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Utilization of Lemongrass Leaves Powder (*Cymbopogon citratus*) in Improving Beef Burger

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Abstract

This study aimed to prepare beef burger formulae by substituted of beef meat by dried lemongrass with different ratio 1.0, 2.0 and 3.0%. Chemical composition, lipid oxidation, microbiological and organoleptic evaluation were investigated during frozen storage at -20o for three months. Results indicated that Moisture, protein and fat were determined in both raw and cooked beef burgers. Thiobarbituric acid, peroxide number and total bacterial count were determined in beef burgers during frozen storage period for three months at - 20°C. Results indicated that both moisture and protein were decreased as the storage period proceeded, while total lipids were increased. Storage deteriorated diameter retention, moisture retention and cooking loss were increased during frozen storage. Cooking yield was increased by storage time. As the storage period increased, the thiobarbituric acid (TBA) values were increased for all beef burgers. The higher value was found in control sample and the lowest was found in 3.0% lemongrass. Total bacterial counts to prepared beef burgers was decreased as the level of lemongrass increased . During frozen storage the number of bacteria was gradually decreased. Lemongrass showed an antibacterial effect. Organoleptic evaluation of prepared beef burgers was recorded highly score of all sensory properties and also highly acceptable by the panelists. The formulae contained 1.0% lemongrass showed the best acceptability.

Key words: antioxidants, antimicrobial, beef burger, Lemongrass Leaves Powder, and sensory evaluation.

INTRODUCTION

Lemongrass (*Cymbopogon citratus*) is an aromatic herb, notable within the North and West tropical Africa, in Peninsula and in Egypt (Khadri *et al*., 2010). Lemongrass a tall perennial grass comprising of concerning fifty-five species, is native to heat region and grows in the majority tropical and subtropical countries (Cheel *et al*., 2005). The biologically active constituent of lemon grass is citral constituting over 75 % (w/w) of its essential oil (Huynh *et al*., 2008). It is wide used as an herb in Asian preparation, contains a delicate citrus flavor and may be dried and fine, or used as contemporary. It is usually employed in teas, soups, and curries, is also appropriate for poultry, fish, beef, and food. Moreover, lemongrass is employed as a preservative (Shadab *et al*., 1992). Also, lemongrass essential oil is applied for its healthful price to cure skin problem, oily skin, flatulence, headaches, and blood circulation issues (Pearson, 2010).

Lemongrass could be wealthy supply of citral, that is employed in perfumery, pharmaceutical industries, and bioactive compounds (flavonoids and nutriment C). The natural flavonoids are attracting additional and more attention not solely because of their antioxidant properties, however conjointly as anti-carcinogenic medication and anti-inflammatory agents owing to their lipid anti-peroxidation effects (Martin *et al*., 2002). Flavonoids extracted from lemongrass are of appreciable interest as natural plant elements with antioxidant and antifungal activity. Moreover, of the flavonoids gift in lemongrass, licochacone A and licochacone B that have equal antioxidant activity of fat-soluble vitamin and glabrene which is three times as active in comparison with vitamin E (Abd-El Fattah *et al*., 2010).

Lemongrass is often employed in folk's medication for treatment of nervous and duct disturbances, and as an antispasmodic agent, analgesic, anti-inflammatory, anti-pyretic, a diuretic drug and a sedative (Lodhi *et al*., 2014). It contains active ingredients like myrcene, an anti-bacterial and also the pain relievers, citronella, and geraniol (Blanco *et al*., 2009). Asian country is that the largest producer of lemongrass of that concerning 80% is exported (Leite *et al*. (2000). Stability of lipid in

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meats and meat merchandise could be a vital issue, that has influence on quality and shopper acceptableness (Mitsumoto *et al*., 2005).

Lemongrass contains many bioactive compounds, that are helpful in many health problems and are found in leaves (Olorunnisola *et al*., 2014). Oxidative processes cause degradation of lipids and proteins and are one among the first mechanisms of quality deterioration with limiting the time period in meat and meat merchandise (Lui *et al*., 2010). Microbial contamination will cause major public health hazards and economic loss in terms of malady and meat spoilage (Kingchaiyaphum and Rachtanapun ,2012).Thus, the applying of appropriate agents possessing each antioxidant and antimicrobial activities could also be helpful for maintaining meat quality, extending shelf-life and preventing economic loss (Yin and Cheng,2003). Varied efforts are conducted to seek out natural alternatives to forestall microorganism and flora growth also to inhibit the oxidation process in foods.

It is worthy to notice that the demand for healthful herb (i.e. plants contain phytochemicals) has begun to grow and gain quality. Chaisawadi *et al*., (2003) reported that a number of the chosen healthful herbs of food ingredients (e.g. coriander, ginger, lemongrass, and sweet basil,…etc) had antimicrobial activity, also the potential use of lime peel as natural antimicrobial have also been confirmed. Since, the worldwide trend towards the employment of natural additives in food; natural healthful plants/herbs are thought of a very important target to be investigated so as to produce a replacement supply of natural antioxidants and/or antimicrobial agents from a security read purpose. Therefore, the current study is interested to use natural antioxidant and antimicrobial compounds from lemongrass for food preservation (Nieto *et al*., 2010). Lemongrass offers around 22.2 calories together with 4.59 g protein, 0.96 g sugar and 1.80 mg antioxidant per 100 g of powder.

