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Effect of Some Spices Oil Extract on The Bacterial Quality Of Experimentally Produced Chicken Shawarma

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Abstract

Three trials based experiment was designed to study the effect of adding standard oleoresins of coriander, clove and mixture of them on the quality traits of chicken shawarma before and after cooking till the 5th day of cold storage at 4°C. The 1st model of the product was not treated with any spice oleoresins and used as control. The 2nd and 3rd models treated with 300 and 400 ppm of coriander oleoresin, respectively. The 4th and 5th models were treated with 150 and 200 ppm of clove oleoresin, respectively. The 6th model was treated with 300 ppm coriander oleoresin and 150 ppm of clove oleoresin. The 7th model was treated with 400 ppm coriander oleoresin and 200 ppm of clove oleoresin. The obtained results showed that clove and coriander oleoresins had significant effect on reduction of all of bacteriological traits in terms of aerobic plate count, Coliforms count, Faecal Coliforms count in experimentally produced chicken shawarma during chilled storage for 5 days. Clove induced the highest reduction rate followed by the mixture treated trials. The clove treated trials had lowest values. Staphylococcus aureus, Salmonellae and E. coli species failed to be isolated in all trials either raw or cooked samples. Finally it is recommended add such spice oleoresins to increase the keeping quality of chicken shawarma.

Keywords: Quality, spice oleoresins, clove, coriander,chicken shawarma, bacteriological examination

Introduction

Chicken shawarma is a traditional Middle Eastern Arabic style meat sandwich, and is consumed by many across the rest of the world as well. It is made by stacking layers of chicken meat which is seasoned, marinated, and sliced, onto a vertical skewer to form a cone or cylinder shape. The skewer rotates in front of a heat source as the outer layer of meat is cooked, then carved off in slices. Shawarma is made up include onion, tomato, lettuce with dressing include Tehena, vinegar and spices then served in flat bread together with salads and dips **Essa et al., (2007)**. Microbiological quality problems of chicken shawarma depends greatly on the following factors: low initial quality of raw meat and other ingredients, inefficient cooking process, improper sanitary practices for personnel, and for cooking/processing utensils **(Kayaardi et al., 2006)**.In the preparation of fast foods, there are several cooking methods and/or different types of spice treatments used during the processing. Spices, herbs and their extracts, in addition to contributing to taste and flavor represent an increasing source of natural antimicrobials for food preservation. These natural antimicrobials from herbs and plant are receiving more attention as a promising alternative in order to partially or totally replace the antimicrobial chemical additives in controlling pathogens in foods. Cloves (Syzygium aromaticum.) are the dried unopened flower bud of evergreen tree belonging to myrtle family. It contains eugenol and eugenyl acetate as the major aroma constituents. Cloves are strongly aromatic and have a pungent, spicy taste. Cloves are used in a ground form in processed meat industry. At consumer level whole clove is used to stud baked hams and other meats. It is also used in pickling spices, for meat and pickle products. Coriander (Coriandrum sativum) is an annual herb from plants, seeds and leafs are obtained. Principal component is coriandrol (d-linalool). The seeds are aromatically sweet and make a mild and spicy flavor. Whole coriander is used in pickling spices, for meat and pickles; seeds are indispensable items of Indian spice mixes like garam masalas. Therefore, the present study was planned out to evaluate of the effect of incorporation of different concentrations of standard oleoresins of coriander and clove as well as mixture of them in

different concentrations on the quality attributes of experimentally produced chicken shawarma before and after cooking immediately after production till the fifth day of cold storage at 4 °C.

Material and Methods

Experimental Design

Three trials based experiment was designed to study the effect of incorporation of different concentrations of standard oleoresins of coriander (Corindrum sativum) and clove (Syzygium aromaticum) as well as mixture of them in different concentrations on the quality attributes of experimentally produced chicken shawarma before and after cooking immediately after production till the fifth day of cold storage at 4 °C in order to develop new effective methods that rely primarily on their use to enhance the product's safety.

