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Antioxidant Activity of Lemongrass Leaves In Chicken Burger

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Abstract:*During meat/chicken cooking and storage warmed over flavor (WOF) appears within 24 hrs of refrigerated storage. In this study, the anti-oxidation and color stability effect of lemongrass leaves powder were investigated in fresh and cooked chicken burgersamples. Results indicated that lowest value of Thiobarbituric acid reactive substance (TBA-RS) in all samples treated with lemongrass,(2%) concentration provides best effectiveness. Met-myoglobin formation was decreased in uncooked samples by adding lemongrass powder. The effect of lemongrass was more pronounced in cooked samples. In addition to that, lemongrassreduced lipid peroxidation and degradation of heme pigments caused by cooking and storage.*
Keywords: *Lemongrass, Antioxidant, chicken burger, Lipid peroxidation, Heme degradation*

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I. Introduction

Chicken meat is favored by consumers, it contains low fat with high concentration of poly-unsaturated fatty acids. Oxidation of lipids is a major reason of chicken spoilagethus reducesquality of meat product**(Devatkal and Naveena, 2010;Zhang*et al.,* 2016)**. Stability of lipid in meats and meat products is a very important factor, which has influence on quality and consumer acceptability **(Mitsumoto *et al.,* 2005)**. Reducing of lipid oxidation during storage of meat products can be achieved with antioxidants **(Naveena *et al.,* 2006)**. In recent times many investigations were carried out on natural antioxidants such as rosemary, sage, soy protein, plum and tea catechins **(Nunez de Gonzalez*et al.,* 2008)**. Lemongrass is a rich source of citral and bioactive compounds such as vitamin C and flavonoids, which is used in pharmaceutical industries. Flavonoids are anti-inflammatory and anti-carcinogenic agents because of their lipid anti-peroxidation effects **(Marin *et al.,* 2002)**. Lemongrass contains several bioactive compounds, which are useful in several health issues and are found in leaves **(Olorunnisola *et al.,* 2014)**. Warmed over flavor (WOF) is the rapid development of oxidized flavor in refrigerated, pre-cooked and cooked meat, where rancid flavor became apparent within the first 48 hrs of refrigeration**(Kulkarni, 2011)**. Many plants containing polyphenol compounds are effective antioxidants and can retard the development of WOF in meat products**(Ahn*et al.,* 2007)**.

Therefore the aim of this study was to study the antioxidant effectiveness of lemongrass leaves at various ratios on reducing peroxidation and development of warmed over flavor (WOF) in chicken burger during cold storage.

II. Material and Methods

Lemongrass leaves were purchased from local market, washed with water, dried and milled to a fine powder. Fresh chicken fillet (boneless breasts) and spices were obtained from a local market (Ismailia, Egypt). All reagents, solvents and chemicals used in this study were of analytical grade. Trichloroacetic acid (TCA); 2-thiobarbituric acid (TBA-RS); nitric acid; ferrozine [3-(2-pyridyl)-5, 6-bis (4-phenylsulfonic acid)-1, 2, 4-triazine]; α-tocopherol and ammonium acetate were obtained from Sigma-Aldrich Chemical Co. (St. Louis, Mo, USA).

A- Chicken Burger Processing

Chicken fillets were minced using a meat mincer (SAP Meat Mincer Tc22. Italy), and divided into six equal parts. Chicken burger wasprepared by adding lemongrass at (0.0, 0.5, 1.0, 1.5 and 2.0%), 0.56% spices mixture (clove 4.0%; cumin 15.0%; coriander 12.0%; nutmeg 2.5%; black pepper 45.0%; all spice 10.0% and red pepper 11.5%), onion 0.3%; garlic 0.3% and 1.0% sodium chloride. A positive reference control was prepared by mixing 150 mg tocopherol acetate with 100g of minced chicken. After mixing, samples were divided into small lots (100g) to prepare burger. All samples before and after cooking in a microwave oven for 90 sec. were stored covered in petri dishes for 12 days at 4^{o}C.

