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Effect of Rosemary, Basil, and Mint Leaves Extracts on Quality of Chilled Chicken Burger

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ABSTRACT

The objective of this study was to investigate the effect of basil (*Ocimum basilicum* Genovese), mint (*Mentha spicata* L.), and rosemary (*Rosmarinus officinallis* L) leaves extracts on quality attributes of chilled chicken burger. Each of the aqueous or the ethanolic extracts (3% w/v) was added in prepared chicken burgers. The antimicrobial activity of the leaves was studied. Chemical composition, physical characteristics, and sensory evaluation were evaluated for cooked burgers. The physical characteristics included cooking yield, shrinkage, pH value, and water holding capacity, while the chemical characteristics included peroxide value, acid value, total volatile nitrogen, and thiobarbituric acid of chilled prepared chicken burgers stored at 4±1˚C for 14 days. The resulted data indicated that, rosemary extracts appeared to have higher antioxidants activity than mint and basil extracts. The antioxidants activities of 1% rosemary ethanolic extract was moderate (82.09 mg/ ml) compared to BHT (95.86 mg/ ml). All extracts positively inhibited the growth of pathogenic microorganisms with specific emphasis for the ethanolic extract. The sensory evaluation showed no significant differences ($p < 0.05$) between the control samples and the prepared chicken burger samples with the added extracts. The findings of the current study recommend possible use of rosemary, basil, and mint extracts as natural sources of antioxidants and preservatives to extend the burgers shelf life under chilling storage to provide consumers with save healthy chicken burger.

Keywords: Antioxidants Activity, Antimicrobial Activity, Basil, Chicken Burger, Leaves Extracts, Mint, and Rosemary.

INTRODUCTION

The demand for healthy and safe fast food is rapidly increasing in recent years. Poultry meat quality and safety are very important factors for quality insurance of chicken products (Mead, 2004). Poultry flesh has about 23% protein, however some products like sausages and frankfurters contain about 17% protein (Smith, 2001). Several studies covered the quality and stability of burgers using some herbs or medicinal plants as natural sources of antioxidants (Mielnik *et al.,* 2008). *Salmonella, Escherichia coli, Clostridium perfringens*, and *Listeria monocytogenes* are the main food borne pathogens linked with poultry (Corry & Atabay, 2001).

Antioxidants are substances that delay oxidation by inhibiting initial free radical formation or by preventing them from producing more free radicals which can perpetuate the reaction (Fennema, 1996). Many plants like rosemary, basil, and mint have antioxidants activity (Ahn *et al.,* 2007; Rojas & Brewer, 2007; Elansary & Mahmoud 2015; and Elansary *et al.,* 2016).

The antioxidants activities of rosemary (*Rosmarinus officinallis* L) had been investigated by Lawrence *et al*., (2004) and Elansary & Mahmoud (2015). Rosemary contains carnosic acid, carnosol, rosmanol, isorosmanol, rosmariquinone, rosmaridiphenol, and rosemary diphenol. Rosemary extracts had been used in combination with various other antioxidants (McBride *et al*., 2007) to achive a synergistic effect. Also, some previous studies reported that the antibacterial activities of rosemary refer to phenolic diterpenoids (Cuvelier *et al*., 1996). Rosemary extracts (1%) have a strong inhibiting effect on Gram- positive pathogens like *Listeria monocytogenes, Staphylococcus aureus, and Bacillus cereus,* however, it has a poor inhibiting effect on Gram- negative bacteria. *Penicillium* and *Botrytis* genera grew much slower in the media containing rosemary extract (Fernandez- Lopez *et al*., 2005).

Mint (*Mentha spicata* L.) is one of the most popular medicinal plants with broad uses in household, and flavoring materials, as well as in medicines and cosmetic industry. Antioxidant properties of mint allow to prevent cataract and other illnesses connected with ageing. Mint extracts were bacteriostatic against *Staphylococcus aureus, Staphylococcus pyrogens,* and *E. coli* (MimicaDukic *et al*., 2003; Elansary and Mahmoud 2015).

The aim of this work was to compare and evaluate the effect of adding 3% w/v aqueous and ethanolic extracts of rosemary, basil, and mint on chemical composition, antimicrobial activity, physical characteristics, and sensory evaluation of chicken burgers during chilling storage at 4±1˚c for 14 days to produce safe and healthy chicken burgers.

MATERIALS AND METHODS

Materials

Chemicals and plant materials

All chemicals used in this study were of analytical grade and purchased from Sigma Aldrich, Cairo, Egypt. Fresh leaves of basil (*Ocimum basilicum* Genovese), mint (*Mentha spicata* L.), and rosemary (*Rosmarinus officinallis* L) were collected during November 2016. Samples were identified by Dr. Hosam El-Ansary at Department of Floriculture, Ornamental Horticulture and Garden Design, Faculty of Agriculture, University of Alexandria, Egypt.

Chicken flesh

Fresh chicken flesh drumstick and thigh (1:1 w/w) were obtained from a hypermarket, Damietta, Egypt. The chicken fillet was minced by a home mincer then chilled overnight at 4± 1˚ C before manufacturing the burger.

Spices and additives

Spices, sodium chloride, onion, fat and other additives were obtained from Damietta local market.

Microbial strains

Two Gram-positive bacteria; namely, Bacillus *cereus* (ATCC 14579), and *Staphylococcus aureus* (ATCC 6538) as well as two Gram-negative bacteria; namely, *Escherichia coli* (ATCC 35210) and *Salmonella typhimurium* (ATCC 14028) were used. One mold; namely, *Geotrichum candidum* (NRRL 552), and one yeast; namely, *Candida albicans* (ATCC 10231), also three fungus; namely, *Aspergillus niger (*ATCC 102), *Aspergillus flavus (*ATCC

247), and *Fusarium moniliform* (ATCC 206), were used as test organisms to determine the antimicrobial activity. All strains were obtained from the Departments of Plant Pathology and Floriculture, Ornamental Horticulture, Faculty of Agriculture, University of Alexandria, Egypt.

Cultivation media

Potato dextrose medium, nutrient agar, broth media, Barid- Parker agarmedium, Bismuth sulphite agar medium, and Violet Red Bile agar medium were purchased from Sigma Aldrich, Cairo, Egypt.

Methods

Each of the fresh leaves of basil (*Ocimum basilicum* Genovese), mint (*Mentha spicata* L.), and rosemary (*Rosmarinus officinallis* L) were air dried for 24 hours at 60°C، ground, and sieved to prepare dried powders.

Aqueous extract

The air dried powder of each of the selected plants was suspended in cold distilled water (1:4 w/v) for 4 hours at 5ºC and homogenized for 1 min at the top speed of Waring blender. The mixture was filtered through cheese cloth and centrifuged for 15 min at 5000 rpm. The decanted supernatant was filtered through Whatman No.1 filter paper. The filtrates were concentrated by rotatory evaporating apparatus (Fisher-Bioblock 4000, France) at 45 ºC. The water free extracts were stored in dark at 4ºC until used (Daniel *et al*., 2011, and Elansary & Mahmoud, 2015).