Ingredients preparation

Fresh chicken boneless skinless breasts were purchased from a local slaughterhouse immediately after slaughtering and preparation. They were kept frozen at -18 °C till the day before processing. On the other hand, the seasonings were obtained from a local market in the first third of their shelf life. Standard oleoresins of the aforementioned spices were kindly provided by (Nubassa Gewurzwerk,Vierenheim-Germany).

Shawarma processing

Seven models of chicken shawarma were formulated. Processing of such product includes two main steps which are marinating and cooking. At the day before processing, twenty eight kg of boneless skinless chicken breasts were firstly thawed at refrigerator, and then at the next day they were marinated by different seasonings.

The marinated chicken meat was divided into seven groups each of them was subdivided into two portions (2 kg each) where, one portion used as a raw sample while the other used for cooking. The 1st group was considered as negative control (i.e. without addition of oleoresins) while, the other six groups were mixed with different concentrations of oleoresins as illustrated in table (a). All groups were kept at refrigerator overnight at 4 °C. At the next day, the cooking step started with heating of grill up to 250 °C just for 5 minutes then placing of the chicken meat of the different groups. After obtaining of the required samples for further investigations, Raw and cooked chicken shawarma are stored in the refrigerator at 4 °C ill the next day to be examined.

Table (a): Different treatments of chicken shawarma

Group	Trial No.	Oil extract	Concentration
1st	1 (raw)	-	-
	2 (cooked)	-	-
2nd	3 (raw)	Coriander	300 ppm
	4 (cooked)	Coriander	300 ppm
3rd	5 (raw)	Coriander	400 ppm
	6 (cooked)	Coriander	400 ppm
4th	7(raw)	Clove	150 ppm
	8 (cooked)	Clove	150 ppm
5th	9 (raw)	Clove	200 ppm
	10 (cooked)	Clove	200 ppm
6th	11 (raw)	Coriander + Clove	300 ppm + 150 ppm
	12 (cooked)	Coriander + Clove	300 ppm +150 ppm
7th	13 (raw)	Coriander + Clove	400 ppm + 200 ppm
	14 (cooked)	Coriander + Clove	400 ppm +200 ppm

Preparation of samples (ICMSF, 1996)

For preparation of chicken shawarma homogenate; dilution and spreading of 10 grams of chicken shawarma was transferred to a sterile polyethylene bag to which 90 ml of sterile Ringer solution (OXOID) was aseptically added. The contents of the bag were then stomached for 60 seconds using stomacher (Stomacher lab. Blender 400, Seward lab – Serial No. 30469 Type Ba7021 London) to have a dilution of 1/10, one ml from the original suspension was transferred with a sterile pipette to another tube containing 9 ml of sterile Ringer solution and mixed well using test tube shaker to make next dilution.

Bacteriological investigations:

Enumeration of Aerobic Plate Count (FAO, 1992)

From each of the previously prepared sample homogenate, 0.1 ml was aseptically spread onto the surface of double sets of dried standard plate count agar plates using sterile bent glass spreader. The plates were incubated at 30°C for 48 hours.

Enumeration of Coliforms Bacteria "MPN" (FAO, 1992)

Three tubes method were performed; where 3 tubes of Laury sulphate tryptose broth "LST" (Oxoid, CM 451) contained inverted Durham's tubes were inoculated with 1 ml of the previously prepared homogenate 1:10 and another 3 tubes for dilution 1:100, and 3 tubes for dilution 1:1000 were inoculated, then the "LST" tubes were incubated at 37°C for 24-48 hours.

Enumeration of Faecal Coliforms count "MPN" (FAO, 1992)

A loopful from each gas positive tubes of (LST) was transferred to Escherichia coli broth (Oxoid, CM 853), the inoculated tubes were incubated at 44.5±0.5 °C in water bath for 24-48 hours. Positive tubes showed gas production in Durham's tubes were recorded as positive and the MPN of faecal coliforms was calculated.