B- Analytical Methods

1- Total Phenolic Compounds (TPC)Determination:

Total phenolic compounds (TPC) were determined in ethanolic extract (one gram sample was extracted by 25ml ethanol 50%) according to the method described by **Jaramillo-Flores *et al.*, (2003)** with some modifications as follows:

100µl of ethanolic extract was mixed with 900µl of Folin-Ciocalteu 10% (diluted in distilled water 1:10) and allowed to stand for 5 min. at room temperature;0.75ml ofsodium bicarbonate7% ($NaHCO_3$) was added to the mixture and vortexed for 30sec., then allowed to stand for 90min. at room temperature. The absorbance was measured at725nm using a spectrophotometer (6505 Uv/vis, Jenway, UK).

2- Determination of Antioxidant Activity

The antioxidant activity was determined by 2,2-diphenyl 1-1-picrylhydrazyl (DPPH) method according to **Lee *et al.*, (2003)** with some modifications as follows: 100µl of sample extract was reacted with 3.9ml of DPPH solution (60 µmol/L DPPH solution was made in ethanol 99%) for 60min in a dark place. The absorbance was measured using a spectrophotometer at 515nm against a blank of ethanol 95%. Antioxidant activity was calculated as follows:

DPPH radical-scavenging activity (%) = $(A_{control} - A_{sample})/ A_{control}$ X 100

Where, A is the absorbance at 515nm.

3- Total Iron

Total iron concentration was determined in wet-ashed samples as described by**(Stockey, 1970)**.Chicken burger (0.2 – 0.3g) in a test tube digested with concentrated nitric acid and hydrogen peroxide (30%) on a hot plate until white ash was formed. Then dissolve in 0.2ml HCl (1.0N), deionized water (0.85ml) and ascorbic acid (1ml, 1%) was added and the tube contents were mixed. After 20min. 1ml of ammonium acetate buffer (10%) and 1ml of ferrozine color reagent (1mM)were added and well mixed. The mixture was allowed to stand at room temperature for 45min. then the absorbance was determined at 562nm using Baush and Lamb spectrophotometer. The concentration of iron was determined from a standard curve made with standard iron solution (Sigma, St. Louis, Mo).

4- Heme Iron

Heme iron was measured according to the method of **Lee *et al.* (1998)**. (2g) of cooked chicken burger wastransferred into a tube of polypropylene (50ml), then 9 ml of acetone 90% acidified with HCl 2% was added. The mixture was then macerated with a glass rod and allowed to stand for 1hrs in a dark cabinet at room temperature. The extract was filtered through Whatman filter paper 42 and the absorbance was read at 640nm against the acid acetone blank.

Total pigments as acid hematin, were calculated using the formula:

Total pigments (ppm) = A_{640} X 680

And heme iron was calculated as follows **(Clark *et al.*, 1997)**:

Heme iron (ppm) = total pigment (ppm) x 8.82/100

5- Non-heme Iron

The concentration of non heme iron in samples was calculated using the formula:

Non-heme iron (ppm) = total iron – heme iron

6- Metmyoglobin

Metmyoglobin was determined according to**Krzywicki (1982)** as following;Minced meat (5g) was mixed with 25ml of ice-coldphosphate buffer (pH6.8, 40mM). The mixture was homogenized at 10.000rpm for 10sec using an Ultra-Turrax T50 (Jank & Kunkel Gmbh, Straufen Germany). The homogenized sample was allowed to stand for 1hr at 4^{o}C and centrifuged at 5000rpm for 30min. at 4^{o}C. The supernatant was filtered through whatman (1) filter paper and the absorbance was read at 700, 572 and 525nm with spectrophotometer.

Percent of metmyoglobin calculated according to the formula:

% MetMb = 1.395 – {$(A_{572} - A_{700})/ (A_{525} - A_{700})$} x 100

7- TBA Reactive SubstanceValues (TBA-RS)

Thiobarbituric acidreactive substance values (TBA-RS) was determined as described by **Pearson (1981)**.

8- Warmed–Over Flavor (WOF)

Sensory evaluation was carried out after 48hrsof storage of cooked samples at 4^{o}C ±1. All chicken burgersamples were reheated in bath water to an approximate internal temperature of 70^{o}C and served while hot.

The panel scoring system was as following: 5: no WOF, 4: slight WOF, 3: moderate WOF, 2: pronounced WOF and 1: very pronounced WOF.

