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EFFECT *OF CINNAMOMUM ZEYLANICUM* ESSENTIAL OIL ON QUALITY OF CHICKEN SAUSAGE

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Received: 8 March 2016; **Accepted:** 27 April 2016

ABSTRACT

The purpose of the present investigation was to study the effect of *Cinnamomum zeylanicum* essential oil adding at two concentrations (0.02% and 0.04% v/w) on pH, lipid oxidation, microbial growth and sensory characteristics of chicken sausage stored at 4 °C for 21 days. The antioxidant activities were compared to that of a standard synthetic antioxidant; butylated hydroxyanisole (BHA). The results declared that the pH values were not differing between the BHA-formulated sausage samples and samples containing *C. zeylanicum* essential oil ($p>0.05$). Incorporation of *C. zeylanicum* essential oil retard lipid oxidation process at the end of storage ($p<0.05$). The initial TBA value was 0.140±0.01 mg malonaldehyde/Kg sample. After 21 days of storage, it reached to 0.191±0.02 mg malonaldehyde/Kg sample in BHA-formulated samples (T1), 0.227±0.02 mg malonaldehyde/Kg sample in *C. zeylanicum* essential oil 0.02% samples (T2) and averaged 0.153±0.02 mg malonaldehyde/Kg sample in *C. zeylanicum* essential oil 0.04% samples (T3). All samples had lower TBARs values and adding *C. zeylanicum* essential oil decreased the lipid oxidation of samples. At storage day 21, sausage samples formulated with *C. zeylanicum* essential oil (T2 & T3) maintained lower APC (6.90±0.06 and 6.30±0.09 $\log_{10}$ CFU/g, respectively) than the MPL, while APC in control samples (T1) exceeded the limit of 7 $\log_{10}$ C-FU/g. Samples containing highest amount of *C. zeylanicum* essential oil (T3) had higher sensory score compared to control sample. The results suggest that *C. zeylanicum* essential oil, which might be seen more healthful than those of synthetic origin and through their combined antioxidant and antimicrobial effects, are potentially useful in preserving chicken sausage.

Key words: *Cinnamomum Zeylanicum, Essential Oil, Quality of Chicken, Sausage*

INTRODUCTION

There is a growing interest in the use of natural products in the human food and animal feed industries, as consumer resistance to synthetic additives is increasing (Ito *et al.*, 1986). The use of natural additives has attracted attention; reportedly, natural compounds have antioxidant effects similar to or better than synthetic preservatives (Sebranek *et al.*, 2005).

The use of plant essential oils as antioxidant and antimicrobial agents in processed foods is a promising alternative for synthetic compounds. The essential oils have been extensively used in food products, not only for their antibacterial, antifungal and antioxidant properties but also as food flavoring agents (Viuda-Martos *et al.*, 2009). The main advantage of essential oils is that they can be used in any food and are generally recognized as safe, providing that their maximum effects are attained with minimal change in the organoleptic properties of the food (Viuda-Martos *et al.*, 2008). The essential oils contain many phytochemicals including phenolic compounds like flavonoids, which are sources of natural antioxidants. Their antioxidant activity depends upon their ability to interact with free radicals (Dawidowicz *et al.*, 2006). In addition to antioxidant activity, herbal compounds have antimicrobial, anti-inflammatory, anti-mutagenic and anti-cancer activities, which have positive effects on functionality of foods against diseases (Khader *et al.*, 2010; Liu *et al.*, 2009; Madhuri and Pandey, 2009 and Namsa *et al.*, 2009).

The bark and leaves of *Cinnamon* are commonly used as spices in the home kitchen and their distilled essential oils or synthetic analogs are used as flavoring agents in the food and beverage industry (Jham *et al.*, 2005). Antifungal and antibacterial principles present in essential oil are effective in preventing food spoilage (Fabio *et al.*, 2007 and Valero and Salmeron, 2003). *Cinnamon* bark had higher inhibitory zone (20-40 mm) against five target

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bacteria (*Escherichia coli, Listeria monocytogenes, Staphylococcus aureus, and Salmonella typhimurium*) and one spoilage bacterium (*Pseudomonas aeruginosa*) as compared with other essential oils, *Cinnamon* bark essential oils used in cooked meat was conducted and an essential oil level of 0.05% was the highest organoleptically acceptable (Ghabraie *et al.,* 2015). Mathew and Abraham (2006) showed that cinnamon extracts contain a number of antioxidant compounds, which could effectively scavenge reactive oxygen species including superoxide anions and hydroxyl radicals as well as other free radicals. Ciftci *et al.* (2010) suggested that cinnamon oil might play an important role as an endogenous antioxidant metabolism and could be applicable as a protective agent against tissue damage.