Enumeration of Presumptive Staphylococcus aureus (Bailey and Scott, 1982)

A quantity of 0.1 ml from each previously prepared dilution was transferred and evenly spread over a dry surface of duplicate Baird Parker agar (Oxoid, CM 272) plates with sterile bent glass rod. The inoculated plates were incubated at 35-37°C for 30-48 hours.

Isolation and identification of pathogenic bacteria

Suspected colonies of Staphylococcus aureus were isolated, purified and identified according to **Varnam and Evans (1991)**. Isolation and identification of E.coli was carried out according to **FAO (1992)**. Isolation and identification of Salmonella species was carried out according to **HPA (2007)**.

Measurement of cooked samples temperature

The temperature of the examined samples was recorded with a digital probe thermometer (Model CT-809, Century Instruments (P) Ltd, Chandigarh) just after collection of the cooked samples. 4 readings of temperature were recorded to each cooked sample which are: superficial temperature, temperature at 1 cm depth, temperature after removal of cooked superficial layer of shawarma and temperature at 1 cm depth after removal of cooked superficial layer of shawarma.

Statistical analysis

Results were analyzed by analysis of variance (ANOVA) using IBM SPSS statistics 20 to find differences among samples. Data of all variables were subjected to correlation matrix as a completely randomized design according to **Snedecor and Cochran (1989)**.

Results

Table (1): Mean values of aerobic plate count (log_{10} cfu/g) of experimentally produced raw chicken shawarmawith different concentrations of spices oleoresins during chilling storage at 4 °C for five days

Trial No.	1	3	5	7	9	11	13
Spices	Control(without spices oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300ppm) + Clove(150 ppm)	Coriander (400 ppm) + Clove (200 ppm)
1st day	$_{i}7.85^{a}$	$_{ii}6.00^{a}$	$_{ii}5.90^{a}$	$_{iii}5.10^{a}$	$_{iii}4.90^{a}$	$_{ii}5.70^{a}$	$_{ii}5.60^{a}$
2nd day	$_{i}8.00^{a}$	$_{ii}6.20^{a}$	$_{ii}5.95^{a}$	$_{iii}5.15^{a}$	$_{iii}4.95^{a}$	$_{ii}5.85^{a}$	$_{ii}5.70^{a}$
3rd day	$_{i}8.50^{b}$	$_{ii}6.50^{b}$	$_{ii,iii}6.10^{a,b}$	$_{iv}5.20^{a}$	$_{iv}5.05^{a}$	$_{iii}6.00^{a,b}$	$_{iii}5.80^{a}$
4th day	$_{i}8.85^{b,c}$	$_{ii}6.75^{b}$	$_{ii}6.25^{a,b}$	$_{iii}5.40^{a}$	$_{iii}5.20^{a}$	$_{ii}6.10^{a,b}$	$_{ii}5.90^{a}$
5th day	$_{i}9.00^{c}$	$_{ii}6.90^{b}$	$_{ii}6.45^{b}$	$_{iii}5.50^{a}$	$_{iii}5.30^{a}$	$_{i}6.20^{b}$	$_{ii}6.05^{a}$

a-c: Means with different superscript within the same column differ significantly at P<0.05.

*** i-iv:** Means with different subscript within the same row differ significantly at P<0.05.

Table (2): Mean values of aerobic plate count (log_{10} cfu/g) of experimentally produced cooked chicken shawarma with different concentrations of spices oleoresins during chilling storage at 4 °C for five days