9- Statistical Analysis

Standard Deviation (SD) and significant differences between the mean values of the estimated tests were performed using the software package Statistical 9.1 for Windows, Stat Soft, Tulsa, Oklahoma, USA, 2009. Differences were considered significant at $P<0.05$.

III. Results and Discussion

1- Total Phenolic Compounds (TPC)

Phenolic compounds are secondary metabolites found in fruits, legume, cereals and vegetables. Phenolic compounds content in chicken burger during refrigerated storage for 12 days are presented in Table (1).The data showed that addition of lemongrass powder to chicken burger increased TPC in the sample.

There were differences among control, sample treated with α-tocopherol as a positive control, and samples treated with different concentrations of lemongrass (0.5, 1.0, 1.5, and 2.0%).

Phenolic compounds level decreased in all chicken burger as storage time increased. After 12 days of storage, phenolic compound amounts were: 44.32, 57.21, 72.02, 88.71, 95.62, and 112.23 mg/100g for control, positive control, lemongrass 0.5, 1.0, 1.5, and 2.0% respectively. Chicken burger sample which containing lemongrass powder 2.0% had the highest level of TPC (112.23 ±0.301mg /100g).

Our results are in agreement with those reported by **Devatkal *et al.* (2010)**who reported that pomegranate rind powder significantly increased level of total phenolic compounds in chicken burger.

The results exhibited higher content of phenolic compounds due to lemongrass treatments (proportionally to the used concentration) compared to untreated samples. The highest amount of phenolic compounds were recorded to the highest concentration of lemongrass. The antioxidant activity of lemongrass is overwhelming due to phenolic compounds which could retard lipid oxidation, consequent mark-downing of oxidative rancidity and deterioration, delaying off-flavor development and upturning consumer acceptance, which could be a natural source replacing synthetic antioxidants recently restricted in application to food because of its toxicological hazards and their carcinogenic probability **(Johnston *et al.*, 2005, Engy *et al.*, 2018)**.

Table 1: Changes in total phenolic compounds (mg/100g) during storage of chicken burger at 4°C± 1 (mean ± S.D).

Treatment / Storage Time	T1	T2	Lemon grassConcentration%			
			T3 (0.5)	T4 (1.0)	T5 (1.5)	T6 (2.0)
0	71.06 ±0.015	95.12 ±0.081	112.08±0.351	129.05±0.001	153.21±0.001	189.15± 0.005
2	67.32 ±0.035	89.81 ±0.080	105.17±0.158	120.16±0.062	146.10±0.113	175.21± 0.215
4	63.06 ±0.158	81.13 ±0.315	98.82±0.211	113.25±0.119	129.32±0.201	164.15± 0.610
6	57.01 ±0.151	75.09 ±0.022	91.72±0.501	107.72±0.005	117.28±0.351	158.30± 0.052
8	52.10 ±0.033	69.15 ±0.115	85.19±0.082	101.18±0.024	110.19±0.086	142.50± 0.108
10	49.81 ±0.101	63.81 ±0.009	79.83±0.213	93.29±0.081	102.13±0.007	129.15± 0.210
12	44.32 ±0.008	57.21 ±0.310	72.02±0.312	88.71±0.109	95.62±0.119	112.23± 0.301

Total phenolic compounds (TPC) of lemongrass powder 49.22%
T1 = control zero lemongrass
T2 = positive control 150 mg α tocopherol

2- Antioxidant Activity (DPPH)

Antioxidant activity (DPPH) was used as free radical to evaluate antioxidant activity.Effect of storage conditions on antioxidant activity at different lemongrass concentrations and storage time intervals compared with control samplesare given in Table(2). The results showed that antioxidant activity of α-tocopherol was weaker than that of lemongrass at all treatment levels.The chicken burger formulated with lemongrass at 2% had higher levels of antioxidant activity than other treatments.

A substantial decrease was observed in control samples compared to treated samples with lemongrass. Increase in lemongrass concentrations tends to improve the stability of antioxidant activity. Higher effects were observed with higher concentrations, and lower activity was associated with lower concentrations of lemongrass. Thus, the high level of antioxidant activity in lemongrass was attributed to the high level of phenolic compounds of lemongrass powder.