Ethanolic extract

Each of the air dried powders of the selected plants was suspended in 80% ethanol (1:4 w/v) in 400 ml beakers. All beakers were covered with aluminum foil paper, shaken and left overnight then filtered. The residue was re-extracted four times with 80% ethanol until it was exhausted. Ethanol was evaporated using vacuum rotary evaporator apparatus at 45◦ C (Fisher-Bioblock 4000, France). The ethanol free extracts were stored in dark at 4ºC until used (Babatunde & Adewumi, 2015).

Chicken burger preparation

Chicken burger samples were prepared according to the method described by Babatunde & Adewumi (2015) with some modifications. The chilled minced chicken flesh was formulated and blended with the other ingredients as shown in Table (1):

Table 1. Ingredients of the chicken burger samples.

Ingredient %	Treatments				
	C1	C2	M	B	R
Minced chicken flesh drumstick and thigh (1:1 w/w)	80.00	79.99	77.00	77.00	77.00
Iced water	9.00	9.00	9.00	9.00	9.00
Finely ground fresh onion	2.80	2.80	2.80	2.80	2.80
Starch	5	5	5	5	5
Sodium chloride	2	2	2	2	2
Spices mixture*	1.2	1.2	1.2	1.2	1.2
Sodium nitrite	-	0.01	-	-	-
Mint extract (aqueous or ethanolic)	-	-	3	-	-
Basil extract (aqueous or ethanolic)	-	-	-	3	-
Rosemary extract (aqueous or ethanolic)	-	-	-	-	3
Total	100	100	100	100	100

***20% white pepper, 10% nutmeg powder, 10% garlic powder, and 50% Arabic chicken seasonings.**

C1: negative control (without preservatives); C2: positive control (with 100 ppm sodium nitrite as preservatives); M: sample with 3 % mint extract; B: sample with 3 % basil extract; R: sample with3 % rosemary extract.

The produced mixture was manually shaped using a stainless burger maker to circular burgers of 10 cm diameter, 0.5 cm thickness. Each piece was separated from the other using polyethylene layer before packaging in foam trays wrapped inside polyethylene bags. All samples were stored in home refrigerator at 4± 1ºC up to 14 days. Samples in three replicates from each batch were subjected to chemical composition, antimicrobial activity, physical characteristics, and sensory evaluation initially and periodically after 7 and 14 days of cold storage.

The effect of addition of selected medicinal plants extracts compared with negative control (without preservatives) and with positive control (with 100 ppm sodium nitrite as preservatives) samples of chicken burger quality attributes were studied.

Analytical methods

Proximate chemical analysis

Moisture, fat, crude protein and ash contents were determined according to the AOAC (A.O.A.C 2005). Total carbohydrates were calculated by differences. Calorific value was estimated as follows: for carbohydrate and protein 4 Cal per gram and for fat 9 Cal per gram (FAO/WHO, 1974). Peroxide and acid values were estimated using the method described by the A.O.A.C., (2005). Total volatile nitrogen and thiobarbituric acid were determined using the methods described by Harold *et al.*, (1987).

Mineral composition

The ash was dissolved in 5 ml of concentrated hydrochloric acid and the volume was completed to 100 ml using distilled water. Sodium (Na), calcium (Ca) and potassium (K) were estimated using Gallen Kamp Flame Analyzer. Iron (Fe), magnesium (Mg), zinc (Zn) and copper (Cu) were estimated using Perkin Elmer Atomic Absorption Spectrophotometer, according to in A.O.A.C (2005).

Microbiological assay

The antimicrobial activity were determined in aqueous and ethanolic extracts of rosemary, basil and mint leaves using the methods described by Elansary &Mahmoud, (2015).

Antioxidant activity

Antioxidant activity assay

The antioxidant capacity of rosemary, basil, and mint leaves dried powder were determined using the methods of 2, 2′-diphenypicrylhydrazyl (DPPH) assay (Elansary and Mahmoud, 2015). The experiments were repeated twice in triplicates. Antioxidant activity was expressed as the percentage using the following equation: (% Antioxidant activity=Abscontrol - Abssample /Abscontrol x 100), Abs =

absorbance at 517 nm. A positive control butylated hydroxytoluene (BHT).

Phytochemical analysis

The crude extract was used for screening of phytochemicals such as saponines, alkaloids, flavonoids, and phenolic acid. Preliminary phytochemical screening was carried out on the plant extracts, according to standard procedures described before (Harborne, 1973 and Okwu, 2005). The aqueous and 80% ethanol extracts of leaves were analyzed for the presence of various phytoconstituents by standard phytochemical tests.

Physical methods

Cooking yield, cooking loss and shrinkage value of cooked chicken burger were determined according to George & Berry (2000). Water holding capacity and plasticity were measured according to the method described by Volovinskaya & Merkoolova (1958).

Cooking method of chicken burger

All the prepared burger samples were grilled, with no added fat, on a non- stick electrical hot plate, for 4 min at 72±1º C on each side. The cooked burgers were prepared just prior to the sensory evaluation.

Sensory evaluation of cooked chicken burger

Samples of cooked chicken burger were evaluated by 12 panelists. A hedonic scale of 1 (very poor), 2-4 (poor), 5-6 (fair), 7-8 (good), and 9-10 (excellent) were used, according to Gelman & Benjamin (1989).

Statistical analyses

The results were presented as means of triplicates ± SD (Standard Deviation). Analysis of variance (ANOVA) was used as implemented in SAS software (Ver. 9.2) at a level of significance of $P \leq 0.05$. Differences among means were determined by Duncan's Multiple Range test (SAS, 2012).

RESULTS AND DISCUSSION

Proximate chemical analysis

Chemical composition of chicken burger

The proximate chemical composition presented in (Table 2), the results showed that minced chicken flesh contained moisture 72.16 %, crude protein 17.94 %, fat 7.74 %, ash 2.08 %, and carbohydrates 0.08%. Raw chicken burger (negative control) contained moisture 70.96 %, crude protein 15.58 %, fat 8.81 %, ash 3.15 %, and carbohydrates 1.50% which is in agreement with EOS (2005). The moisture content of the cooked samples (67.00%) was significantly lower than the uncooked samples, due to the heat treatment. Accordingly, the cooked samples were significantly ($P < 0.05$) higher in protein, fat, ash, and caloric value than the uncooked burgers. This results are comparable with previous studies Mora *et al*., (2011), and Valquı´ria *et al*., (2016).

Table 2. Proximate chemical composition of minced flesh, uncooked, and cooked control chicken burgers.