Cinnamomum zeylanicum essential oil contains a distinct antioxidant activity, which is attributed to the presence of phenolic and poly-phenolic compounds (Chericoni *et al.,* 2005 and Jayaprakasha *et al*., 2006). Three of the main components of the essential oils obtained from the bark of *C. zeylanicum* are trans-cinnamaldehyde, eugenol, and linalool, which represent 82.5% of the total composition (Chericoni *et al.,* 2005). Trans-cinnamaldehyde, accounts for approximately 49.9–62.8% of the total amount of bark oil (Singh *et al.,* 2007 and Simic *et al.,* 2004). Trans-cinnamaldehyde as the major constituents of the total amount of bark oil contains relatively high amounts of phenolic compounds (18.2% of the oil); their phenolic group plays an important role in antioxidant activity, which act as hydrogen donor (El-Baroty *et al.,* 2010 and Shen *et al.,* 2012). The *Cinnamomum zeylanicum* essential oil acted as a good inhibitor of primary and secondary oxidation products formation in mustard oil at the concentration of 0.02% (Singh *et al.,* 2007). The plant tissue has also strong antioxidant capacity because of richness from some antioxidant vitamins and minerals (Jayaprakasha, 2007 and Gul and Safdar, 2009). Varalakshmi *et al.* (2012) reported that bark of *C. zeylanicum* was a potential source of natural antioxidants, and could be used in any preparations for combating free radical mediated damage to the body.

Sausage is one of the popular foodstuffs among processed meat products (Barbut, 2001). However, during storage, quality attributes of the product deteriorate due to lipid oxidation and microbial growth. Lipids oxidation is responsible for reduction in nutritional quality as well as changes in flavor (Aguirrezábal *et al.,* 2000), while microbial contamination can pose major public health hazards and economic loss in terms of food poisoning and meat spoilage. Thus, application of suitable agents possessing both antioxidant and antimicrobial activities may be useful for maintaining meat quality, extending shelf life and preventing economic loss (Yin and Cheng, 2003).

The objective of this study was to investigate the antioxidant as well as the antimicrobial effectiveness of two *Cinnamomum zeylanicum* concentrations (0.02% and 0.04% v/w) in preserving raw chicken sausage during storage at 4°C.

MATERIALS AND METHODS

Extraction of Cinnamomum zeylanicum essential oil:
Dried aerial parts of *C. zeylanicum* spice were acquired from a local market. The essential oil of *C. zeylanicum* was extracted by hydro-distillation, using a modified Clevenger apparatus method. Plant material was added to water in a 2 L volumetric distillation flask and coupled to the altered Clevenger device and the extraction was performed for 2.5 hrs. at 100 °C. The essential oil was collected and the remaining water were removed with anhydrous sodium sulfate. The oil was stored at 4°C in glass flasks wrapped in aluminum foil. (Oliveira *et al.,* 2010).

Preparation of chicken sausage:
The chicken sausage was produced with boneless chicken meat purchased from a local commercial source. The chicken meat and immediate subcutaneous fat, which was scraped from the outermost layer of skin, were ground together through a 0.4-cm grinder plate (Super grinder-MK-G3; Matsushita Electric Industrial, Japan). The mass of the sausage was divided into three separate lots, BHA-formulated sausage samples (T1), sausage with *C. zeylanicum* essential oil 0.02% v/w (T2) and sausage with *C. zeylanicum* essential oil 0.04% v/w (T3). Butylated hydroxyanisole (BHA) was purchased from El Gomhoria Pharmaceutical Com. and used as a reference antioxidant. It was added to the sausage formulation at a concentration of 0.1 g/kg (USDA, 1999).

