Wyness, 2016). It also has a high digestibility factor, and high absorption by the body as well as the availability of a vitamin B complex such as B12 and cobalamin and some important mineral elements such as iron and zinc and contain essential fatty acids and thus constitute an important part of the balanced diet with other nutrients (Santos and Oliveira, 2012) The shelf life of meat and meat products is affected by many factors, like mycobacterial contamination during processing and in storage conditions and oxidation, which lead to disease when eating this meat by humans. The use of preservatives suitable for meat products is required to prevent microbial contamination (Ahn *et al*., 2007 & Dave and Ghaly, 2011) many additives have been used for centuries. To preserve the flavor and improve the taste and have prolonged the shelf life of meat Recently, new natural and synthetic additives and preservatives that reduce nutrient damage have been identified by antioxidant and antimicrobial activities (Barbosa-Pereira *et al*., 2014 & Mitropoulou *et al*., 2015). Nanotechnology refers to the new aspect of science modifies its physical, chemical and biological properties leading to new applications or enhanced utility (Singh *et al*., 2016), This technology is expected to affect the global economy by at least $ 3 trillion by 2020 and may require at least 6 million workers at the end of this decade (Roco *et al*., 2010). This technique manipulates the structure of materials, therefore nanobodies has at least one dimension and differ in physical and chemical properties from the properties of the same material in the Not nanoparticles state (Sozer and Kokini, 2009 & Ravichandran, 2010). This technology has been introduced in many industries, including the food and meat industry, and has been used to improve the quality and safety of products such as improving taste, flavor and texture, reducing fat and salt in products, packaging techniques and improving the detection system of pathogens (Singh *et al*., 2016). The goal of this research is to evaluation of effectiveness natural antioxidants nanoparticles to extend the life of the reservoir of ground beef.

Materials and Methods

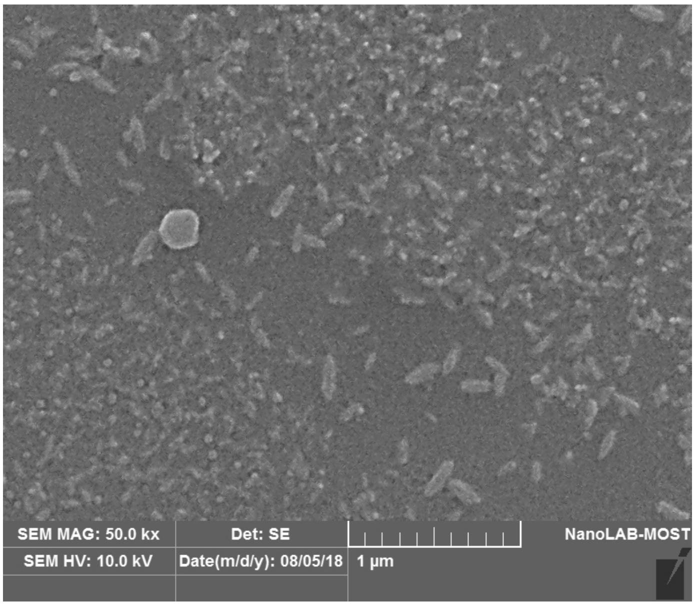
This study occurred in the Graduate Laboratory at Agricultural College, University of Baghdad, and Laboratory in Ministry of Science and Technology, were used leg meat from a local calf after the slaughter, The meat was refrigerated at a temperature of 2°C for (12) hours and cutted by a sterile knife into small pieces with dimensions of 4-5 cm^3 to facilitate the subsequent chopping process by using sterile gloves, and chop the meat with an electric grinding machine and the meat pieces were homogenized together to ensure the distribution of the components of the meat Equally, then the weight of the meat was divided into six parts with 2 kg per part and each part was treated with the special concentration of each subject according to the control treatment. The experiment included six treatments according to the added concentrations of meat and the required tests were conducted after 30, 60 and 90 days of refrigerated storage at -18°C to the effect of the experiment treatment mentioned above on fat oxidation and the study quality of ground frozen beef meat. Preparation of green silver nanoparticles by turmeric and cinnamon ethanolic extracts were done according to Ojha *et al*. (2017) and Krishnadhas *et* *al*. (2017) with some adjustment Five ml of each extract was sprayed into 95 ml of 10 mM silver nitrate $AgNO_3$ solution (which prepared by dissolving 1.69 g $AgNO_3$ into 1 L dionized water) separately dropwise with a flow rate of 0.2 ml/min under ultrasonic conditions, with an ultrasonic power of 100 W and a frequency of 42 kHz. After sonication for 20 min were stirred the solutions at 800 rpm at 25°C for 30 min, then kept in dark bottles at 25°C for 24 h. After 24 h the reaction mixture was purified by centrifugation for 10 min at 10000 rpm to get clear supernatant. were stored The final colloid samples in dark bottles at 4°C. During 48 hours the color of solutions were changed from clear Yellowish orange to greenish yellow for turmeric silver nanoparticles (TAgNPs) and from Light brown to reddish brown for cinnamon silver nanoparticles (CAgNPs), this change in color indicates the formation of silver nanoparticles (AgNPs). Was used SEM (Scanning electron microscopy) to describe the size and morphology of nanoparticles, according to a method Dimitrijevic *et al*. (2013), were used XRD (X-ray Diffraction) is a technique to determine the phase composition of a sample, crystal structure, texture or orientation In silver nanoparticles, the XRD gives nature and purity of the particles (Bindhu and Umadevi, 2013) were used Zeta potential analyzer to determine the stability of synthesized nanoparticles were used SAS data analysis to study the effect of different transactions on the qualities studied according to a complete random design (CRD) for each period and compared the moral differences between averages to the Duncan multi-border test.