Trial No	2	4	6	8	10	12	14
Spices	Control (without spices oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300 ppm)+Clove(150ppm	Coriander (400 ppm) + Clove (200 ppm)
1st day	$_{i}3.70^{a}$	$_{ii}2.95^{a}$	$_{ii}2.85^{a}$	$_{iii}2.10^{a}$	$_{iii}1.90^{a}$	$_{ii}2.70^{a}$	$_{ii}2.50^{a}$
2nd day	$_{i}4.00^{a}$	$_{ii,iv}3.10^{a,b}$	$_{ii,iv}2.95^{a,b}$	$_{iii,v}2.15^{a}$	$_{iii}1.95^{a}$	$_{ii}2.75^{a}$	$_{iv,v}2.60^{a}$
3rd day	$_{i}4.60^{b}$	$_{ii}3.20^{a,b}$	$_{ii,iv}3.10^{a,b}$	$_{iii}2.20^{a}$	$_{iii}2.05^{a}$	$_{ii,iv}2.85^{a}$	$_{iv}2.70^{a}$
4th day	$_{i}5.00^{b}$	$_{ii}3.25^{a,b}$	$_{ii,iv}3.20^{a,b}$	$_{iii}2.30^{a}$	$_{iii}2.15^{a}$	$_{ii,iv}2.90^{a}$	$_{iv}2.75^{a}$
5th day	$_{i}6.00^{c}$	$_{ii}3.50^{b}$	$_{ii,iv}3.30^{b}$	$_{iii}2.40^{a}$	$_{iii}2.30^{a}$	$_{iv}3.00^{a}$	$_{iv}2.90^{a}$

* **a-c:** Means with different superscript within the same column differ significantly at P<0.05.
* **i-v:** Means with different subscript within the same row differ significantly at P<0.05.

Table (3): Mean values of Coliforms count (log_{10} CFU/g) of experimentally produced raw chicken shawarma with different concentrations of spices oleoresins during chilling storage at 4 °C for five days

Trial No.	1	3	5	7	9	11	13
Additive	Control (without spices oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300 ppm) + Clove (150 ppm)	Corander(400 ppm)+Clove (200 ppm)
1st day	$_{i}1.95^{a}$	$_{ii}1.18^{a}$	$_{ii}1.18^{a}$	$_{iii}0.60^{a}$	$_{iii}0.48^{a}$	$_{ii}1.05^{a}$	$_{ii,iii}0.95^{a}$
2nd day	$_{i}1.18^{b}$	$_{i}1.05^{a,b}$	$_{i}1.05^{a,b}$	$_{ii}0.48^{a}$	$_{iii}< 0.48^{b}$	$_{i}0.95^{a,b}$	$_{i}0.85^{a}$
3rd day	$_{i}1.05^{b}$	$_{i}0.95^{a,b}$	$_{i}0.95^{a,b}$	$_{ii}< 0.48^{b}$	$_{ii}< 0.48^{b}$	$_{i}0.85^{a,b}$	$_{i}0.60^{a}$
4th day	$_{i}0.95^{b}$	$_{i}0.85^{a,b}$	$_{i}0.85^{a,b}$	$_{ii}< 0.48^{b}$	$_{ii}< 0.48^{b}$	$_{i}0.60^{a,b}$	$_{i}0.48^{a}$
5th day	$_{i}0.85^{b}$	$_{i}0.60^{b}$	$_{i}0.60^{b}$	$_{ii}< 0.48^{b}$	$_{ii}< 0.48^{b}$	$_{i}0.48^{b}$	$_{i}0.48^{a}$

a-c: Means with different superscript within the same column differ significantly at P<0.05.
i-iii: Means with different subscript within the same row differ significantly at P<0.05.

Table (4): Mean values of Coliforms count (log_{10} CFU/g) of experimentally produced cooked chicken shawarma with different concentrations of spices oleoresins during chilling storage at 4 °C for five days

Trial No.	2	4	6	8	10	12	14
Spices	Control (without spices oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300 ppm) + Clove (150 ppm)	Cor nder (400 ppm) + Clove (200 ppm)
1st day	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$
2nd day	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$
3rd day	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$
4th day	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$
5th day	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$

* **a:** Means with different superscript within the same column differ significantly at P<0.05.
* **i:** Means with different subscript within the same row differ significantly at P<0.05.