	Treatment (g/100g sample) (wet basis)				
Factor	***EOS (2005)**	**Minced chicken flesh**	**Uncooked chicken burger (negative control)**	**Cooked chicken burger (negative control)**	**ANOVA**
Moisture	70% or less	$72.16^{a} \pm 0.21$	$70.96^{b} \pm 0.30$	$67.00^{c} \pm 0.32$	< 0.001
Crude protein	Not less than 16%	$17.94^{a} \pm 0.08$	$15.58^{b} \pm 0.36$	$17.51^{a} \pm 0.11$	< 0.001
Fat	12% or less	$7.74^{c} \pm 0.31$	$8.81^{b} \pm 0.13$	$10.59^{a} \pm 0.29$	< 0.001
Ash	About 3%	$2.08^{c} \pm 0.24$	$3.15^{b} \pm 0.28$	$4.79^{a} \pm 0.32$	< 0.001
Carbohydrates	-	$0.08^{b} \pm 0.12$	$1.50^{a} \pm 0.04$	$0.11^{b} \pm 0.08$	< 0.001
Calorific value(Cal /100g)	-	$141.74^{c} \pm 0.27$	$147.61^{b} \pm 0.41$	$165.79^{a} \pm 0.36$	< 0.001

Values are shown as mean± standard deviations, n=3.

Means in a raw which are not followed by the same letter are significantly differed ($p < 0.05$)

There were significant difference ($P < 0.05$) between control samples (C_1, and C_2) and cooked burgers with 3 % aqueous or ethanolic extract. As shown in Table (3), the addition of rosemary, basil, and mint 3 % ethanolic extracts had significant effect ($P < 0.001$) on the nutritional value of the cooked burgers. The highest significant values ($P < 0.001$) of fat content, ash, carbohydrates, and calorific value were for burgers with rosemary extract (10.94, 4.77, 2.14 g/100g, and 175.66 Cal/100g, respectively) compared to the negative control burgers (10.59, 4.49, 0.11 g/100g, and 165.79 Cal/100g, respectively) and positive control burgers (10.70, 4.51, 0.08 g/100g, and 167.38 Cal/100g, respectively). These results are in agreement with Soma *et al*., (2016). While Babatunde & Adewumi (2015) reported that addition of some herbals ethanolic extracts did not affect significantly the nutritional value of the prepared chicken burgers.

Table 3. Proximate chemical composition of cooked chicken burgers with 3% ethanolic extract.

	Treatment (g/100g sample) (wet basis)					ANOVA
Factor	**C_1**	**C_2**	**ME**	**BE**	**RE**	
Moisture	$67.00^{a} \pm 0.32$	$67.02^{a} \pm 0.12$	$64.96^{b} \pm 0.52$	$64.98^{b} \pm 0.52$	$64.99^{b} \pm 0.52$	< 0.001
Crude protein	$17.51^{a} \pm 0.11$	$17.69^{a} \pm 0.24$	$17.11^{b} \pm 0.61$	$17.13^{b} \pm 0.52$	$17.16^{b} \pm 0.52$	< 0.001
Fat	$10.59^{ab} \pm 0.29$	$10.70^{ab} \pm 0.11$	$10.92^{a} \pm 0.69$	$10.99^{a} \pm 0.52$	$10.94^{a} \pm 0.52$	< 0.001
Ash	$4.49^{ab} \pm 0.32$	$4.51^{ab} \pm 0.09$	$4.83^{a} \pm 0.32$	$4.88^{a} \pm 0.52$	$4.77^{a} \pm 0.52$	< 0.001
Carbohydrates	$0.11^{b} \pm 0.08$	$0.08^{b} \pm 0.17$	$2.18^{a} \pm 0.08$	$2.02^{a} \pm 0.52$	$2.14^{a} \pm 0.52$	< 0.001
Calorific value (Cal /100g)	$165.79^{b} \pm 0.36$	$167.38^{b} \pm 0.20$	$175.44^{a} \pm 0.36$	$175.51^{a} \pm 0.36$	$175.66^{a} \pm 0.36$	< 0.001

Values are shown as mean± standard deviations, n=3.

Means in a raw which are not followed by the same letter are significantly differed ($p < 0.05$).

C_1: negative control (without preservatives); C_2: positive control (with 100 ppm sodium nitrite as preservatives); ME: sample with 3 % mint ethanolic extract; BE: sample with 3 % basil ethanolic extract; R: sample with rosemary 3 % ethanolic extract.

Phytochemical screening

The results of the preliminary phytochemical analysis of rosemary, basil, and mint leaves powder are presented in Table (4). Rosemary had significantly ($P < 0.05$) the highest content of protein 3.41 g/100g, and fat 6.19 g/100g, while had the lowest content of carbohydrates 83.11 g/100g. Mint and basil had significantly showed ($P < 0.05$) higher content of ash being 3.59 and 3.15 g/100g, respectively.

Basil had significantly higher ($P < 0.05$) content of iron, potassium, calcium, and magnesium (88.92, 2542, 14, 2159, 23, and 721, 44 mg/100g, respectively). Moreover, it had lower content of sodium (79, 11 mg/100g) compared to mint and basil leaves powder (323, 12 and 149, 12 respectively). These results were in agreement with Daniel *et al*., 2011 and Aluko *et al*., 2012, who reported that basil had high potassium, calcium content and noticeable quantity of magnesium and sodium. All these values were less than those present in other plants leaves (Aliyu *et al*., 2008). The difference in the chemical composition for the same plant species might be attributed to some factors like agriculture environment, geographical area, and the stage of plant growth.

Table 4. Preliminary phytochemical analysis of rosemary, basil, and mint leaves dried powder (dry weight).

Chemical composition (g/100g sample)	Mint	Basil	Rosemary	ANOVA
Crude protein	$1.85^{b} \pm 0.02$	$3.17^{a} \pm 0.16$	$3.41^{a} \pm 0.11$	< 0.001
Fat	$2.37^{b} \pm 0.04$	$1.92^{c} \pm 0.13$	$6.19^{a} \pm 0.01$	< 0.001
Ash	$3.59^{a} \pm 0.04$	$3.15^{a} \pm 0.08$	$1.78^{b} \pm 0.09$	< 0.001
Carbohydrates	$87.93^{b} \pm 0.12$	$88.61^{a} \pm 0.14$	$83.11^{c} \pm 0.23$	< 0.001
Minerals (mg/100g sample)				
Fe	$86.62^{b} \pm 0.08$	$88.92^{a} \pm 0.07$	$28.33^{c} \pm 0.15$	< 0.001
Na	$323.12^{a} \pm 0.15$	$79.11^{c} \pm 0.17$	$149.12^{b} \pm 0.17$	< 0.001
K	$1864.11^{b} \pm 0.17$	$2542.14^{a} \pm 0.24$	$968.11^{c} \pm 0.11$	< 0.001
Ca	$1473.03^{b} \pm 0.04$	$2159.23^{a} \pm 0.09$	$1294.12^{c} \pm 0.14$	< 0.001
Mg	$594.26^{b} \pm 0.02$	$721.44^{a} \pm 0.08$	$224.12^{c} \pm 0.07$	< 0.001
Phytochemicals (mg/g)				
Saponines	$6.16^{a} \pm 0.24$	$4.98^{b} \pm 0.12$	$5.02^{b} \pm 0.09$	< 0.001
Alkaloids	$0.88^{a} \pm 0.17$	$0.62^{b} \pm 0.25$	$0.78^{a} \pm 0.12$	< 0.001
Flavonoids	$18.56^{c} \pm 0.45$	$20.41^{b} \pm 0.22$	$27.27^{a} \pm 0.11$	< 0.001
Phenolic acid	$14.18^{b} \pm 0.32$	$10.26^{c} \pm 0.19$	$56.23^{a} \pm 0.41$	< 0.001

Values are shown as mean± standard deviations, n=3.
Means in a raw which are not followed by the same letter are significantly differed ($p < 0.05$).