The aim of this study was to evaluate the effects of added lemongrass (powder) in beef burger on its quality attributes and evaluated the antimicrobial and natural antioxidants, chemical analysis, physical characteristics, thiobarbituric acid reactive substances (TBARS), peroxide number, microbiological and sensory evaluation were determined in burger samples throughout frozen storage at -20°C for three months.

MATERIALS AND METHODS

The Lemongrass (*Cymbopogon citratus*) were obtained from Station of the Desert Research Center at Khamisa Village , Siwa Oasis, Egypt . Also, (ground beef meat, spices, white and black pepper, onion powder, garlic powder and salt) were obtained from the local market, Cairo, Egypt.

Preparation of lemongrass powder:

Lemongrass were selected and washed with clean tap water for several times in order to remove possible saponin residues. The lemongrass leaves were dried by spread fresh leaves for 10 days at sun drying. Lemongrass were ground into fine powder using a high-speed blender mill (25000/min), (WK-1000A; Qing Zhou Machinery Co., Ltd.), and then stored in polyethylene bags at 4°C until analysis.

Preparation of beef burgers:

Four beef burger formulae were prepared from beef meat and replaced of beef meat by lemongrass powder with different ratio (1.0, 3.0 and 5.0%) as shown in the Table (1).

Each formula was mixed with all ingredients and formed into beef burgers using a burger forming machine (Expro. Co., Shanghai, China) with a diameter of 8 cm. The beef burgers were cooked for 20 min in a pre-heated hot-air oven at 180 ± 1°C to an internal temperature of 75°C measured at the geometrical center using a digital probe thermometer (Oakton, Eutech Instruments, China), to ensure a uniform cooking. Then the beef burgers were turned over at 5 min intervals. Three sample replicates from each formula were evaluated for their quality attributes.

Table (1): Ingredients (%) of formulated of beef burgers.

Ingredients	Lemongrass powder (%)			
	Control	LG (1.0%)	LG (3.0%)	LG (5.0%)
Lean meat	71.0	70.0	68.0	66.0
Added fat	10.0	10.0	10.0	10.0
Cold water	15.4	15.4	15.4	15.4
Salt	1.0	1.0	1.0	1.0
White pepper	0.2	0.2	0.2	0.2
Black pepper	0.2	0.2	0.2	0.2
Garlic powder	0.2	0.2	0.2	0.2
Onion powder	2.0	2.0	2.0	2.0
Lemongrass powder (LG)	0.0	1.0	3.0	5.0

(LG1.0%) is treatment with 1.0% LG powder, (LG3.0%) is treatment with 3.0% LG powder and (LG5.0%) is treatment with 5.0% LG powder.

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Chemical Analysis:

DPPH radical scavenging activity of Lemongrass powder exracts and beef burger formulae were determined according to the methods described by Aromatic *et al*., (2013). Estimation of antioxidant activities of fixed and volatile oils extracted from aromatic (clove). Used Spectrophotometer Laboratory Instrument "Thermo Scientific Heryios "dry weight (100g) of the food (calculated by difference). Moisture, protein and fat contents of both raw beef burger (RBB) and cooked beef burger (CBB) were performed using Food Scan™ Pro meat analyzer (Foss Analytical A/S, Model 78810, Denmark), Peroxide value was determined by A.O.A.C, (1990). Thiobarbituric acid (TBA) test was carried out according to the method described by Tarlagis *et al*., (1964). The TBA values were represented as mg malonaldhyde/Kg sample. Total viable count determined by ISO. Microbiology of the food chain –Hospital method for the enumeration of microorganisms -Part 1- Colony count at 30^{o} C by the pour plate technique. And ISO 7218. (2007). Microbiology of food and animal feeding stuffs – General requirements and guidance for microbiological examinations . Cairo University Research Park (CURP), Faculty of Agriculture, Cairo University.

Determination of cooking properties:

The cooking yield was determined as reported by Naveena *et al*., (2006) as follows:

$$\text{Cooking yield} = \frac{\text{Weight of cooked burger}}{\text{Weight of raw burger}} \times 100$$

Based on the method of El- Magoli *et al*. (1996), the moisture retention was determined as follows:

$$\text{Moisture retention} = \text{Cooking yield} \times \frac{\%\ \text{Moisture in cooked}}{\%\ \text{Moisture in raw burger}}$$

Fat retention was calculated according to Murphy *et al*., (1975) as follows:

$$\text{Fat retention} = \text{Cooking yield} \times \frac{\%\ \text{fat in cooked burger}}{\%\ \text{fat in raw burger}}$$

The diameter of each treatment was measured before and after cooking with a digital caliper. Changes in diameters were determined using the following equation as mentioned by Modi *et al*., (2004) as follows:

$$\text{Diameter reduction (\%)} = \frac{\text{Raw burger diameter- Cooked burger diameter}}{\text{Raw burger diameter}} \times 100$$

Color measurement:

The color of cooked and raw beef burger patties was measured by Chroma meter (Konica Minolta, model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer at Cairo University Research Park (CURP), Faculty of Agriculture. Color was expressed using the CIE L, a, and b color system (CIE, 1976). A total of three spectral readings were taken for each sample on different locations of the LD muscle. Lightness (L*) (dark to light), the redness (a*) values (reddish to greenish). The yellowness (b*) value (yellowish to bluish) was estimated.