Results and Discussion

The results of SEM analysis showed the particles are spherical in shape, with nanometer in size for TAgNPs and CAgNPs (figures 1). Large nanoparticles were seen due to aggregation. This aggregation took place due to the presence of cell components on the surface of nanoparticles and acts as capping agent (Helen and Rani, 2015). This result is agree with Surega, (2015) SEM determination showed the formation of AgNPs, which were well dispersed and the aggregation of the particles could be seen (Rajoriya, 2017).



A: SEM image showed the shape and size of TAgNPs nanoparticles.

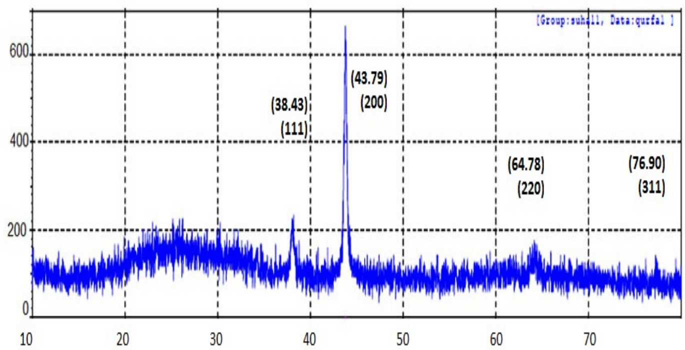


B: SEM image showed the shape and size of CAgNPs nanoparticles.

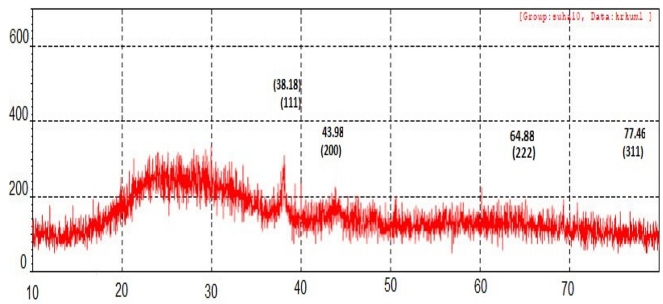
Fig. 1 : SEM image

X-ray diffractometer (XRD)

The X-ray diffraction (XRD). In figure (2) recorded four obvious diffraction peaks at 2θ values 38.43, 43.79, 64.78, 76.90 for CAgNPs and 76.90, 64.78, 43.79, 38.18 for TAgNPs which were corresponded to 111, 200, 220 and 311 planes of silver, the XRD pattern showed the AgNPs formed by the reduction of Ag+ ions using turmeric and cinnamon extracts are naturally crystalline. Some of unassigned peaks were observed, it may be due to the bio-organic phase/ metalloproteins occurs on the surface of silver nanoparticles (Saware *et al*., 2014). Or it may be due to the fewer biomolecules of stabilizing agents such as enzymes or proteins in the plant extract (Anuj and Ishnava, 2013). This result is agree with Gurunathan *et al.* (2015)



A: The XRD pattern of CAgNPs.