The secondary metabolites phytochemicals analysis of the three selected plants leaves powder indicate the presence of saponines, alkaloids, flavonoids, and phenolic acids, as shown in Table (4). Data showed that mint leaves powder recorded the highest saponine content being 6.16 mg/g (dry weight) compared to rosemary and basil leaves which had 5.02, and 4.98 mg/g, respectively. On the other hand, the highest level of alkaloids, flavonoids, and phenolic acid was recorded in rosemary followed by mint and basil, respectively.

Antioxidants activity of ethanolic extracts

As shown in Table (5), the antioxidants activity of mint, basil and rosemary ethanolic extracts are compared with BHT as a positive control using DPPH method. Rosemary extract showed the highest antioxidant activity followed in a descending order by mint and basil extracts. The antioxidants activities of 1% rosemary ethanolic extract was moderate (82.09 mg/ ml) compared to BHT (95.86 mg/ ml). These finding are in agreement with those of Shan *et al*., (2005), who reported that, the antioxidants effect of herbs might be attributed to the phenolic –OH group. Moreover, Dorman *et al.,* (2003) mentioned that, the antioxidants properties of rosemary was not completely explained by the total phenolic content of the extracts, but appeared to be strongly dependent on rosmarinic acid.

Table 5. Antioxidants activity of ethanolic extracts of rosemary, basil, and mint leaves measured by DPPH.

Concentration%	%Total antioxidant activity			BHT
	Mint	Basil	Rosemary	(positive control)
0.1	$48.99^{c} \pm 0.14$	$40.63^{d} \pm 0.12$	$53.41^{b} \pm 0.06$	$64.98^{a} \pm 0.06$
0.2	$55.82^{c} \pm 0.12$	$52.16^{d} \pm 0.09$	$64.45^{b} \pm 0.06$	$81.27^{a} \pm 0.04$
0.4	$59.04^{c} \pm 0.05$	$55.73^{d} \pm 0.06$	$72.81^{b} \pm 0.06$	$88.23^{a} \pm 0.08$
0.8	$62.78^{c} \pm 0.02$	$60.01^{d} \pm 0.11$	$78.27^{b} \pm 0.06$	$93.56^{a} \pm 0.05$
1.0	$67.81^{c} \pm 0.08$	$65.65^{d} \pm 0.07$	$82.09^{b} \pm 0.06$	$95.86^{a} \pm 0.07$

Values are shown as mean± standard deviations, n=3.
Means in a raw which are not followed by the same letter are significantly differed ($p < 0.05$).

Antimicrobial activity of aqueous and ethanolic extracts

Antimicrobial activity of rosemary, basil, and mint extracts (aqueous and ethanolic) were studied against two Gram-positive bacteria (*Bacillus cereus,* and *Staphylococcus aurous*), two Gram-negative bacteria (Escherichia *coli*, and *Salmonella typhimurium),* and one mold *Geotrichum candidum*, and one yeast *Candida albicans* as presented in Table (6).

The data show that the inhibition zone ranged from 9 to 34 mm. *Bacillus cereus* and *Staphylococcus aureus* showed inhibition zone of 33 mm at 3% for rosemary ethanolic extract. The rosemary ethanolic extracts showed higher activity against *Candida*

albicans, and *Geotrichum candidum*, where the inhibition zone was 34 and 32 mm at a concentration of 3%, respectively. The rosemary, basil, and mint extracts markedly inhibited the growth of most of the bacteria strained used in the present study. However, the effects differed with regard to the extracts type (aqueous and/ or ethanolic), extracts concentrations, and bacteria species. In general, ethanolic extracts showed strong antimicrobial activity in the ratio ranged between 1- 3%. These data were in agreement with previous studies (Mimica Dukic *et al*., 2003, Elansary and Mahmoud 2015, Vidhani *et al*., 2016**)**, they reported that mint and basil extracts were bacteriostatic against *Staphylococcus aureus, Staphylococcus pyrogens, Serratia marcescens, Escherichia coli, and Mycobacterium avium.* Also, Moreno *et al*. (2006) mentioned that, rosemary leaves were a very rich source of phenolic compounds with high antimicrobial activity against both Gram-negative and Gram-positive bacteria. Its antimicrobial activity might be attributed to carnosol and carnosic acids.

Table 6. Antimicrobial activity of selected plants aqueous and ethanolic extracts of rosemary, basil, and mint leaves.