Shear force:

The shear force (kg/cm³) was estimated using Instron Universal Testing Machine (Model 2519-105, USA) at Cairo University Research Park (CURP), Faculty of Agriculture. Six tests from each sample were taken. The shearing machine was adjusted at crosshead speed of 200 mm/min.

Storage of the Lemongrass:

Lemongrass burger were stored at refrigerator ($^{-}20^{0}$ C) until the analyses. They were analyzed immediately after processing for three months of frozen storage.

Sensory evaluation:

Sensory evaluation was carried out by ten panelists at Agricultural Industrialization Unit, Desert Research Center, Cairo, Egypt. The panelists were asked to evaluate appearance, color, taste, tenderness, juiciness, flavor, texture and overall acceptability using 10-point scale for grading the quality of samples as described by Kassem and Emara (2010).

Statistical analysis:

All analyses were performed in triplicate and data reported as mean ± standard deviation (SD). Data were subjected to analysis of variance (ANOVA). All tests were conducted at the 5% significant level."SPSS" Statistics, (1998), version 20.

RESULTS AND DISCUSSION

Chemical composition:

Chemical composition of uncooked (RBB) and cooked beef burger (CBB) are presented **in Table (2)**. Fat, protein and moisture content of uncooked samples were ranged from 11.04 to11.48%, 16.41to16.87%, and 64.29 to 65.91%, respectively. The

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values for cooked samples were in the range of 12.46 to13.81%, 15.53 to15.82%, and 51.26 to 54.81, respectively. Significant difference ($p \leq 0.05$) were obtained in moisture, protein and fat of both uncooked and cooked samples.

Table (2): Chemical composition of prepared beef burgers fortified by different levels of lemongrass powder during frozen storage period.

	Formulae	Raw zero time	Raw end time	Cooked zero time	Cooked end time
Fat	**Control (C)**	$11.86^{a}\pm0.09$	$11.99^{a}\pm0.06$	$12.46^{b}\pm0.21$	$15.17^{b}\pm0.73$
	LG 1%	$11.04^{c}\pm0.15$	$12.11^{a}\pm0.09$	$12.46^{b}\pm0.01$	$14.28^{b}\pm0.59$
	LG 3%	$11.2^{c}\pm0.09$	$11.76^{b}\pm0.06$	$13.52^{a}\pm0.03$	$16.82^{a}\pm0.29$
	LG 5%	$11.48^{b}\pm0.01$	$11.79^{b}\pm0.03$	$13.81^{a}\pm0.07$	$17.51^{a}\pm0.15$
Protein	**Control (C)**	$17.2^{a}\pm0.1$	$16.81^{a}\pm0.10$	$16.2^{a}\pm0.1$	$15.81^{a}\pm0.104$
	LG 1%	$16.87^{b}\pm0.032$	$16.39^{b}\pm0.04$	$15.82^{a}\pm0.56$	$15.39^{b}\pm0.044$
	LG 3%	$16.49^{c}\pm0.08$	$16.19^{c}\pm0.09$	$15.74^{a}\pm0.68$	$15.19^{c}\pm0.088$
	LG 5%	$16.41^{c}\pm0.11$	$15.98^{d}\pm0.06$	$15.53^{a}\pm0.56$	$14.98^{d}\pm0.059$
Moisture	**Control (C)**	$65.83^{a}\pm0.09$	$65.24^{a}\pm0.22$	$55.01^{a}\pm1.29$	$49.52^{a}\pm2.59$
	LG 1%	$65.91^{a}\pm0.15$	$65.59^{a}\pm0.58$	$54.81^{a}\pm0.41$	$48.81^{a}\pm0.20$
	LG 3%	$65.1^{b}\pm0.36$	$64.66^{a}\pm0.36$	$52.98^{b}\pm0.27$	$47.55^{a}\pm2.56$
	LG 5%	$64.29^{c}\pm0.29$	$63.57^{b}\pm0.11$	$51.26^{b}\pm0.06$	$47.26^{a}\pm0.69$

(C) is control beef burger, (LG1.0) is the beef burger treatment with 1.0% lemongrass powder, (LG3.0) is the beef burger treatment with 3.0% lemongrass powder, (LG5.0) is the beef burger treatment with 5.0% lemongrass powder. Mean values in the same raw / column followed by different letters are significantly different (p≤0.05).