All other ingredients were added in equal amounts (g/kg) to the various formulations of sausage meat: 100 g shattered ice, 20 g salt (sodium chloride), 1.5 g sodium polyphosphate, 1 g monosodium glutamate, 0.1 g sodium nitrate, and 6.2 g sausage seasoning (3.5 g white pepper, 1.5 g nutmeg, 0.7 g sage and 0.5 g allspice). The batter was mixed in an emulsifier for 3 min and the resulting mixture was stuffed tightly into hydrocellulose casings 1.5 cm in diameter (Viskase Corporation, Chicago, USA), which were subsequently divided into food-casing lengths of about 12 cm per unit. The sausage units were packaged in polyethylene bags, labeled and stored for 21 days at 4°C. The following evaluations were performed on the sausage products – pH, thiobarbituric acid (TBA), aerobic plate count (APC) and sensory panel test at 0, 3, 6, 9, 12, 15, 18 and 21 day.

1) PH value
The pH of the samples was determined following the method AOAC (1995). The pH was measured by blending a 10 g sample with 90 mL deionized water

for 2 min. The pH of the obtained suspension was measured with a digital pH meter.

2) Lipid oxidation

Thiobarbituric acid (TBA) assay was carried out according to the procedure of Schmedes and Holmer (1989). Sausage sample (10 g) was mixed with 25 ml of trichloroacetic acid solution (200 g/l of TCA in 135 ml/l phosphoric acid solution) and homogenized in a blender for 30 s. After filtration, 2 ml of the filtrate were added to 2 ml TBA solution (3 g/l) in a test tube. The test tubes were incubated at room temperature in the dark for 20 h; then the absorbance was measured at 532 nm by using UV–VIS spectrophotometer (model UV-1200, Shimadzu, Japan). TBA value was expressed as mg malonaldehyde per kg of sausage.

3) Aerobic plate count

APC was determined by the method described by APHA (1984). Sausage sample (10 g) was homogenized with 90 ml of sterile peptone water (1g/l) in a laboratory homogenizer and serial dilutions were prepared, then 0.1 ml of each dilution was spread with a bent sterile glass rod on duplicate plates of pre-poured and dried standard plate count agar. After 48-h incubation at 25°C, colonies were counted and results were expressed as $\log_{10}$ CFU/g of sausage sample.

4) Sensory evaluation:

The investigated samples were evaluated using a panel test of a point hedonic scale (Sendecor and Cochran, 1987). Representative samples of the different sausage formulations were cooked in hot water at 75°C for 25 min. The intensity of *C. zeylanicum* odor, taste, tenderness and overall acceptability scores of the sausage were determined by 10 panelists. Samples were cut into uniform size (about 3 cm in length), and introduced to panelists in covered serving dishes coded with 3-digit random numbers. An eight-point hedonic scoring scale (Sendecor and Cochran, 1987) (8=extremely intense/tender; 7=very intense/tender; 6=moderately intense/tender; 5= slightly intense/tender; 4=slightly bland/tender; 3=moderately bland/tender; 2=very bland/tender; 1=extremely bland/tender) was employed for *C. zeylanicum* odor, taste and tenderness intensity of sausage. A nine-point hedonic scale (9=like extremely; 8=like very much; 7=like moderately; 6=like slightly; 5=neither like nor dislike; 4=dislike slightly; 3=dislike moderately; 2=dislike very much; 1=dislike extremely) was used for evaluation of the overall acceptability.

5) Statistical analysis:

Triplicate samples (n = 3) were analyzed for each property. The results were expressed in terms of mean and Stander Error (SE) of mean. Statistical analysis (ANOVA) was applied to the data followed by Duncan's Multiple Range Test (Duncan, 1955) using SPSS software. Differences between means were determined by the least significant difference test, and significance was defined at $P<0.05$.

RESULTS

1) pH values:

The PH values of refrigerated sausage at 4°C for samples containing *C. zeylanicum* essential oil and control samples during different periods are presented in Table (1). The initial pH value was 6.65±0.02 in BHA-formulated samples (T1), 6.86±0.01 in sausage samples formulated with *C. zeylanicum* essential oil 0.02% v/w (T2) and 6.86±0.01 in sausage samples formulated with *C. zeylanicum* essential oil 0.04% v/w (T3). After 21 days of storage, it reached to 6.22±0.01, 6.12±0.03 and 6.14±0.01 in (T1), (T2) and (T3) respectively. In all sausage formulations, storage had a significant effect ($P<0.05$) on the pH values, which tended to increase with storage time. However, after 21 days of storage no significant difference was detected between pH of BHA-formulated samples (T1), samples formulated with *C. zeylanicum* essential oil 0.02% v/w (T2) and samples formulated with *C. zeylanicum* essential oil 0.04% v/w (T3).