Isolates	*Inhibition zones (mm)							
Conc%	0.25	0.50	0.75	1.0	1.5	2.0	2.5	3.0
Mint aqueous extracts								
Bacillus cereus(ATCC 14579)	0	0	0	0	12±0.02	13±0.07	14±0.05	17±0.04
Staphylococcus aureus (ATCC 6538)	0	0	0	0	0	0	11±0.02	13±0.03
Escherichia coli (ATCC 35210)	0	0	0	0	0	0	10±0.08	11±0.06
Salmonella typhimurium (ATCC 14028)	0	0	0	0	0	0	0	10±0.08
Geotrichum candidum (NRRL 552)	0	0	0	0	0	14±0.03	15±0.07	15±0.02
Candida albicans (ATCC 10231)	0	0	0	0	0	13±0.05	15±0.02	16±0.03
Mint ethanolic extracts								
Bacillus cereus (ATCC 14579)	0	0	16±0.09	17±0.06	28±0.03	30±0.02	30±0.04	32±0.04
Staphylococcus aureus (ATCC 6538)	0	0	13±0.06	15±0.11	18±0.07	22±0.04	22±0.09	22±0.02
Escherichia coli (ATCC 35210)	0	0	0	16±0.02	18±0.01	21±0.06	23±0.02	23±0.08
Salmonella typhimurium (ATCC 14028)	0	0	0	0	13±0.02	17±0.04	17±0.02	17±0.01
Geotrichum candidum (NRRL 552)	0	15±0.02	17±0.07	19±0.08	21±0.04	22±0.03	22±0.06	22±0.03
Candida albicans (ATCC 10231)	0	0	15±0.11	16±0.12	18±0.06	21±0.02	23±0.01	23±0.02
Basil aqueous extracts								
Bacillus cereus (ATCC 14579)	0	0	0	0	9±0.03	10±0.03	11±0.06	12±0.01
Staphylococcus aureus (ATCC 6538)	0	0	0	0	0	0	9±0.04	10±0.07
Escherichia coli (ATCC 35210)	0	0	0	0	0	0	9±0.08	10±0.03
Salmonella typhimurium (ATCC 14028)	0	0	0	0	0	0	0	9±0.05
Geotrichum candidum (NRRL 552)	0	0	0	0	0	11±0.13	12±0.02	12±0.08
Candida albicans (ATCC 10231)	0	0	0	0	0	10±0.02	12±0.11	13±0.02
Basil ethanolic extracts								
Bacillus cereus (ATCC 14579)	0	0	13±0.08	14±0.05	25±0.09	28±0.01	28±0.02	30±0.04
Staphylococcus aureus (ATCC 6538)	0	0	10±0.12	12±0.02	16±0.04	20±0.09	20±0.04	20±0.02
Escherichia coli (ATCC 35210)	0	0	0	13±0.08	14±0.02	19±0.07	21±0.03	21±0.06
Salmonella typhimurium (ATCC 14028)	0	0	0	0	10±0.06	14±0.08	14±0.04	14±0.02
Geotrichum candidum (NRRL 552)	0	13±0.11	15±0.04	17±0.04	19±0.02	20±0.11	20±0.02	20±0.02
Candida albicans (ATCC 10231)	0	0	11±0.07	13±0.03	15±0.11	19±0.09	21±0.03	21±0.05
Rosemary aqueous extracts								
Bacillus cereus (ATCC 14579)	0	12±0.03	13±0.07	16±0.01	17±0.05	20±0.14	22±0.02	25±0.08
Staphylococcus aureus (ATCC 6538)	0	13±0.06	16±0.04	18±0.05	21±0.13	22±0.06	22±0.04	26±0.16
Escherichia coli (ATCC 35210)	0	0	0	0	13±0.02	16±0.09	18±0.08	19±0.11
Salmonella typhimurium (ATCC 14028)	0	0	0	11±0.08	14±0.11	16±0.03	19±0.02	21±0.07
Geotrichum candidum (NRRL 552)	0	0	11±0.02	14±0.04	17±0.06	19±0.08	22±0.15	23±0.04
Candida albicans (ATCC 10231)	0	11±0.02	15±0.04	18±0.09	21±0.04	23±0.02	24±0.09	28±0.03
Rosemary ethanolic extracts								
Bacillus cereus (ATCC 14579)	16±0.03	16±0.11	24±0.01	30±0.05	32±0.01	32±0.06	33±0.08	33±0.09
Staphylococcus aureus (ATCC 6538)	13±0.03	13±0.07	20±0.06	26±0.12	28±0.06	33±0.08	33±0.04	33±0.04
Escherichia coli (ATCC 35210)	12±0.06	12±0.03	17±0.05	20±0.08	22±0.03	24±0.04	24±0.08	26±0.06
Salmonella typhimurium (ATCC 14028)	0	0	16±0.08	19±0.07	25±0.02	27±0.03	27±0.07	27±0.07
Geotrichum candidum (NRRL 552)	12±0.04	12±0.01	19±0.09	24±0.03	28±0.08	31±0.03	31±0.04	32±0.12
Candida albicans (ATCC 10231)	16±0.08	16±0.13	20±0.07	27±0.02	32±0.03	32±0.05	32±0.11	34±0.16

Values are shown as mean± standard deviations, n=3.
***The inhibition zone is measured in millimeters, including the hole of 8 mm in diameter.**

Antifungal activity of selected plants aqueous and ethanolic extracts

As seen in Table (7), the antifungal activity of rosemary, basil, and mint extracts differed according to the concentration as compared with the control. The antifungal activities expressed as inhibition zone of the mint aqueous extracts (3%) against three fungus strains; namely, *Aspergillus niger, Aspergillus flavus,* and *Fusarium moniliform* were 11, 13, and 11, respectively. The same effect was observed with the mint ethanolic extracts, which was in agreement with Hulin *et al*., (1998). In the case of rosemary 3% aqueous extracts,

Aspergillus flavus showed the higher inhibition zone followed by *Fusarium moniliform, and Aspergillus niger* being 31, 26, and 25, respectively. The inhibition zone was higher in the rosemary ethanolic extracts than its aqueous extracts. These data were in agreement with Bozin *et al*., (2007).

Phenolic compounds considered as strong antioxidants which were successful in inhibiting the growth of some pathogenic microorganisms (Khoobchandani *et al*., 2010), while Saponins act as antifungal (Sapna *et al*., 2009). The action for flavonoids and phenolic compounds on microbes might be attributed to their binding to cell walls and enzymes inactivation. Futher, the alkaloids intereolate into the cell wall and bind with DNA (Frankel *et al*., 1996).

Table 7. Antifungal activity of selected plants aqueous and ethanolic extracts of rosemary, basil, and mint leaves.

Isolates	*Inhibition zones (mm)				
	Conc% 1.0	1.5	2.0	2.5	3.0
Mint aqueous extracts					
*Aspergillus niger (*ATCC 102)	0	0	0	10±0.05	11±0.03
Aspergillus flavus (ATCC 247)	0	0	0	12±0.02	13±0.01
Fusarium moniliform (ATCC 206)	0	0	0	0	11±0.07
Mint ethanolic extracts					
*Aspergillus niger (*ATCC 102)	0	0	10±0.11	12±0.07	13±0.04
Aspergillus flavus (ATCC 247)	0	0	12±0.13	15±0.09	16±0.07
Fusarium moniliform (ATCC 206)	0	0	9±0.04	13±0.11	16±0.02
Basil aqueous extracts					
*Aspergillus niger (*ATCC 102)	0	0	0	9±0.06	10±0.08
Aspergillus flavus (ATCC 247)	0	0	0	10±0.11	12±0.06
Fusarium moniliform (ATCC 206)	0	0	0	0	10±0.12
Basil ethanolic extracts					
*Aspergillus niger (*ATCC 102)	0	0	9±0.09	10±0.03	11±0.04
Aspergillus flavus (ATCC 247)	0	0	10±0.11	13±0.07	15±0.06
Fusarium moniliform (ATCC 206)	0	0	9±0.07	12±0.09	15±0.04
Rosemary aqueous extracts					
*Aspergillus niger (*ATCC 102)	0	9±0.03	13±0.14	21±0.02	25±0.08
Aspergillus flavus (ATCC 247)	0	9±0.11	19±0.06	26±0.04	31±0.16
Fusarium moniliform (ATCC 206)	0	9±0.02	15±0.03	22±0.08	26±0.11
Rosemary ethanolic extracts					
*Aspergillus niger (*ATCC 102)	9±0.06	10±0.03	19±0.12	28±0.05	32±0.07
Aspergillus flavus (ATCC 247)	0	14±0.02	27±0.08	34±0.07	39±0.11
Fusarium moniliform (ATCC 206)	0	11±0.03	26±0.07	29±0.06	45±0.11