Moisture content was lower in raw samples containing LG 5.0% ($p \leq 0.05$), which could be due to the increase in solid material content. The decrease in moisture content of cooked samples were more visible, where all the samples with LG had lower moisture as compared to control sample ($p \leq 0.05$). 3.0% and 5.0% samples had lower moisture content compared to 1.0% samples ($p \leq 0.05$). It could be concluded that, moisture content of prepared beef burgers substituted of beef meat by lemongrass powder was significantly deceased ($p \leq 0.05$) as the levels of lemongrass increased in either at raw or cooked burgers. Also, there was decreased as the prolonged time proceeded. The same results are in agreement with those noticed by López-Vargas *et al*., (2014). Crude protein of prepared beef samples was significantly deceased ($p \leq 0.05$) as the percentage of lemongrass increased in both raw and cooked samples. During frozen storage, crude protein was slightly decreased till the end of storage. The same trend of results was also observed by (Konieczny *et al*., 2007) and they reported that protein content decreased during frozen storage. The higher fat content of LG 5.0% samples could be attributed to high levels of oil in the lemongrass powder. It was found that all cooked samples with added lemongrass powder had higher fat content as compared to control samples ($p \leq 0.05$).

Cooking properties:

Table (3) indicated that showed the effect of LG powder on cooking yield, diameter reduction, moisture retention, fat retention and cooking loss of beef burger formulae. Cooking yield of the samples ranged between 68.0 and 74.0% at zero time and between 55.1 and 57.14% at end of time storage respectively.

Table (3): Physical properties of beef burgers replaced of beef meat by lemongrass powder during frozen storage period.

Storage peroid	Formulae	Cooking yield%	Moisture rentention%	Fat rentention%	Diameter reduction%	Cooking loss%
Zero time	Control(C)	$69.0^{b}\pm1$	$55.51^{a}\pm2.32$	$87.3^{b}\pm5.000$	$17.3^{a}\pm2.7$	$31.0^{a}\pm1.0$
	LG 1%	$68.0^{b}\pm0$	$51.93^{a}\pm3.46$	$87.3^{b}\pm5.000$	$18.2^{a}\pm1.7$	$32.0^{a}\pm0$
	LG 3%	$70.7^{b}\pm1.2$	$51.31^{a}\pm1.44$	$100.77^{a}\pm3.51$	$15.6^{a}\pm1.3$	$29.30^{a}\pm1.2$
	LG 5%	$74.0^{a}\pm2$	$49.06^{a}\pm2.40$	$110.10^{a}\pm3.04$	$13.5^{a}\pm3.2$	$26.0^{b}\pm2.0$
End time	Control (C)	$56.43^{ab}\pm1.24$	$43.39^{a}\pm0.36$	$71.44^{b}\pm2.24$	$26.25^{a}\pm1.25$	$43.58^{a}\pm0.63$
	LG 1%	$55.1^{b}\pm0$	$42.47^{a}\pm2.23$	$64.79^{c}\pm3.04$	$25.0^{a}\pm4.2$	$44.9^{a}\pm8.7$
	LG 3%	$56.76^{ab}\pm0.66$	$41.18^{a}\pm0.67$	$80.82^{a}\pm2.02$	$19.17^{b}\pm0.72$	$43.24^{ab}\pm0.66$
	LG 5%	$58.5^{a}\pm0.52$	$39.77^{a}\pm1.96$	$84.74^{a}\pm0.65$	$16.33^{b}\pm1.26$	$41.5^{b}\pm1.18$

(C) is control beef burger, (LG1.0) is the beef burger treatment with 1.0% lemongrass powder, (LG3.0) is the beef burger treatment with 3.0% lemongrass powder , (LG5.0) is the beef burger treatment with 5.0% lemongrass powder. Mean values in the same raw / column followed by different letters are significantly different (p≤0.05).

Cooking yield, in meat and meat products, is associated with fat and water retention (Aleson-Carbonell *et al*., 2005). According to Kastner and Felício, (1980), grinding of meat during burger processing results in a tender product due to the breakdown of the myofibrils and connective tissue, which, however, promotes weight loss during the cooking process. Similar results were obtained with Ammar *et al*., (2014). It could be concluded that cooking yield of prepared burgers was increased as

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the level of lemongrass increased in either after processing or at the end of storage. In contract, cooking loss was decreased as the level of lemongrass increased after processing.

Moisture retention of lemongrass beef burger were ranged from 49.06 to 51.93% at zero time and 39.77 to 42.47% at end of time storage, respectively. Addition of LG powder was decreased moisture retention of samples as compared to control samples. This result is in line with total moisture content of the samples, where significant ($p \leq 0.05$) loss in moisture was obtained with added LG powder. Therefore, the likely reason in decrement of moisture retention could be the lower moisture content of the products formulated with LG. Contrary to our findings, as confirmed by Selani *et al*., (2015).

Fat retention of beef patties was ranged from 87.3 to110.1% at zero time and 64.79 to 84.74% at end of time storage respectively. Beef burgers showed the lowest fat retention. This result indicated that incorporation of LG powder led to an increase in fat retention of the samples. Maximum fat retention was found in LG.5% samples ($p \leq 0.05$), the average amount of LG powder showed the best performance among LG powder treatments in holding fat in the matrix upon cooking. These results were in a concordance with the findings of López-Vargas *et al*., (2014). The reduction in diameter as the result of the denaturation of meat proteins with the loss of water and fat (López-Vargas *et al*., 2014).