Table (5): Mean values of faecal coliforms count (log_{10} cfu/g) of experimentally produced raw chicken shawarma with different concentrations of spices oleoresins during chilling storage at 4 °C for five days

Trial No.	1	3	5	7	9	11	13
Spices	Control (without spices oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300 ppm) + Clove (150 ppm)	Coriander (400 ppm) + Clove (200 ppm)
1st day	$_{i}0.60^{a}$	$_{i}0.48^{a}$	$_{i}0.48^{a}$	$_{ii}< 0.48^{a}$	$_{ii}< 0.48^{a}$	$_{ii}< 0.48^{a}$	$_{ii}< 0.48^{a}$
2nd day	$_{i}0.48^{a}$	$_{ii}< 0.48^{b}$	$_{ii}< 0.48^{b}$	$_{ii}< 0.48^{a}$	$_{ii}< 0.48^{a}$	$_{ii}< 0.48^{a}$	$_{ii}< 0.48^{a}$
3rd day	$_{i}< 0.48^{b}$	$_{i}< 0.48^{b}$	$_{i}< 0.48^{b}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$
4th day	$_{i}< 0.48^{b}$	$_{i}< 0.48^{b}$	$_{i}< 0.48^{b}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$
5th day	$_{i}< 0.48^{b}$	$_{i}< 0.48^{b}$	$_{i}< 0.48^{b}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$	$_{i}< 0.48^{a}$

* **a-b:** Means with different superscript within the same column differ significantly at P<0.05.
* **i-ii:** Means with different subscript within the same row differ significantly at P<0.05.

Table (6): Mean values of faecal coliforms count (log_{10} cfu/g) of experimentally produced cooked chicken shawarma with different concentrations of spices oleoresins during chilling storage at 4 ^{0}C for five days

Trial No.	2	4	6	8	10	12	14
Spices	Control (without spices oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300 ppm) + Clove (150 ppm)	Coriander (400 ppm) + Clove (200 ppm)
1st day	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$
2nd day	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$
3rd day	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$
4th day	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$
5th day	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$	$_{i}<0.48^{a}$

* **a:** Means with different superscript within the same column differ significantly at P<0.05.
* **i:** Means with different subscript within the same row differ significantly at P<0.05.

Table (7): Mean values of presumptive Staphylococci count (log_{10} cfu/g) of experimentally produced raw chicken shawarma with different concentrations of spices oleoresins during chilling storage at 4 ^{0}C for five days

Trial No.	1	3	5	7	9	11	13
Spices	Control (without spice oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300 ppm) + Clove (150 ppm)	Cor a der (400 ppm) + Clove (200 ppm)
1st day	$_{i}3.20^{a}$	$_{ii}2.50^{a}$	$_{ii,iii}2.40^{a}$	$_{ii,iii}2.20^{a}$	$_{ii,iii}2.10^{a}$	$_{ii,iii}2.10^{a}$	$_{iii}2.00^{a}$
2nd day	$_{i}3.30^{a}$	$_{ii}2.30^{a}$	$_{ii}2.30^{a}$	$_{ii}2.00^{a}$	$_{ii}2.00^{a}$	$_{ii}2.00^{a}$	$_{ii}2.00^{a}$
3rd day	$_{i}3.50^{a}$	$_{ii}2.30^{a}$	$_{ii}2.10^{a}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$
4th day	$_{i}4.00^{b}$	$_{ii}2.20^{a}$	$_{ii}2.10^{a}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$
5th day	$_{i}4.20^{b}$	$_{ii}2.10^{a}$	$_{ii}2.00^{a}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$	$_{iii}<2.00^{b}$

* **a-b:** Means with different superscript within the same column differ significantly at P<0.05.
* **i-iii:** Means with different subscript within the same row differ significantly at P<0.05.

Table (8): Mean values of presumptive Staphylococci count (log_{10} cfu/g) of experimentally produced cooked chicken shawarma with different concentrations of spices oleoresins during chilling storage at 4 ^{0}C for five days

Trial No.	2	4	6	8	10	12	14
Spices	Control (without spices oleoresins)	Coriander (300 ppm)	Coriander (400 ppm)	Clove (150 ppm)	Clove (200 ppm)	Coriander (300 ppm) + Clove (150 ppm)	Coriander (400 ppm) + Clove (200 ppm)
1st day	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$
2nd day	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$
3rd day	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$
4th day	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$
5th day	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$	$_{i}<2.00^{a}$

* **a:** Means with different superscript within the same column differ significantly at P<0.05.
* **i:** Means with different subscript within the same row differ significantly at P<0.05.