Values are shown as mean± standard deviations, n=3.
***The inhibition zone is measured in millimeters, including the hole of 8 mm in diameter.**

Sensory evaluation of cooked chicken burgers

The mean taste panel scores for the hot cooked chicken burgers containing plant extracts (3 % aqueous or ethanolic) were shown in Table (8). Sensory evaluation is an important indicator of potential consumer preferences. Sensory attributes (general appearance, internal colur, odur, taste, texture, and overall palatability) were evaluated by 12 randomly chosen panelists. The analysis of the sensory data revealed that no significant differences ($p < 0.05$) were found among all the tested samples replicates and /or panelists. However, ANOVA test showed significant differences ($p < 0.05$) in the sensory evaluation among general appearance, taste, and texture of 3% mint and/ or basil ethanolic extracts compared with the control and other samples. On the basis of the data of sensory evaluation and statistics data analysis, it could be concluded that addition up to 3% mint, basil, rosemary extracts either aqueous and/or ethanolic extracts to chicken burgers had no high significant differences ($p < 0.05$) on the different sensory evaluation attributes of burgers. These data were in agreement with George and Berry, (2000).

Table 8. Sensory evaluation profile of cooked chicken burgers.

Factor	C1	C2	MA	ME	BA	BE	RA	RE
General appearance	9.70±0.45 ^{a}	9.64±0.58^{a}	9.23±0.41^{b}	9.37±0.34 ^{ab}	9.27±0.26^{b}	9.21±0.22 ^{b}	9.60±0.35 ^{a}	9.63±0.21 ^{a}
Internal color	9.13±0.47^{a}	9.17±0.65^{a}	9.10±0.32^{a}	9.07±0.41^{a}	9.07±0.34^{a}	9.03±0.55^{a}	9.09±0.26^{a}	9.11±0.45^{a}
Odor	9.53±0.35^{a}	9.50±0.42^{a}	9.50±0.21^{a}	9.43±0.57^{a}	9.53±0.43^{a}	9.57±0.64^{a}	9.53±0.32^{a}	9.60±0.41^{a}
Taste	9.60±0.42^{a}	9.60±0.31^{a}	9.50±0.26^{a}	9.37±0.34^{ab}	9.53±0.28^{a}	9.33±0.31^{ab}	9.57±0.52^{a}	9.53±0.63^{a}
Texture	9.63±0.26^{a}	9.63±0.28^{a}	9.27±0.51^{ab}	9.33±0.47^{ab}	9.23±0.21^{ab}	9.37±0.25^{ab}	9.57±0.31^{a}	9.57±0.24^{a}
Overall palatability	9.77±0.61^{a}	9.80±0.41^{a}	9.63±0.43^{a}	9.30±0.73^{a}	9.37±0.35^{a}	9.43±0.35^{a}	9.57±0.35^{a}	9.63±0.35^{a}

Values are shown as mean± standard deviations, n=3.
Means in a column which are not followed by the same letter are significantly differed ($p < 0.05$).
C1: negative control (without preservatives); C2: positive control (with 100 ppm sodium nitrite as preservatives); MA: sample with 3 % mint aqueous extract; ME: sample with 3 % mint ethanolic extract; BA: sample with 3 % basil aqueous extract; BE: sample with 3 % basil ethanolic extract; RA: sample with 3 % rosemary aqueous extract; RE: sample with 3 % rosemary ethanolic extract.

Physical characteristics attributes of cooked chicken burgers

The effect of cold storage (4 ± 1°C for 14 days) on cooking yield, shrinkage, pH value, and water holding capacity, of prepared chicken burgers were presented in Figure (1). Cooked chicken burgers with 3% rosemary ethanolic extract showed the highest initial cooking yield of 87.19%, while both of the control samples showed lower initial cooking yield of 84.12% (positive control burger), and 83.89% (negative control burger). Also, all burgers, during cold storage for 14 days, decreased significantly ($p < 0.05$) in the cooking yield values.

The cooking loss might be attributed to moisture loss during cooking (Alakali *et al*., 2010). The data exhibited that the cooking loss of all burgers samples increased significantly ($p < 0.05$) with increasing storage period up to 14 days at 4±1ºC. The rosemary samples showed the lower initial cooking loss (15.01 RA and 14.45 RE) and reached to (18.83 RA and 17.16 RE) after cold storage for 14 days at 4±1ºC. These finding were in agreement with Gibriel *et al*., (2007), and Babatunde & Adewumi (2015) who reported that, the cooking loss progressively increased with prolonged storage period.