Therefore, the levels of LG 5.0% could lead to textural cracking of the product, probably due to the increased solid material and decreased moisture content. The change of diameter in treatments was recorded between 13.5 and18.2% at zero time and 16.33 and 25.0% at end of time storage, respectively. It could be concluded that LG powder inclusion provided an equivalent diameter reduction to control samples regardless of the level added. Keeping fat within the matrix of meat products during cooking and storage is necessary to ensure sensory quality and acceptability (Anderson and Berry, 2001).

The cooking loss was decreased with the prolonged storage period. The less preferable cooking loss was observed at 3 month and most preferable cooking loss was observed at 0-day observation. The change of cooking loss in treatments was ranged between 26.0 and 32.0% at zero time and 41.5 to 44.9% at end of time storage, respectively. Cooking loss refers to the reduction in weight of meat during the cooking process (Jama *et al*., 2008). Major components of cooking losses are thawing, dripping and evaporation.

Shear force:

The texture of prepared beef burgers substituted of beef meat by lemongrass powder with different percentage 1.0, 3.0 and 5.0% during frozen storage at -20^0c for three months was shown in Table (4). The obtained results indicated that, tenderness was slightly decreased as the level of lemongrass powder increased. During frozen storage period, the tenderness of burger formulae was decreased.

These results corroborate those of the existing literature, which reports that some substitutes may provide better texture to products made with ground beef because these ingredients absorb water, dissolve with the meat protein matrix and result in increased softness of the product (Khalil, 2000 and Aleson-Carbonell *et al*. 2005).

Table (4): Tenderness of prepared beef burgers fortified by lemongrass powder during frozen storage period.

Formulae	Control (C)	LG 1%	LG 3%	LG 5%
Zero time	1.07±0.05	1.22±0.08	1.31±0.09	1.28±0.01
End time	1.01±0.01	1.19±0.06	1.27±0.11	1.24±0.01

Antioxidant Activity (DPPH):

Data in Table (5) shows the changes of antioxidant activity of beef burger during frozen stage for three months. A significant increase ($p \leq 0.05$) was observed in the antioxidant activity of (DPPH) in burger samples as compared with control sample. Also, the gradient increase in the amounts of all added powders caused a proportional increase in the antioxidant activity. Thus, the highest levels were observed in LG 5.0% exhibited higher antioxidant activities 55.03%. These results were related to the composition of the lemongrass raw powders which had high levels of antioxidant activity 70.86%. The antioxidant properties of phenolic compounds were very well documented and a significant relation between phenolic content and antioxidant activity. Thus, the high level of antioxidant activity in beef burgers containing lemongrass powder was attributed to the high level of phenolic compounds found in these powders. These results are confirmed by El-Gharably and Ashoush, (2011).

Table (5): DPPH radical scavenging activity of prepared beef burgers fortified by lemongrass powder during frozen storage period.

	Fresh lemongrass	Control(C)	LG 1.0%	LG 3.0%	LG 5.0%
DPPH%"RSA" (zero time)	70.86a±0.017	47.71^{d}±0.011	47.91^{c}±0.014	48.64^{b}±0.015	53.49^{a}±0.017
LSD	0.02663				
DPPH % "RSA" (End storage)		47.59^{d}±0.009	48.77^{c}±0.011	53.18^{b}±0.012	55.03^{a}±0.014
LSD	0.02294				

(C) is control beef burger, (LG1.0) is the beef burger treatment with 1.0% lemongrass powder, (LG3.0) is the beef burger treatment with 3.0% lemongrass powder, (LG5.0) is the beef burger treatment with 5.0% lemongrass powder. Mean values in the same raw / column followed by different letters are significantly different ($p \leq 0.05$).

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Total phenolic compounds in treatments still had high level of antioxidant activity at three months. These values of antioxidant scavenging activities indicate that lemongrass powder could be effectively used to retard the oxidative process in beef products. Also, this result obtained by Tiwari *et al*. (2010) who reported that Leaves extract of lemongrass shows antioxidant property by DPPH scavenging test. According to Hasim *et al*. (2015) lemongrass leaves extract have bioactivity compounds, such as Tannins, flavonoids and phenols as an antioxidant.

Peroxide Value:

Table (6) shows that the change of peroxide values of beef burgers during frozen storage peroid. Peroxide values are used as an index of the degree of oxidative rancidity of lipids as regard to Liberman and Petrovski, (1972). Generally, it could be concluded that peroxide value of prepared beef burgers was decreased as the percentage of lemongrass powder increased, i.e. The higher addition of lemongrass powder, the lower value of peroxide value was observed.

During frozen storage period, the peroxide values were increased as the prolonged of time proceeded. This increaseing of peroxide value as result of lemongrass addition may be due to that lemongrass has an antioxidant effect. This result are in agreement with those obtained by; Abd-El-Qader, (2003) and Gheisari, (2011).