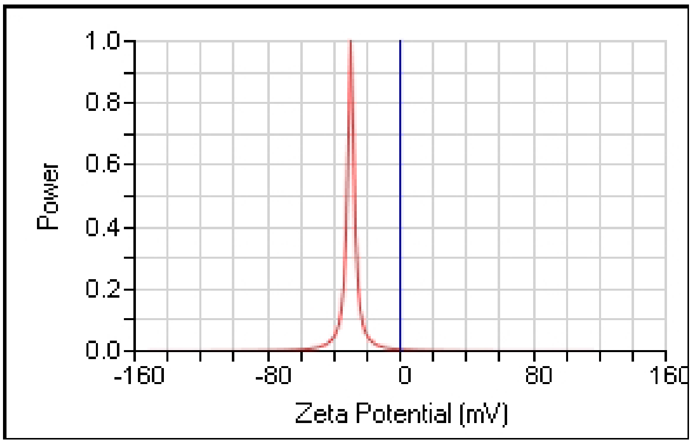


B: The XRD pattern of TAgNPs.

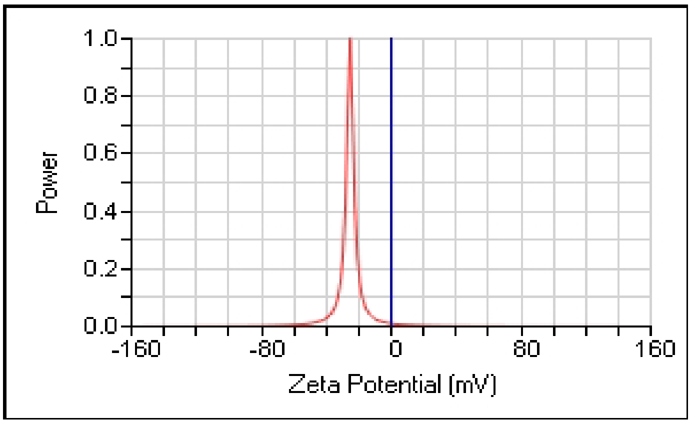
Fig. 2 : The XRD pattern

Zeta potential analysis

The results of zeta potential values of the synthesized nanoparticles were -25.25 mV for TAgNPs and -29.67 mV for CAgNPs (figures 3). Zeta potential is a key indicator of the stability of colloidal dispersions. The magnitude of the zeta potential indicates the degree of electrostatic repulsion between adjacent, similarly charged particles in dispersion generally, the zeta potential of the nanoparticles should be either highest than +30 mV or lower than -30 mV (Shaban *et al.*, 2014; Samy, 2016). So from these results, TNPs showed stability while the rest nanoparticles were very near from normal stability range. This finding is agreed with Surega, (2015), both turmeric and cinnamon extracts have been successfully applied in our environmentally benign production of AgNPs. Generally, natural extracts contain a large number of biologically active components, many of which can be responsible for the reduction of silver ions as well as for the stabilization of the obtained nanoparticles.



A : the zeta potential value of CAgNPs



b : the zeta potential value of TAgNPs

Fig. 3 : The zeta potential value

Chemical composition of ground beef meat, stored by freezing:

Moisture percentage:

Table 1 shows the effect of the interaction between different treatments and the storage period by freezing in the moisture percent of frozen ground beef, in this table show significant increase (P<0.05) in the moisture percent in T4 (Turmeric 496.9 ppm) it has recorded the highest percent of moisture (74.26%) in the storage period of 30 day, as compared with treatment T2 Negative control treatment (without addition) which gave the lowest moisture percent that reached 70.84% in the period of 90 days of storage, There were varying differences between treatments and different storage periods.

Several studies showed that the addition of medicinal plants or plant extracts to meat increases moisture content, The active substances in natural nanoparticle extracts have a role in preserving cell membranes The oxidative damage that occurs in the fat of these membranes and thus maintain the content of moisture and nutritional value (Arora, 2000), This result agrees with several studies that indicated the higher moisture percentage when adding some medicinal plants or their extracts Muhammad and Al-Rubeii (2018).