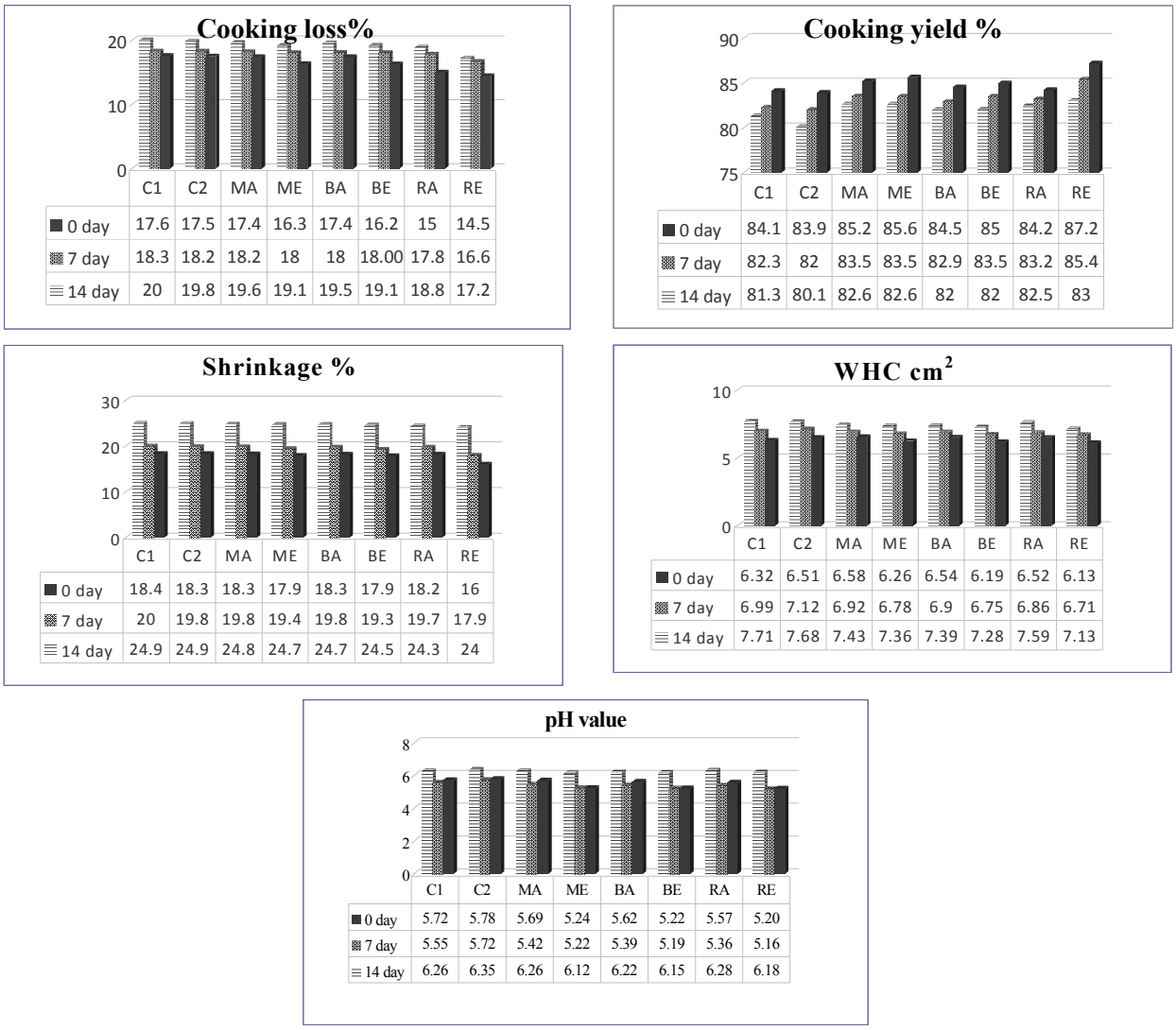

Figure 1. Physical characteristics attributes of cooked chicken burgers

C1: negative control (without preservatives); C2: positive control (with 100 ppm sodium nitrite as preservatives); MA: sample with 3 % mint aqueous extract; ME: sample with 3 % mint ethanolic extract; BA: sample with 3 % basil aqueous extract; BE: sample with 3 % basil ethanolic extract; RA: sample with 3 % rosemary aqueous extract; RE: sample with 3 % rosemary ethanolic extract.

Shrinkage (%) was presented in Figure 1. All burgers with 3% ethanolic extract showed the lowest reduction at zero time (17.91 ME, 17.88 BE, and 16.04 RE) and reached to (24.69 ME, 24.52 BE, and 24.01 RE) after cold storage up to 14 days at 4±1°C. Shrinkage in burgers diameters was the ultimate outcome of two factors moisture and cooking loss during cooking and storage. These results were in agreement with Madkour *et al*., (2000), and Gibriel *et al*., (2007). They reported that burger samples with high moisture loss and low cooking yield showed the highest shrinkage in diameter after cold storage. However, several reports indicated that burger weight loss and shrinkage might be attributed to added fibers or protein matrix during cooking and moisture loss (Turhan *et al*., 2009; Kurt & Kılınççeker, 2011; Aly *et al*., 2013).

The water holding capacity (WHC cm^2) of all samples showed major decreases with the increase of external zones during cold storage period. All burgers with 3% ethanolic extract showed the lowest reduction at zero time (6.26 ME, 6.19 BE, and 6.13 RE) and reach bcvhed to (7.36 ME, 7.28 BE, and 7.13 RE) after cold storage up to 14 days at 4±1°c. Meanwhile, both control samples had the highest WHC values after cold storage up to 14 days at 4±1°C.

pH values of prepared chicken burgers through cold storage (4±1°C for 14 days) were given in Figure 1. All samples showed slight decreases in pH values during storage up to 6 days, while after 14 days there was an increases in pH values. The pH values ranged from 5.20 to 5.72 at zero time and from 6.12 to 6.35 after cold storage for 14 days at 4±1°C. The slight decreased in pH values after the first week of cold storage for all burgers samples could be attributed to the glycogen breakdown with the formation of lactic acid. However, the slight increase in pH values after 14 days' storage could be attributed to the partial protein hydrolysis with the formation of free alkaline group (Madkour *et al*., 2000; and Gibriel *et al*., 2007).

Chemical characteristics of chicken burgers

The results of peroxide value were presented in Table (9). Peroxide values of all the prepared burgers increased significantly ($p < 0.05$) with prolong of storage period. The burgers with 3% ethanolic extracts of rosemary, basil, and mint exhibited the lowest peroxide values during the storage period being 5.61, 6.55, and 6.40% m.eq o2/kg, respectively. These data were in agreement with that of Georgantelis *et al*., (2007), and Darwish *et al*., (2012).

Table 9. Chemical characteristics of chicken burgers during chilled storage for14 days at 4±1°C

Storage period (Days)	Treatments							
	C1	C2	MA	ME	BA	BE	RA	RE
Peroxide value (m.eq o2/kg)								
0	2.56^{c}±0.23	2.61^{c}±0.16	2.63^{c}±0.32	2.42^{c}±0.28	2.65^{c}±0.22	2.45^{c}±0.17	2.55^{c}±0.11	2.32^{c}±0.34
7	3.88^{b}±0.17	3.94^{b}±0.22	3.99^{b}±0.43	3.40^{b}±0.22	4.12^{b}±0.09	3.49^{b}±0.28	3.26^{b}±0.19	3.01^{b}±0.51
14	7.11^{a}±0.14	7.23^{a}±0.26	7.29^{a}±0.63	6.40^{a}±0.29	7.32^{a}±0.16	6.55^{a}±0.33	7.08^{a}±0.24	5.61^{a}±0.46
Acid value as (% Oleic acid)								
0	0.99^{c}±0.27	0.95^{c}±0.31	0.97^{c}±0.28	1.05^{c}±0.12	0.98^{c}±0.29	1.08^{c}±0.52	1.03^{c}±0.27	1.04^{c}±0.41
7	3.11^{b}±0.62	3.25^{b}±0.22	3.19^{b}±0.42	2.76^{b}±0.28	3.21^{b}±0.27	2.84^{b}±0.37	3.31^{b}±0.29	2.01^{b}±0.19
14	5.82^{a}±0.34	5.96^{a}±0.26	5.91^{a}±0.36	5.32^{a}±0.41	5.95^{a}±0.23	5.41^{a}±0.24	5.84^{a}±0.25	4.92^{a}±0.24
TVN content (mg/100g)								
0	17.04^{c}±0.32	17.21^{c}±0.28	16.79^{c}±0.18	16.86^{c}±0.21	16.80^{c}±0.28	16.89^{c}±0.25	16.94^{c}±0.24	16.32^{c}±0.11
7	22.10^{b}±0.24	22.26^{b}±0.22	21.92^{b}±0.30	19.96^{b}±0.25	21.99^{b}±0.33	20.01^{b}±0.46	21.82^{b}±0.31	19.36^{b}±0.32
14	25.37^{a}±0.19	25.49^{a}±0.41	25.01^{a}±0.29	21.62^{a}±0.18	25.16^{a}±0.19	21.77^{a}±0.21	24.36^{a}±0.18	20.42^{a}±0.26
TBA value as (mg malonaldehyde/ kg)								
0	0.99^{c}±0.26	0.95^{c}±0.11	0.92^{c}±0.19	0.98^{c}±0.23	0.93^{c}±0.32	0.99^{c}±0.17	0.93^{c}±0.28	0.90^{c}±0.16
7	2.92^{b}±0.28	2.93^{b}±0.24	2.93^{b}±0.51	2.35^{b}±0.46	2.93^{b}±0.16	2.41^{b}±0.34	1.94^{b}±0.52	1.88^{b}±0.34
14	4.26^{a}±0.31	4.33^{a}±0.19	3.92^{a}±0.43	3.57^{a}±0.25	3.95^{a}±0.19	3.61^{a}±0.22	2.91^{a}±0.13	2.63^{a}±0.52