Table (6): Peroxide value of prepared beef burgers during frozen storage period.

Peroxide Value "miliequ./Kg"	Control(C)	LG 1.0%	LG 3.0%	LG 5.0%
Zero time	3.89^{b}±0.03	4.19^{a}±0.04	3.62^{c}±0.08	2.38^{d}±0.03
One month	4.93^{a}±0.12	4.82^{a}±0.11	4.20^{ab}±0.7	3.74^{b}±0.07
Two months	5.93^{a}±0.12	5.64^{b}±0.1	5.61^{b}±0.11	4.67^{c}±0.06
Three months	6.80^{a}±0.7	6.67^{a}±0.08	6.30^{a}±0.6	4.82^{b}±0.11

(C) is control beef burger, (LG1.0) is the beef burger treatment with 1.0% lemongrass powder, (LG3.0) is the beef burger treatment with 3.0% lemongrass powder , (LG5.0) is the beef burger treatment with 5.0% lemongrass powder. Mean values in the same raw / column followed by different letters are significantly different (p≤0.05).

Thiobarbituric Acid (T.B.A) Values:

Table (7) indicated that showed the Thiobarbituric Acid (T.B.A) values (mg of malonaldhyde/kg sample) as a criterion of lipid oxidation of meat products. The results show positive effect (p≤ 0.05) was noticed of addition different levels of lemongrass powder 1.0, 3.0 and 5.0% as a natural antioxidant as compared to control sample. Lipid oxidation inhibition effect was the highest with adding lemongrass powder, especially at concentration of 3.0% and 5.0% at all storage times. TBA values were significantly (p≤ 0.05) increased in control sample as the time of frozen storage period increased. Also, results can be observed that, the increase in TBA values of prepared samples were slow and remained lower than of control sample up to end of storage period. This result could be correlated to the presence of phenolic compounds in lemongrass powder. The large amount of phenolics contained in lemongrass may cause its strong antioxidant ability (Li *et al*., 2006). Kanatt *et al*., (2014) noticed that irradiated meat containing lemongrass extract had lower TBA values. In addition, De Moraes Barros *et al*., (2012) reported that natural antioxidant improved lipid oxidation of fat products and meals. These results are in agreement with the results of El-Gharably and Ashoush, (2011).

Table (7): Thiobarbituric acid values of prepared beef burgers supplemented by lemongrass during frozen storage period.

TBA"mg/Kg"	Control(C)	LG 1.0%	LG 3.0%	LG 5.0%
zero time	0.49a±0.08	0.47a±0.08	0.45a±0.04	0.42a±0.06
One month	0.74a±0.09	0.63a±0.16	0.60a±0.01	0.51a±0.08
Two months	0.89a±0.08	0.81ab±0.08	0.69bc±0.05	0.59c±0.06
Three months	1.22a±0.07	0.99ab±0.17	0.75bc±0.09	0.62c±0.07

(C) is control beef burger, (LG1.0) is the beef burger treatment with 1.0% lemongrass powder, (LG3.0) is the beef burger treatment with 3.0% lemongrass powder , (LG5.0) is the beef burger treatment with 5.0% lemongrass powder. Mean values in the same raw / column followed by different letters are significantly different (p≤0.05).

Microbiological assessments:

Total bacterial count of prepared beef burger formulae substituted of beef meat by lemongrass powder with different percentages 1.0, 3.0 and 5.0% during frozen storage at -20^{0}c for three months was tabulated in Table (8). The obtained results showed that total bacterial counts of prepared burgers was ranged from 6.0×10^{5} to 6.0×10^{4} cfu / g. It is worthy to mention that, the higher addition of lemongrass, the lower numbers of bacteria was observed. This decrease of total bacterial counts may be due to that lemongrass has an antibacterial effect Ibrahim *et al*., (2013) and Hussein *et al*., (2015).

During frozen storage period, total bacterial count was decreased as the prolonged time proceeded till reached from 1.1 to 2.7×10^{5} cfu/g. This decrease due to storage may be attributed that the effect of crystal ice on the cell of bacteria (Emam, 1990). The relatively high initial counts of control samples may be attributed to the grinding process, which introducing the pathogens into the interior of the meat and contributes to the increase of total viable counts of the products (Mead and Griffin,

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1998). Results indicated that all prepared burger formulae were in the permissible limits of total bacterial counts as recommended by Egyptian Standard Specification, (1991). Lemongrass has an antibacterial effects.

Table (8): Total bacterial count of prepared beef burgers fortified by lemongrass during frozen storage period.

formulae	Control(C)	LG 1.0%	LG 3.0%	LG 5.0%
Storage				
zero time	4.8×10^5	1.9×10^5	3.7×10^5	2.7×10^5
One month	6.0×10^5	3.8×10^5	2.6×10^5	2.4×10^5
Two months	10.0×10^4	3.1×10^5	2.4×10^5	2.0×10^5
Three months	6.0×10^4	10.0×10^4	1.7×10^5	1.1×10^5

(C) is control beef burger, (LG1.0) is the beef burger treatment with 1.0% lemongrass powder, (LG3.0) is the beef burger treatment with 3.0% lemongrass powder , (LG5.0) is the beef burger treatment with 5.0% lemongrass powder. Mean values in the same raw / column followed by different letters are significantly different (p≤0.05).