Table 1 : The effect of the interaction between different treatments and the period of storage by freeze in the moisture percentage of ground beef (mean ± SE)

Treatments	Period of freeze storage/day		
	30	60	90
T_1	d 73.67±0.083	g 71.98±0.128	j 70.84±0.132
T_2	e 73.21±0.078	i 71.37±0.133	k 70.35±0.067
T_3	**a** 74.26±0.164	e 73.04±0.075	h 71.60±0.087
T_4	bc 74.03±0.123	g 72.12±0.093	ih 71.43±0.075
T_5	ba 74.18±0.131	g 72.13±0.086	i 71.35±0.098
T_6	c 73.89±0.064	f 72.42±0.075	i 71.36±0.062

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3ppm) , T4 (Turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm) , T6 (cinnamon 166.16 ppm).

Protein percentage

Table 2 explained the effect of the interaction between different treatments and the period of storage by freezing in the protein percent of frozen ground beef. in this table show significant increase (P<0.05) in the protein percent in T5 (cinnamon 83.08 ppm), it has recorded the highest percent of protein 18.45, 19.24 and 19.71% in the storage period of 30, 60 and 90 day, as compared with treatment T1 Positive control treatment (add water) which gave the lowest protein percent that reached 17.11, 17.45 and 18.41 % in the period of 30, 60 and 90 days of storage, There were varying differences between treatments and different storage periods.

Abdullah *et al.* (2017) indicate in his study when adding two concentrations of cinnamon extract (2 , 4%) by spraying and dipping methods to ground meat from Awassi lambs at one year age to significant increase of protein percent in the treatment (4% immersion), Soltanizadeh *et al.*, (2015) showed the protein percent value was increased with increase period of storage and increased concentration of addition materials, this agree with Muhammad and Al-Rubeii (2018).

Table 2 : The effect of the interaction between different treatments and the period of storage by freeze in the Protein percentage of ground beef (mean ± SE):

Treatments	Period of freeze storage/day		
	30	60	90
T_1	h 17.11±0.152	gf 17.45±0.092	ed 18.41±0.185
T_2	gh 17.17±0.139	f 17.55±0.074	ed 18.42±0.111
T_3	ed 18.41±0.182	d 18.51±0.194	cb 18.93±0.073
T_4	e 18.11±0.064	cd 18.64±0.088	cb 18.92±0.195
T_5	ed 18.30±0.095	a 19.66±0.182	a 19.82±0.088
T_6	ed 18.45±0.130	b 19.24±0.090	a 19.71±0.104

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3ppm) , T4 (Turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm) , T6 (cinnamon 166.16 ppm).

Fat percentage:

The result in table 3 showed the effect of the interaction between the different treatments and the periods of frozen storage in the fat percentage in ground frozen beef, A significant decrease (P< 0.05) was observed in T3 (Turmeric 248.3 ppm), it was recorded at (5.42%) for 30 day period, while T1 Positive control treatment (add water)was recorded the highest fat percentage at (7.99 and 7.96%) for the period 60 and 90 days. Was significant difference between treatments with different storage periods. highest fat percent in the additives were due to the ability of natural additives to protect fat from oxidation and decomposition by preventing the formation of free radicals and Reactive Oxygen Species ROS (Jaworska *et al*., 2016) The lambs fed rosemary extract had a significant decrease (P <0.01) in fat percentage compared with the feed on the black seed and control (Al-Rubeii, 2008).

Table 3: The effect of the interaction between different treatments and the period of storage by freeze in the fat percentage of ground beef (mean ± SE):

Treatments	Period of freeze storage/day		
	30	60	90
T_1	i 6.83±0.023	a 7.99±0.025	a 7.96±0.028
T_2	j 6.27±0.018	d 7.46±0.037	b 7.66±0.031
T_3	o 5.42±0.022	k 6.16±0.017	f 7.17±0.028
T_4	m 5.76±0.038	e 7.26±0.022	c 7.52±0.017
T_5	n 5.63±0.018	l 6.07±0.019	h 6.91±0.036
T_6	m 5.75±0.015	l 6.05±0.020	g 6.98±0.012

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3 ppm), T4 (Turmeric 4969. ppm), T5 (cinnamon 83.08ppm), T6 (cinnamon 166.16ppm).