Table 1: pH values of chicken sausage formulated with *C. zeylanicum* essential oil stored at 4°C (Mean ± SE).

Storage (days)	PH values (Mean± SE)							
	0	**3**	**6**	**9**	**12**	**15**	**18**	**21**
T1	6.65 ± 0.02^{Aa}	6.39 ± 0.01^{Aa}	6.30 ± 0.06^{Aa}	6.28 ± 0.01^{Ab}	6.28 ± 0.01^{Ab}	6.26 ± 0.01^{Ac}	6.23 ± 0.01^{Ac}	6.22 ± 0.01^{Ad}
T2	6.86 ± 0.01^{Aa}	6.83 ± 0.03^{Aa}	6.83 ± 0.01^{Ab}	6.76 ± 0.02^{Aa}	6.71 ± 0.01^{Ab}	6.68 ± 0.01^{Ac}	6.38 ± 0.01^{Ac}	6.12 ± 0.03^{Ad}
T3	6.86 ± 0.01^{Aa}	6.84 ± 0.01^{Aa}	6.77 ± 0.01^{Ab}	6.71 ± 0.01^{Aa}	6.63 ± 0.02^{Ab}	6.58 ± 0.01^{Ac}	6.39 ± 0.01^{Ac}	6.14 ± 0.01^{Ad}

^{AB} Values followed by different capital letter within the same column are significantly different *(P<0.05).*

^{abcd} Values followed by different small letter within the same row are significantly different *(P<0.05).*

T1= BHA-formulated sausage samples, T2= sausage samples formulated with *C. zeylanicum* essential oil 0.02% v/w

T3= sausage samples formulated with *C. zeylanicum* essential oil 0.04% v/w

2) Lipid oxidation:

Table (2) shows the effect of *C. zeylanicum* essential oil addition and storage time on the lipid oxidation of chicken sausage. The initial TBA value was 0.140±0.01 mg malonaldehyde/Kg sample in BHA-formulated samples (T1), 0.138±0.02 mg malonaldehyde/Kg sample in sausage samples formulated with *C. zeylanicum* essential oil 0.02% v/w (T2) and 0.139±0.01 malonaldehyde/Kg sample in sausage samples formulated with *C. zeylanicum* essential oil 0.04% v/w (T3) . After 21 days of storage, it reached to 0.191±0.02, 0.227±0.02 and 0.153±0.02 mg malonaldehyde/Kg sample in (T1), (T2) and (T3) respectively. All samples had lower TBARs values and adding *C. zeylanicum* essential oil decreased the lipid oxidation of samples. A significant difference was noted between (T2) and (T3) formulated samples, Also a significant difference was noted between (T1) and (T3) where, there is a little increase in TBA values in (T1) and (T2) than (T3) samples during the 21 days of storage.

Table 2: Effect of *C. zeylanicum* on thiobarbituric acid reactive substances (TBARs) values of chicken sausage during 21 days of storage at 4˚C (Mean ± SE).

Storage days	TBA mg Malonaldehyde/Kg ±SE							
	0	**3**	**6**	**9**	**12**	**15**	**18**	**21**
T1	0.140 ± 0.01^{Aa}	0.152 ± 0.01^{Aa}	0.161 ± 0.01^{Bb}	0.172 ± 0.01^{Bc}	0.177 ± 0.01^{Bc}	0.182 ± 0.03^{Cd}	0.186 ± 0.02^{Cd}	0.191 ± 0.02^{De}
T2	0.138 ± 0.02^{Aa}	0.163 ± 0.02^{Ab}	0.176 ± 0.01^{Bb}	0.182 ± 0.02^{Bb}	0.191 ± 0.01^{Bc}	0.224 ± 0.01^{Dc}	0.223 ± 0.01^{Dc}	0.227 ± 0.02^{Dd}
T3	0.139 ± 0.01^{Aa}	0.140 ± 0.01^{Aa}	0.140 ± 0.00^{Aa}	0.142 ± 0.01^{Ab}	0.143 ± 0.02^{Bb}	0.146 ± 0.01^{Bc}	0.148 ± 0.02^{Bc}	0.153 ± 0.02^{Cd}