Color analysis:

The colour parameters of different treatments of beef burger with lemongrass powder are summarized in Table (9). For L* values during storage, there was a decreasing trend in samples containing lemongrass powder LG 1.0%, LG 3.0%, LG 5.0%. On the other hand, L* values during storage of samples containing LG 1.0%, LG 3.0% , LG 5.0% showed an increasing trend, which could be due to gradual protein decomposition, leading to increase of light scattering McDougall,(1983). A decreasing trend was observed as regards to a* values, which is attributed to the gradual oxidation of myoglobin and accumulation of metmyoglobin with time Mancini and Hunt, (2005). The colour stabilizing effects of carnosine may be the result of its ability to chelate transition metals involved in free radical generation and/or free radical scavenging, thereby delaying the oxidation of oxymyoglobin to metmyoglobin Lee *et al*., (1999). The b* values of beef burger with lemongrass powder samples LG 1.0%, LG 3.0% , LG 5.0% which could be attributed to the natural yellowish colour of lemongrass powder affecting the beef burger colour. Similar observations have been also found by Georgantelis *et al*., (2007) in beef burger control and all treated samples was observed.

Table (9): Color of prepared beef burgers fortified by lemongrass during frozen storage period.

Parameter	Formulae	Lemongrass beef burger			
		R.zero time	R.end time	C.zero time	C.end time
L*	Control (C)	$43.67^{a}\pm0.46$	$44.65^{a}\pm0.52$	$49.09^{a}\pm1.11$	$50.25^{a}\pm1.96$
	LG 1%	$43.24^{ab}\pm0.26$	$46.78^{a}\pm0.79$	$47.23^{ab}\pm0.05$	$50.82^{a}\pm1.21$
	LG 3%	$42.13^{b}\pm0.43$	$44.11^{a}\pm2.54$	$44.79^{bc}\pm1.03$	$48.25^{a}\pm1.98$
	LG 5%	$42.21^{ab}\pm0.92$	$44.43^{a}\pm0.34$	$42.9^{c}\pm1.22$	$50.52^{a}\pm5.09$
a*	Control (C)	$13.17^{a}\pm0.66$	$8.28^{a}\pm0.13$	$5.87^{a}\pm0.49$	$5.42^{a}\pm0.23$
	LG 1%	$8.31^{b}\pm0.27$	$5.6^{b}\pm0.09$	$4.3^{b}\pm0.21$	$4.22^{b}\pm0.63$
	LG 3%	$4.38^{c}\pm0.02$	$2.87^{c}\pm0.09$	$2.85^{bc}\pm0.79$	$2.59^{c}\pm0.47$
	LG 5%	$2.56^{d}\pm0.32$	$2.03^{c}\pm0.62$	$2.34^{c}\pm0.62$	$1.79^{c}\pm0.35$
b*	Control (C)	$12.12^{c}\pm0.65$	$9.65^{b}\pm0.05$	$13.42^{b}\pm0.42$	$8.76^{b}\pm0.44$
	LG 1%	$13.2^{bc}\pm0.28$	$8.93^{c}\pm0.04$	$13.34^{b}\pm0.54$	$8.39^{b}\pm0.59$
	LG 3%	$13.59^{b}\pm0.34$	$9.73^{b}\pm0.17$	$12.93^{b}\pm0.07$	$9.11^{b}\pm0.07$
	LG 5%	$15.35^{a}\pm0.30$	$11.29^{a}\pm0.21$	$15.84^{a}\pm0.43$	$10.42^{a}\pm0.24$

(C) is control beef burger, (LG1.0) is the beef burger treatment with 1.0% lemongrass powder, (LG3.0) is the beef burger treatment with 3.0% lemongrass powder , (LG5.0) is the beef burger treatment with 5.0% lemongrass powder. Mean values in the same raw / column followed by different letters are significantly different (p≤0.05).

Sensory evaluation:

Table (10) and Fig. (1) indicated that showed the results of lemongrass beef burgers and their treatments evaluations of taste, color, odor, texture, tenderness, juiciness and overall acceptability were evaluated in prepared beef burger and their treatment after cooking are given in figure (1). Results indicated that the treatment made from 1.0% lemongrass gave the best acceptability 9.2, followed by the treatment contained 3.0% of lemongrass 8.8. Moreover, showed the lowest overall acceptability was found in LG 5.0% lemongrass.

All prepared beef burgers were recorded highly acceptable score of color, taste, odor, texture, tenderness, juiciness and overall acceptability for the panelists. Moreover, formulae 2 recorded higher score of overall acceptability 9.2.

Table (10): Sensory evaluation of prepared beef burgers fortified by lemongrass powder.