Table (9): Correlation matrix between temperature and bacteriological attributes of experimentally produced chicken shawarma

	Temperature			
APC	-0.234**			
Coliforms	-0.382**			
Faecal coliforms	-0.452*			
E. coli	-0.250**			
Presumptive staphylococci	-0.324**			
Salmonellae	-0.250**			
pH	-0.232**			
Temperature	1			

*. Correlation is significant at the 0-0.05 level
**. Correlation is significant at the 0-0.01 level

Discussion

Data in Table 1 and Table 2 summarized results of aerobic plate count (APC) of experimentally produced chicken shawarma before and after cooking with different treatments of oil extracts of coriander and clove immediately after processing and during five days of chilling storage at 4 °C. It was evident that adding of oleoresins with different concentrations had a significant effect ($p<0.05$) on reduction of the APC of the product from the first day to the end of the storage period. The APC in the control raw chicken shawarma immediately after processing recorded 7.85 log_{10} cfu/g while it recorded 3.70 log_{10} cfu/g after cooking. These results increased significantly ($p<0.05$) during the chilling storage where the product reached 9 and 6 log_{10} cfu/g for both raw and cooked samples, respectively in the last day of storage. None of these obtained results was agreed with **Microbiological guidelines for food (2014)** and **GSS 1016/1998.** It is of importance to spotlight that the clove oleoresin induced the highest significant reduction of APC where, the addition of 150 ppm of clove oleoresin to the product resulted in a reduction of APC in the raw product at zero day to 5.10 log_{10} cfu/g and to 2.10 log_{10} cfu/g in the cooked product. However, the APC recorded 5.50 and 2.40 cfu/g for both raw and cooked samples, respectively in the fifth day of storage. Meanwhile, by increasing of clove oleoresin up to 200 ppm the APC immediately after processing reduced significantly ($p<0.05$) to 4.90 and 1.90 cfu/g for both raw and cooked samples, respectively. Therefore, it could be concluded that the more the concentration of clove oleoresin, the more the reduction of APC. Moreover, these results were accepted according to **Microbiological guidelines for food (2014)** and **GSS 1016/1998** all-over the storage period. The volatile oils of clove exhibited considerable inhibitory effects and antibacterial activity against several genera of bacteria, including food poisoning and spoilage bacteria **(Dorman and Deans, 2000).**

Regarding the effect of adding coriander oleoresin on the APC, it was obviously lower ($p<0.05$) than that of clove oleoresin even by increasing the concentration of the coriander. By adding 300 ppm and 400 ppm of coriander oleoresin, the APC of raw product at the 1st day was 6 and 5.90 cfu/g, respectively while it was 2.95 and 2.85 cfu/g for the cooked samples, respectively. The APC of raw product at the last day of chilling storage was 6.90 and 6.45 cfu/g, respectively while it was 3.50 and 3.30 cfu/g for the cooked samples, respectively. Meanwhile, these results also obeyed the **Microbiological guidelines for food (2014)** and **GSS 1016/1998** all-over the storage period. Results of APC in the product with mixture of both clove and coriander oleoresin continued to decrease significantly ($p<0.05$) during the chilled storage but still significantly higher than samples with clove oleoresin only and slightly but not significantly lower than samples with coriander oleoresin only. That give the potential to consider the combination of both oleoresins was not synergistic. **Gutierrez et al. (2008)** suggested that, as the plant essential oils or extracts possess similar compositions; their combinations may exhibit an additive rather than a synergistic effect. However, the magnitude of synergistic interactions between the mixtures of extracts and essential oils or their individual components, also reported previously seems to be too low to be of any practical importance **(Kalemba and Kunicka, 2003).**