^{ABCD} Values followed by different capital letter within the same column are significantly different *(P<0.05).*
^{abcde} Values followed by different small letter within the same row are significantly different *(P<0.05).*
T1= BHA-formulated sausage samples, T2= sausage samples formulated with *C. zeylanicum* essential oil 0.02% v/w
T3= sausage samples formulated with *C. zeylanicum* essential oil 0.04% v/w

3) Aerobic plate count

Initial aerobic plate count (APC) in the sausage was 4.41 $\log_{10}$ CFU/g; and during the first 10 days of storage, the count in all sausage formulations remained below 7 $\log_{10}$ CFU/g, which is the MPL (Maximal Permissible Limit) for APC recommended by ICMSF (1986). At storage day 21, sausage samples formulated with *C. zeylanicum* essential oil (T2 & T3) maintained lower APC (6.90±0.06 and 6.30±0.09 $\log_{10}$ CFU/g, respectively) than the MPL, while APC in control samples (T1) exceeded the limit of 7 $\log_{10}$ C-FU/g.

Table 3: Effect of *C. zeylanicum* on aerobic plate count (APC) of chicken sausage, during 21 days of storage at 4˚C (Mean ± SE).

Storage days	APC log cfu/g±SE							
	0	**3**	**6**	**9**	**12**	**15**	**18**	**21**
T1	4.40 ± 0.01^{Aa}	4.97 ± 0.02^{Ab}	5.41 ± 0.09^{Bb}	6.19 ± 0.05^{Cc}	6.82 ± 0.05^{Cd}	7.24 ± 0.08^{Cd}	7.82 ± 0.03^{Cd}	8.52 ± 0.07^{De}
T2	4.39 ± 0.02^{Aa}	4.83 ± 0.04^{Ab}	4.87 ± 0.02^{Ab}	5.30 ± 0.06^{Bc}	5.54 ± 0.02^{Bc}	6.14 ± 0.05^{Cc}	6.49 ± 0.03^{Cc}	6.90 ± 0.06^{Cd}
T3	4.45 ± 0.01^{Aa}	4.83 ± 0.01^{Ab}	4.87 ± 0.02^{Ab}	5.15 ± 0.09^{Bc}	5.51 ± 0.06^{Bc}	5.81 ± 0.04^{Bd}	5.93 ± 0.04^{Bd}	6.30 ± 0.09^{Ce}

^{ABCD} Values followed by different capital letter within the same column are significantly different *(P<0.05).*
^{abcde} Values followed by different small letter within the same row are significantly different *(P<0.05).*
T1= BHA-formulated sausage samples, T2= sausage samples formulated with *C. zeylanicum* essential oil 0.02% v/w
T3= sausage samples formulated with *C. zeylanicum* essential oil 0.04% v/w

4) Sensory evaluation:
The results of sensory assessment of chicken sausage formulated with *C. zeylanicum* essential oil samples are shown in Table (4). In general, samples with *C. zeylanicum* essential oil had the higher scores than control sample. Regarding to odor, the score of *C. zeylanicum* essential oil 0.04% sample was significantly higher than other samples (p<0.05). The taste and overall acceptability scores of samples with *C. zeylanicum* essential oil were higher than control one, but there were no significant difference between them (p>0.05). The tenderness of all samples was not significantly affected by addition *C. zeylanicum* essential oil (p>0.05).

Table 4: Mean scores of sensory characteristics of cooked sausage formulated with *C. zeylanicum* essential oil.

Sensory attributes	Sensory scores		
	T1	**T2**	**T3**
Taste	5.57 ± 2.00	6.42 ± 1.74	6.61 ± 1.61
Odor	6.42 ± 1.34	6.52 ± 1.16	6.61 ± 1.28
Tenderness	6.00 ± 1.81	6.72 ± 1.44	6.73 ± 1.69
Overall acceptability	5.68 ± 0.47	6.15 ± 0.68	6.94 ± 1.39

T1= BHA-formulated sausage samples, T2= sausage samples formulated with *C. zeylanicum* essential oil 0.02% v/w
T3= sausage samples formulated with *C. zeylanicum* essential oil 0.04% v/w

DISCUSSION

1) pH values:
Regarding to pH values, *C. zeylanicum* essential oil did not show statistically significant effect (p>0.05) on pH in each day of storage days between the control (T1) and samples containing *C. zeylanicum* essential oil at two concentrations (T2 & T3), while time was the most influential factor in this respect. In the control (T1), *C. zeylanicum* essential oil 0.02% samples (T2) and *C. zeylanicum* essential oil 0.04% sample (T3), the pH significantly decreased from 6.65, 6.86 and 6.86 at day 0 to 6.22, 6.12 and 6.14, respectively, at day 21 (p < 0.05). This phenomenon may have been due to the fall in pH coincided with the more growth of lactic acid bacteria in control sample in compare with other samples, which would lead to more lactic acid production (Viuda-Martos *et al.,* 2010).