Formulae	Color	Taste	Odor	Texture	Tenderness	Juiciness	Overall acceptability
Control	9.3	9.0	9.0	9.1	9.0	7.8	9.1
LG 1%	9.5	9.0	9.3	9.0	9.2	8.4	9.2

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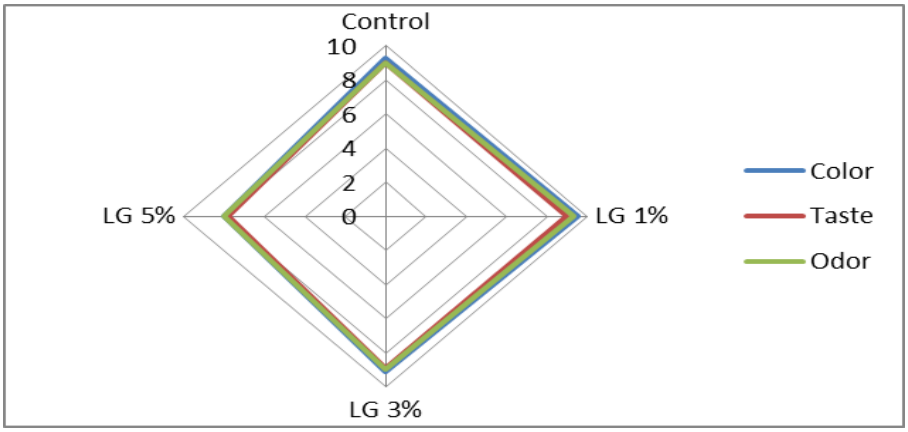
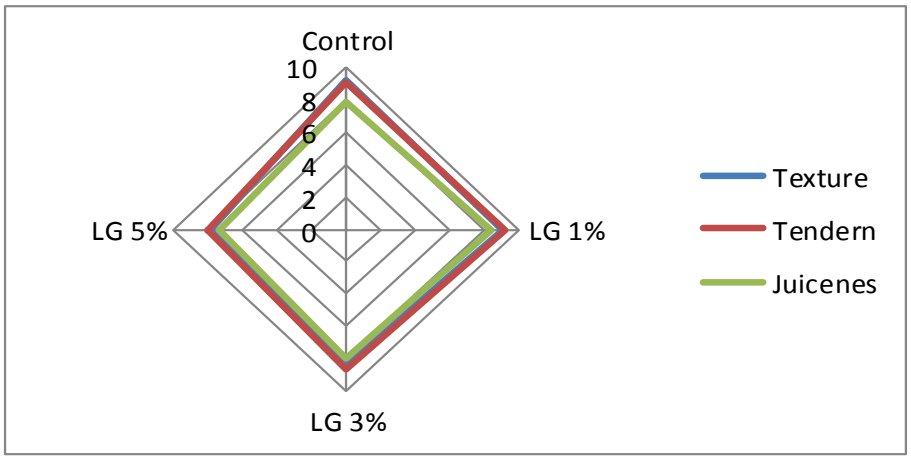
LG 3%	9.1	8.9	9.0	8.3	8.6	7.9	8.8
LG 5%	8.0	7.8	8.0	7.9	8.0	7.4	7.9





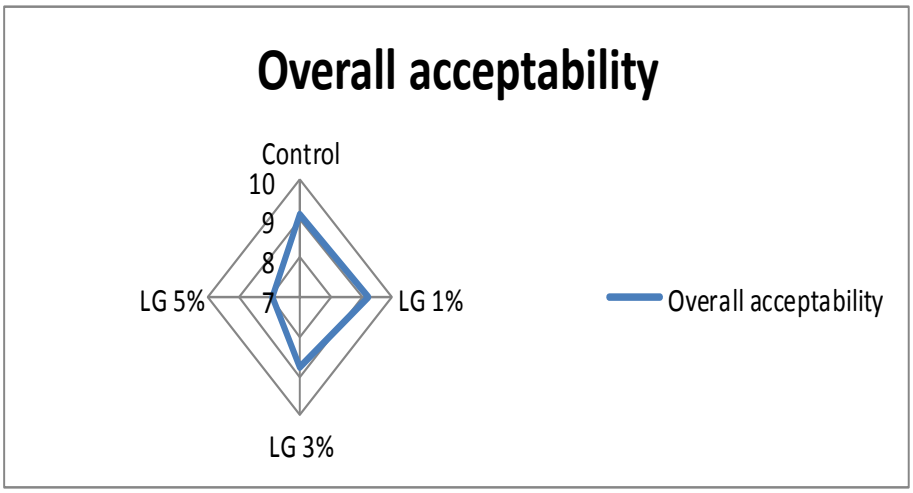


Fig.1: Sensory evaluation of prepared beef burgers fortified by lemongrass powder.

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CONCLUSION

It is suggested that lemongrass can be used as natural meat preservatives with both antioxidants and antimicrobial activities against food borne pathogens and spoilage organisms. Therefore, may be useful in maintain the meat quality, extending shelf-life of meat products, preventing economic loss and providing the consumer with food containing natural additives, which are considered more healthful than those of synthetic origin.

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