Ash percentage:

In table 4 were observed the effect of the interaction between the treatments and the different storage periods in the ash percentage of ground fresh beef frozen was recorded T5 (cinnamon 83.08 ppm) the lowest significant (P< 0.05) (1.19%) in the ash percent in 30 day period in freezing storage, while T2 Negative control treatment (without addition) was recorded highest percent of ash (1.89%) in period 90 day. As of the same table, it was also found that there was a significant effect (P<0.05) on the ash percent in freshly chopped veal for all treatments. And all periods of frozen storage. Previous studies showed a decrease in the ash content in treatments with additives plant extracts compared to control treatment (Moran, 2012), This is consistent with the results obtained by Muhammad & Al-Rubeii, (2018)

Table 4: The effect of the interaction between different treatments and the period of storage by freeze in the Ash percentage of ground beef (mean ± SE):

Treatments	Period of freeze storage/day		
	30	60	90
T_1	f 1.53±0.007	d 1.73±0.017	b 1.83±0.027
T_2	e 1.59±0.019	c 1.79±0.009	a 1.89±0.019
T_3	k 1.32±0.006	i 1.38±0.013	g 1.49±0.009
T_4	l 1.28±0.011	i 1.44±0.021	h 1.46±0.011
T_5	n 1.19±0.018	k 1.31±0.018	f 1.52±0.017
T_6	m 1.24±0.008	i 1.43±0.011	f 1.53±0.016

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3ppm , T4 (Turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm) , T6 (cinnamon 166.16 ppm).

pH value

Table 5 shows the effect of the interaction between the treatments and the different of freezing storage periods in the pH value of ground beef, Treatment T5 (cinnamon **83.08** ppm), has significance (p <0.05) exceeded the pH value it was recorded the highest pH value 5.76, 5.89 and 6.19 in the 30,60 and 90 day period, Then the T6 (cinnamon 166.16ppm) followed and recorded value5.69, 5.53 and 5.59 in the 30,60 and 90 day period while T1 Positive control treatment (add water), was recorded the lowest significant difference in the pH value of (5.42) in the 30-day period. There were significant differences between treatments for different storage periods. The reason for the low pH in the early storage periods can be reduced meat water retention or because of attributed rapid activity of μ-calpain and cathepsins (Li *et al*., 2014). These results are agreed with those of Falowo *et al*. (2017).

Table 5 : The effect of the interaction between different treatments and the period of storage by freeze in pH value of ground beef (mean ± SE):

Treatments	Period of freeze storage/day		
	30	60	90
T_1	j 5.42±0.018	i 5.53±0.012	j 5.42±0.018
T_2	h 5.61±0.018	h 5.60±0.026	h 5.61±0.018
T_3	h 5.59±0.027	g 5.65±0.028	h 5.59±0.027
T_4	h 5.61±0.015	f 5.68±0.017	h 5.61±0.015
T_5	e 5.76±0.020	dc 5.89±0.018	e 5.76±0.020
T_6	f 5.69±0.012	e 5.74±0.023	f 5.69±0.012

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3ppm) , T4 (Turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm) , T6 (cinnamon 166.16 ppm).

Thiobarbituric acid:

The results of table 6 indicated a significant decrease (P<0.05) in the value Thiobarbituric acid (TBA) in treatment T3 (Turmeric 248.3 ppm ((1.37mg malonealdehyde/Kg meat) in 90 day period, as compared with T1 Positive control treatment (add water) has significant increase (2.31 mg malonealdehyde/ Kg meat) in 90 day period, Significant differences were observed between the treatments and for different storage periods.This is consistent with the results of Falowo *et al*. (2017) which indicated a decrease in TBA value by increasing the concentration of additives when studying the antioxidant effect of *Moringa oleifera* and *Bidens pilosa* leaf extract on the physical and chemical properties of ground beef and cold storage for 6 days at 4 °C. which is one of the by-products of oxidation of fats in meat and meat products due to the breakdown of peroxides. The gradual rise in the value of TBA during periods of cold storage of meat is normal as a result of oxidative processes and the production of free radicals and ROS and peroxides etc. (Amaral *et al*., 2018). the biogenic synthesized silver nanoparticles from *Salicornia brachiata* aqueous extract also exhibited excellent free radical scavenging activity (Seralathan *et al*., 2014), It is worth mentioning that the extracts in their nanostructures are more effective compared to the extracts of the same plant in natural form (Abdel-Aziz *et al*., 2014 and Baharara *et al*., 2015).

Table 6: The effect of the interaction between different treatments and the period of storage by freeze in thiobarbituric acid values of ground beef (mean ± SE)

Treatments	Period of freeze storage/day		
	30	60	90
T_1	i 1.31±0.033	e 1.64±0.033	a 2.31±0.016
T_2	i 1.28±0.017	f 1.58±0.018	b 2.22±0.032
T_3	j 1.16±0.027	h 1.37±0.034	d 1.75±0.018
T_4	j 1.18±0.076	hg 1.41±0.027	c 1.80±0.056
T_5	j 1.19±0.017	g 1.45±0.032	c 1.81±0.038
T_6	j 1.20±0.023	g 1.44±0.012	c 1.83±0.018

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3ppm) , T4 (Turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm) , T6 (cinnamon 166.16 ppm).