2) Lipid oxidation:
TBA value is routinely used as an index of lipid oxidation in meat products in store (Raharjo and Sofos, 1993), and the rancid flavor is initially detected in meat products between TBA values of 0.5 and 2.0 mg malonaldehyde/Kg sample (Gray and Pearson, 1987). The TBA values for the refrigerated chicken sausage at 4°C are presented in Table (2).

All examined samples in (T1), (T2) and (T3) had lower TBARs values and adding *C. zeylanicum* essential oil decreased the lipid oxidation of samples. A significant difference was noted between (T2) and (T3) formulated samples, also a significant difference was noted between (T1) and (T3) where, there is a little increase in TBA values in (T1) than (T3) and (T2) than (T3) samples during the 21 days of storage. Such activity is basically due to the composition of essential oils: mainly to flavonoids and phenolic compounds. Flavonoids act as antioxidants because their structural features like scavenging lipid peroxy radicals by donating hydrogen and become more stable phenoxy radicals (Choe and Min, 2009). Spice essential oils with antioxidant activities may also interfere with the propagation reactions (Russo *et al.,* 2000) besides inhibiting the enzymatic systems involved in initiation reactions (You *et al.,* 1999). In addition, they can act as the hydrogen donor, scavengers of free radicals, metallic ion chelation or even acting as substrate of radicals such as superoxide or hydroxyl (Al-Mamary *et al.,* 2002).

3) Aerobic plate count:
Initial aerobic plate count (APC) in the sausage was 4.41 $\log_{10}$ CFU/g; and during the first 10 days of storage the count in all sausage formulations remained below 7 $\log_{10}$ CFU/g which is the MPL (Maximal Permissible Limit) for APC recommended (ICMSF, 1986).

Table (3) shows at storage day 21, chicken sausage samples formulated with *C. zeylanicum* essential oil either 0.02% (T2) or 0.04% (T3) maintained lower APC (6.90±0.06 and 6.30±0.09 $\log_{10}$ CFU/g, respectively) than the MPL, while APC in BHA formulated samples (T1) exceeded the limit of 7 $\log_{10}$ C-FU/g by 1.52±0.07 logs. The anti-microbial action is considered to arise mainly from the potential of hydrophobic essential oils to obstruct the bacterial

cell membrane and its structures, which leads to ion leakage. It has been proposed that eugenol and cinnamaldehyde inhibit production of an essential enzyme by the bacteria and/or cause damage to the cell wall of bacteria (Burt, 2004).

This result is agree with the result obtained by Jagadeesh Babu *et al.* (2012), they found that In chicken meat patties treated with essential oil of cinnamon, the *Staphylococcus aureus* counts were significantly (P<0.05) different from control. Among the treatment groups chicken meat patties treated with essential oil of cinnamon at 1:250 and 1:500 concentrations recorded significantly (P<0.05) lower counts of *Staphylococcus aureus* during the storage period. The decreased *Staphylococcus aureus* count may be due to cinnamaldehyde the antimicrobial compound of cinnamon. Since the essential oil of cinnamon gave similar results even at lesser concentration (i.e.at 1:500) it is considered as having the best antimicrobial effect in this study. Also, the result of this study was similar to the findings of Hoque *et al.* (2007) who found that essential oil of cinnamon at 10 percent concentration showed highest antimicrobial effect and Sema agaoglu *et al.* (2007) reported that diethyl ether treated cinnamon extract was found to be most effective against *Staphylococcus aureus.*

4) Sensory evaluation:

According to the results of sensory evaluation, samples with *C. zeylanicum* essential oil had the higher scores than control ones in all of sensory attributes. These results are agree with the results obtained by (Erich *et al.,* 2006) and (Estévez *et al.,* 2005), they reported that addition of natural essential oils have been enhance sensory characteristics of emulsion type meat products by reducing hardness, adhesiveness, gumminess and chewiness. In addition, the results of the present study showed that the odor of samples was not significantly affected by adding *C. zeylanicum* essential oil (p>0.05). In agreement with our findings, it has been reported that overall acceptability of fish fillet sample coated with solution containing *C. zeylanicum* essential oil was higher than control sample at 16th day (Ojagh *et al.,* 2010).