Values are shown as mean± standard deviations, n=3.
TVN: total volatile nitrogen; TBA: thiobarbituric acid.
Means in a column which are not followed by the same letter are significantly differed ($p < 0.05$).

Acid value was an important factor for products quality control, which indicated lipid degradation during processing, cooking, and cold storage. The free fatty acids partially resulted from hydrolysis of food lipid as well as from further oxidation of the secondary oxidation products (aldehydes and ketones) formed during cold storage, according to Kun, (1988). The acid value of the prepared chicken burgers showed highly significant increase ($p < 0.05$) during cold storage. The oleic acid percentage for negative control sample (C1) was increased from 0.99 at zero time to 5.82 % at the end of the cold storage period. The positive control sample (C2) presented the highest acid value (5.96) at 4±1°c for 14 days. However, the burgers with 3% ethanolic extracts (rosemary, basil, and mint) presented the lowest acid values during the storage period (4.92, 5.41, and 5.32% oleic acid, respectively). These finding were in agreement with McBride *et al*., (2007); Sokovic *et al*., (2009); Darwish *et al*., (2012); and Babatunde and Adewumi, (2015).

Total volatile nitrogen (TVN) content is an indicator for protein decomposition caused by microorganisms and/or tissue proteolytic enzymes during storage (Gibriel *et al*., 2007). As shown in Table (9), all burgers samples at zero time had non-significant difference ($p < 0.05$) of the TVN values. However, there values significantly increased ($p < 0.05$) during the storage period up to 14 days. Results also revealed that, both control samples (C1, and C2) had a

higher TVN content (17.04, and 17.21mg/100g, respectively) at zero time and continuously increased to be 25.37, and 25.49 mg/100g, respectively after 14 days at 4±1ºC. Whereas, burgers with 3% ethanolic extracts (rosemary, basil, and mint) presented the lowest TVN values (20.42, 21.77, and 21.62 mg/100g, respectively) during storage period for 14 days. The increase the TVN values might be attributed to the break-down of the nitrogenous substances caused by microbial activity (Madkour *et al*., 2000; and Gibriel *et al*., 2007, and Darwish *et al*., 2012).

TBA values (thiobarbituric acid as mg malonaldehyde/ kg) of the prepared chicken burgers were presented in Table (9). Data reflected that, all samples had a very close TBA values inclined to significant increase ($p < 0.05$) during storage period. Both of the control samples (C1, and C2) had a higher TBA values (4.26, and 4.33 mg malonaldehyde/ kg, respectively) after 14 days of storage at 4±1 °C. The rosemary burgers presented the lowest TBA values (2.91, and 2.63 mg malonaldehyde/ kg, respectively) during storage period up to 14 days. The previous data were in agreement with Gibriel *et al*., (2007), and Darwish *et al*., (2012).

CONCLUSION

It could be concluded that the addition of 3% aqueous and ethanolic extracts of basil (*Ocimum basilicum* Genovese), mint (*Mentha spicata* L.), and rosemary (*Rosmarinus officinallis* L) to chicken burgers provide remarkable antimicrobial and antioxidants activities which showed benefits to raw chicken burgers during chilling cold storage up to 14 days at 4 ± 1ºC. The results also showed that rosemary extracts appeared to have higher antioxidants influence than mint and basil extracts. The effect differed in regard to the extract with aqueous or ethanolic, concentration, type of microorganisms, and chilling storage duration. The sensory evaluation test showed no significant differences ($p < 0.05$) among the control samples and the prepared chicken burger samples with plants extracts. These finding could high light the fact that rosemary, basil, and mint extracts could be used in food industries as natural sources of antioxidants that extend the burgers shelf life under cold storage and accordingly, provide the consumers with healthy chicken burgers.

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تأثير أضافة مستخلصات أوراق الروزمارى و الريحان و النعناع على جودة برجر الدجاج المبرد

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تهدف هذه الدراسة لدراسة تأثير اضافة مستخلصات نباتات الروزمارى (*Rosmarinus officinallis.* L) و الريحان (*Ocimum basilicum* Genovese) و النعناع (*Mentha spicata.* L) على جودة برجر الدجاج المبرد على ٤˚م ± ١ لمدة ١٤ يوم .استخدم نوعين من المستخلصات النباتية للأوراق(المائى و الايثلى) بنسبة ٣ % فى اعداد عينات برجر الدجاج. تم تقدير التركيب الكيميائى و النشاط الميكروبى و الخصائص الفيزيائية و الصفات الحسية لعينة الكنترول مقارنة مع البرجر المطبوخ و المحتوى على مستخلصات النباتات المستخدمة. و أشارت النتائج إلى ان نشاط مضادات االأكسدة لمستخلصات الروزمارى كان أعلى من مستخلصات النعناع و الريحان مع ذلك اظهر مستخلص الروز مارى بتركيز ١% نشاط متوسط لمضادات الأكسدة (٨٢,٠٩ ملجم/ مل) مقارنة بالبيتوليدهيدروكسى تلوين و حامض الاسكوربيك . جميع المستخلصات اظهرت نتائج ايجابية على تقليل نمو الميكروبات الممرضة. بالاضافة لذلك تم دراسة التأثير على الخواص الطبيعية (عائد الطبخ – الانكماش – رقم pH – القدرة على الاحتفاظ بالماء) و الخصائص الكيميائية (رقم البيروكسيد – رقم الحموضة – النيتروجين المتطاير الكلى – حامض الثيوباربيتيورك) لعينات البرجر المبردة على ٤˚م ± ١ لمدة ١٤ يوم. أوضحت اختبارات جودة الخواص الحسية عدم وجود فروق معنوية بين عينات الكنترول و العينات المضاف لها مستخلصات الأوراق. و مما سبق ذكره تخلص هذه الدراسة إلى امكانية استخدام مستخلصات الريحان والنعناع و الروزمارى كمصدر طبيعى لمضادات الاكسدة بهدف زيادة فترة صلاحية برجر الدجاج المبرد بهدف إمداد المستهلك ببرجر صحى أمن خالى من المواد الحافظه الكيماوية.