Thaw loss

The result in table 7 showed the effect of the interaction between the different treatments and the periods of frozen storage in the Thaw loss percentage in fresh ground beef, A significant decrease (P< 0.05) was observed in T4 (Turmeric 496.9 ppm), it was recorded at (1.32%) for 30 day period, while T1 Positive control treatment (add water) and T2 Negative control treatment (without addition)was recorded the highest Thaw loss percentage at (4.60 and 4.52%) for the period 90 days. Was significant difference between treatments with different storage. This is due to the effect of the addition of nanoparticles plant extracts, which have the role of antioxidants and the ability to protect the cell wall from the breakdown by the oxidation, which increases the stability and reduce the release of Exuded liquid from inside the cell, Abdullah *et al.* (2017) indicated that the use of cinnamon extract by spraying method at 2% concentration with Awassi lamb meat had a significant effect (P <0.05) in reducing the Thaw loss compared to the control treatment. This is consistent with the results of Viuda-Martos *et al.* (2015).

Table 7: The effect of the interaction between different treatments and the period of storage by freeze in Thaw loss of ground beef (mean ± SE):

Treatments	Period of freeze storage/day		
	30	60	90
T_1	b 3.78±0.0163	a 4.24±0.0105	b 3.78±0.0163
T_2	b 3.81±0.038	a 4.21±0.064	b 3.81±0.038
T_3	hi 1.52±0.072	d 2.80±0.026	hi 1.52±0.072
T_4	i 1.32±0.038	gf 2.13±0.015	i 1.32±0.038
T_5	i 1.38±0.049	ef 2.34±0.048	i 1.38±0.049
T_6	hg 1.88±0.063	ed 2.69±0.136	hg 1.88±0.063

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3ppm,) T4 (Turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm) , T6 (cinnamon 166.16 ppm).

Water Holding Capacity WHC

Table 8 shows the effect of the interaction between the treatments and the different storage periods in WHC percentage of ground fresh beef, significant (P <0.05) treatment T3 (Turmeric 248.3 ppm) was recorded the highest WHC percentage (58.44%) in the period 30 day compared with T2 Negative control treatment (without addition), which recorded the lowest significant difference (P <0.05) (36.16%) In the 90-day period, in the same table, there were significant differences between the treatments for different storage periods. Those natural additives protect protein and improve WHC to increase the concentration of natural additives (Soltanizadeh *et al.* (2014). also pointed out that the reason for the rise in WHC% is that these compounds contributed to raising the pH of treated meat, which increased WHC. (Viuda-Martos *et al.*, 2015) This agreed with the results of Muhammad & Al-Rubeii (2018).

Table 8: The effect of the interaction between different treatments and the period of storage by freeze in Water Holding Capacity WHC of ground beef (mean ± SE):

Treatments	Period of freeze storage/day		
	30	60	90
T_1	d 51.85±0.165	jk 39.96±0.277	d 51.85±0.165
T_2	e 50.94±0.186	i 41.05±0.184	e 50.94±0.186
T_3	a 58.44±0.218	c 53.55±0.247	a 58.44±0.218
T_4	a 58.28±0.198	c 53.39±0.173	a 58.28±0.198
T_5	c 53.74±0.265	g 48.85±0.159	c 53.74±0.265
T_6	b 54.37±0.248	f 49.48±0.219	b 54.37±0.248

- The averages that carries different letters are significantly different (P<0.05) among them.
- T1 Positive control treatment (add water), T2 Negative control treatment (without addition), T3 (Turmeric 248.3ppm) , T4 (Turmeric 496.9 ppm), T5 (cinnamon 83.08 ppm) , T6 (cinnamon 166.16 ppm).

Conclusion

From the results obtained from this study, we can conclude that the addition of Cinnamon and turmeric nanoparticles extract to ground beef, which frozen stored resulted in increased moisture and protein percentages with decreased fat and ash percentage and led to a significant improvement in pH of meat WHC percent for ground beef and decreased Thaw loss percent and oxidation indicators TBA.

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