Data in Table 3 and Table 4 clearly illustrated the mean values of coliforms count (log_{10} cfu/g) in experimentally produced chicken shawarma before and after cooking with different treatments of coriander and clove oleoresin immediately after processing and during five days of chilling storage. The coliforms count was < 0.48 log_{10} cfu/g in both of cooked control samples and cooked samples of different treatments. However, the addition of 200 ppm clove oleoresin induced the highest significant effect ($p<0.05$) on reduction of coliforms. Where, the mean values (log_{10} cfu/g) decreased from 1.95 in control raw samples to 0.48 at zero day of storage and from 1.18 in control samples to <0.48 at 1st day of storage and the remaining days of storage.Concerning the effect of coriander oleoresin on the raw samples, it was evident that a slight non-significant ($p<0.05$) reduction of coliforms count was achieved by addition of this oleoresin.

Nevertheless, the effect of coriander oleoresin is lower ($p<0.05$) than the effect of clove oleoresin on coliforms count. It was of interest to recognize that the same results of coliforms count were obtained regardless the concentration of coriander oleoresin added to the chicken shawarma. **Gill et al. 2002** reported that the coriander oil extracts have a limited inhibitory activity against coliforms.

On the same context, the addition of 400 ppm coriander oleoresin and 200 ppm clove oleoresin to the chicken shawarma formulation was slightly but not significantly more effective than addition of 300 ppm coriander oleoresin and 150 ppm clove oleoresin in reducing the coliforms count. However, the both treatments had the same coliforms count (log_{10} 0.48 cfu/g) in the 5th day of chilling storage. The obtained data are in agreement with those reported by **Ertas et al., 2005** who found no significant difference ($p<0.05$) of the different concentrations of coriander and clove oleoresins mixture on microbiological attributes of breast muscles in Japanese quail. Data in Table 5 and Table 6 summarized results of faecal coliforms count of experimentally produced chicken shawarma before and after cooking. It was of interest to highlight that mean value of the cooked samples was the same value, which is $log_{10} < 0.48$ cfu/g.

On the other hand, the raw samples treated with clove oleoresin either alone or intermixed with coriander oleoresin had the lowest count ($log_{10} < 0.48$ CFU/g) from the first day of production till the end of the storage period. Such results were in agreement with those reported by who **Sofia et al. (2007)** who claimed that clove oleoresin had good inhibitory activities against faecal coliforms especially E. coli. At the first day of production, the mean value of faecal coliforms count (log_{10} cfu/g) of the raw samples treated only with coriander oleoresin slightly not significantly ($p<0.05$) reduced from 0.60 in control samples to be 0.48. Meanwhile, they were the same value (< 0.48) from the third day of production until the final day of storage.

Data in Table 7 and Table 8 summarized results of Presumptive Staphylococci of experimentally produced chicken shawarma before and after cooking with different treatments of oil extracts of coriander and clove. It was clear that incorporation of oleoresins with different concentrations had a significant effect ($p<0.05$) on reduction of the Presumptive Staphylococci of the product from the first day to the end of the storage period. The Presumptive Staphylococci count (log_{10} cfu/g) in all cooked samples was < 2 that could be attributed by the effect of the low pH (Table 11) and temperature (Table 12) of all experiments.

It is of importance to spotlight that the clove oleoresin induced the highest significant reduction of Presumptive Staphylococci in raw samples. In this consideration, the addition of 150 ppm of clove oleoresin to the product resulted in a reduction of Presumptive Staphylococci count (log_{10} cfu/g) in the raw product at zero day to 2.20. However, the Staphylococci count (log_{10} cfu/g) was < 2.00 in the fifth day of storage. Meanwhile, by increasing of clove oleoresin up to 200 ppm the Presumptive Staphylococci count (log_{10} cfu/g) immediately after processing reduced to 2.10. These results are similar to those reported by many authors such as **Burt & Reinders, (2003); Moreira et al. (2005)** and **Sofia et al. (2007).**

Regarding the effect of adding coriander oleoresin on the Presumptive Staphylococci count (log_{10} cfu/g), it was not differ ($p<0.05$) from that of clove oleoresin treated raw samples in the first two days of production. At the third day, the effect of coriander oleoresin showed a slight significant lower effect on the Presumptive Staphylococci count than that of clove oleoresin. Finally, it was evident that the combination of both spices oleoresins had nearly the same effect of adding clove oleoresin alone. Coagulase positive Staphylococcus aureus failed to be isolated in all raw and cooked treatment. Salmonellae and E. coli species failed to be isolated in all trials either raw or cooked. That can be attributed to the marination and cooking to sufficient temperature of such product.