CONCLUSION

This study concluded that *C. zeylanicum* essential oil provide antioxidant and antimicrobial benefits to raw chicken sausage during cold storage (4°C). The addition of spice essential oils such as *C. zeylanicum* seems to be a technologically viable alternative for elaborating cooked meat products because the natural image of the products is improved. In the case of chicken sausage, *C. zeylanicum* essential oil improve acceptance and have desirable effects as regards oxidative stability. The addition of *C. zeylanicum* essential oil alone and in combination with other preservative agents and methods (such as other plant-originated antioxidant agents or vacuum packaging) should be considered as a good method to improve chemical characteristics of chicken sausage.

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دراسة تأثير زيت القرفة على جودة سجق الدجاج

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ان الهدف الأساسي من هذه الدراسة هو معرفة تأثير اضافة زيت القرفة على درجة الحموضة، وأكسدة الدهون، والنمو الميكروبي والصفات الحسية لسجق الدجاج الطازج أثناء تخزينه عند درجة حرارة ٤ درجة مئوية لمدة ٢١ يوما، وقد تمت مقارنة تأثير إضافة زيت القرفة كمادة حافظة طبيعية مضاد للأكسدة بمضادات اكسدة صناعية اخرى مثل بيتيولاتيد هيدروكسى انيسول، حيث قسمت العينات الى ثلاث أجزاء كالتالي: الجزء الأول يترك بدون إضافة زيت القرفة ويضاف اليه فقط مادة بيتيولاتيد هيدروكسى انيسول بتركيز (٠,١ جرام/كجم) كمادة مضادة للأكسدة، الجزء الثاني يضاف إليه زيت القرفة بنسبة ٠,٢ % بينما الجزء الثالث يضاف اليه زيت القرفة بنسبة ٠,٤ % وقد تم قياس الأس الهيدروجيني وقيمة حمض الثيوباربيتيورك وعد البكتريا الهوائية أثناء التخزين عند درجة ٤ درجة مئوية عند اليوم (٠، ٣، ٦، ٩، ١٢، ١٥، ١٨، ٢١) من الحفظ. وقد وجد ان متوسط نتائج حمض الثيوباربيتيورك كانت ٠,١٤٠ ± ٠,٠١ في اليوم الأول من التجربة بينما وصلت إلى ٠,١٩١ ± ٠,٠٢ في العينات التي تركت بدون إضافة زيت القرفة لها وأضيف اليها فقط مادة بيتيولاتيد هيدروكسى انيسول (T1)، و ٠,٢٢٧ ± ٠,٠٢ في العينات المضاف إليها زيت القرفة بنسبة ٠,٢ % (T2) و ٠,١٥٣ ± ٠,٠٢ في العينات المضاف إليها زيت القرفة بنسبة ٠,٤ % (T3) بعد ٢١ يوما من التخزين. أوضحت النتائج أيضا ان إضافة زيت القرفة في المجموعة الثانية (T2) والمجموعة الثالثة (T3) الى سجق الدجاج الطازج قد حافظ على انخفاض العدد الميكروبي ليصل الي ٦,٩٠ ± ٠,٠٦ و ٦,٣٠ ± ٠,٠٩ على التوالي. ومن ذلك حصلنا على ان اضافة زيت القرفة وبيتيولاتيد هيدروكسى انيسول (١ ,٠ جم\كجم) يؤخر أكسدة الدهون ومن ناحية اخرى فان العد البكتيري للعينات انخفض بطريقة واضحة في حالة استخدام زيت القرفة بنسبة ٠,٤ % مما يزيد من فترة صلاحية المنتج للاستهلاك الأدمي. وقد اشار التحليل الحسي للعينات بأن استخدام زيت القرفة بنسبة ٠,٤ % يعطى نكهة مقبولة لسجق الدجاج والخلاصة انه ينصح باستخدام زيت القرفة كمادة حافظة طبيعية لأهميته للصحة العامة بالمقارنة بالمواد الصناعية حيث انه يجمع بين أنه مضاد للأكسدة ومضاد للميكروبات ايضا مما يجعل المنتج صالح للاستهلاك الآدمي أثناء الحفظ.