Data of correlation matrix (Table 9) clearly indicated presence of slight ($P< 0.05$) to strong correlation ($P< 0.01$) between the different investigated criteria. It is of importance to recognize that there was negative correlation between temperatures with the different

bacteriological attributes of experimentally produced chicken shawarma samples.

Conclusion

From the achieved results it can be concluded that: Clove and coriander oleoresins had significant effect on reduction of all of bacteriological traits in experimentally produced chicken shawarma during chilled storage for 5 days. Clove induced the highest reduction rate. Temperature of the experimentally produced cooked chicken shawarma was negatively correlated to different bacteriological attributes.

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الملخص العربي

تأثير بعض المستخلصات الزيتية للتوابل على الجودة الميكروبيولوجية لشاورمة الدجاج

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تم الإنتاج التجريبي لسبع مجموعات من شاورمة الدجاج، الأولى عبارة عن العينة الضابطة (بدون إضافة أي مستخلص زيتي) أما المجموعة الثانية والثالثة فقد أضيف إليهما المستخلص الزيتي للكسبرة بنسبة 300 و400 جزء في المليون على الترتيب، وبالنسبة للمجموعة الرابعة والخامسة أضيف إليهما المستخلص الزيتي للقرنفل بنسبة 150 و200 جزء في المليون على الترتيب، وأخيراً فأن المجموعة السادسة السابعة أضيف إليهما خليط من المستخلص الزيتي للكسبرة والقرنفل بنسبة (300+150) و(400+200) جزء في المليون على الترتيب، وقد تم فحص المنتجات بعد تصنيعها ولمدة 5 أيام مع الإحتفاظ بهاعند 4م° وقد تم إجراء كل تجربة 3 مرات وتم إخضاع العينات لفحص العد الكلي للميكروبات الهوائية، المجموعة القولونية، المجموعة القولونية البرازية، المكورات العنقودية بالإضافة إلى عزل كل من ميكروب القولون والسالمونيلا والمكورالعنقودي الذهبي إضافة إلى أنه قد تم رصد وتدوين درجات الحرارة والأس الهيدورجيني لجميع المجموعات. وقد دلت نتائج الفحص البكتريولوجي للمجموعات على أن إستخدام المستخلص الزيتي للقرنفل منفرداً كان الأعلى تأثيراً في نهاية مدة الحفظ حيث أدي إستخدامه إلى إنخفاض الحمل البكتيري بالمجموعات التي أضيف لها إنخفاضاً معنوياً عن بقية المجموعات التي لم يضف إليها. و تجدر الإشارة إلى أنه بزيادة نسبة إضافته يزداد تأثيره المثبط على الميكروبات بشكل ملحوظ. وجاء خليط المستخلص الزيتي للكسبرة والقرنفل في المرتبة الثانية من حيث التأثيرعلى الحمل البكتيري بالمنتج. أما المجموعات التي تمت معالجتها بالمستخلص الزيتي للكسبرة منفرداً فقد أنخفض الحمل البكتيري بها عن المجموعة الضابطة وأرتفع عن بقية المجموعات الأخري. هذا ولم يتم عزل أي من الميكروبات الممرضة بكل المجموعات وقد خلصت هذة الدراسة إلى الدراسة إمكانية الإعتماد على المستخلصات الزيتية للتوابل مع طرق الحفظ الأخري في الحد من تكاثر ميكروبات التسمم الغذائي. كما ينصح بإجراء تجارب أخرى بإستخدام خليط من أكثر من مستخلص زيتي لبيان مدى قوتها من عدمه.