DPPH free radicals are widely known and used repeatedly to monitor the scavenging abilities of many natural additives and extracts **(Amarowicz *et al.*, 2004)**. The antioxidant activity mechanism of natural herbs might be explained by 2 major functions: (1) Scavenging activity, (2) Hydrogen donating ability **(Hyam and Ferial,**

2013). Polyphenolic compound extracts are superior donors of electron and proton and have immediate stable radicals because of delocalization phenomenon of electron and lacking of contravention by oxygen (O_2) **(Djenane *et al.*, 2005)**. In our study lemongrass treatment exhibited a higher scavenging activity on DPPH radicals than those of both control samples.

Our results are in agreement with results obtained by **Tiwari *et al.* (2010)**who reported that leavesextract of lemongrass shows antioxidantproperty 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.

Table 2: Changes in antioxidant activity (DPPH% during storage treatments at 4°C±1 (mean ± S.D)

Treatment / Storage Time	T1	T2	Lemon grassConcentration%			
			T3 (0.5)	T4 (1.0)	T5 (1.5)	T6 (2.0)
0	15.62±0.132	32.15±0.114	38.11±0.029	51.22±0.009	73.08±0.115	91.02±0.008
2	13.01±0.021	29.11±0.231	36.21±0.017	50.03±0.101	71.61±0.202	88.13±0.002
4	10.92±0.081	28.05±0.326	34.52±0.212	48.91±0.305	69.02±0.119	86.72±0.131
6	10.01±0.009	26.91±0.118	33.81±0.003	47.55±0.331	67.32±0.502	84.88±0.001
8	09.52±0.124	25.00±0.017	33.01±0.115	46.72±0.148	64.82±0.111	82.09±0.121
10	08.87±0.119	23.12±0.052	31.92±0.118	45.19±0.006	60.19±0.101	79.83±0.102
12	07.35±0.225	21.08±0.006	30.02±0.109	43.45±0.209	58.21±0.331	77.65±0.119

***Antioxidant activity (DPPH) of lemongrass powder (88.92%)**
T1 = control zero lemongrass
T2 = positive control 150 mg α tocopherol

3- Metmyoglobin

Mean values of metmyoglobin in chicken burger samples during storage were shown in Table (3). Differences observed between both control samples and treated samples during storage time. The formations of metmyoglobin were time-dependent when burger samples were kept for 12 days at 4^oC.

Samplestreated with lemongrass showed lower metmyoglobin formation after 12 days of storage. Treated samples with higher concentrations of lemon grass were more effective for inhibiting of metmyoglobin formation than those with α-tocopherol and control. The antioxidation activity of lemongrass plays a sizable role in maximizing reduction of metmyoglobin formation. The levels were: 95.3, 62.8, 73.2, 63.1, 55.2, and 47.2 % for control, positive control, lemongrass 0.5%, lemongrass 1.0%, lemongrass 1.5%, and lemongrass 2.0% respectively. The data also showed that increasing concentration of lemongrass resulted in a decrease of metmyoglobin formation at any given time during cold storage, while control sample showed the highest values.

Such results may be due to some natural antioxidants compounds that may be present in lemongrass. **Marin *et al.* (2002)** found that lemongrass is a rich source of flavonoids as antioxidant agent. The antioxidant activity of lemongrass was due to the high levels of phenolic compounds **(Kanatt*et al.*, 2014)**.

The data exhibited the efficiency of lemongrass antioxidation towards metmyoglobin formation. **Renerre *et al.*, (1992)** mentioned that the myoglobin autoxidation susceptibility is the major contributing factor in meat and its products stability, but could not identify the exact oxidation process substances of oxymyoglobin to metmyoglobin. Other researchers concluded the oxygen initiation ability on lipid peroxidation, helping formation of peroxidants which are capable to react with oxymyoglobin resulting of metmyglobin formation **(Acton *et al.*, 1993)**.

Table 3: Effect of lemongrass on metmyoglobin (%) formation in chicken burger during cold storage at 4°C± 1 (mean ± S.D)

Treatment / Storage Time	T1	T2	Lemon grassConcentration%			
			T3 (0.5)	T4 (1.0)	T5 (1.5)	T6 (2.0)
0	24.1±0.121	24.3±0.008	24.2±0.005	24.1±0.008	24.2±0.005	23.9±0.001
2	39.1±0.111	28.1±0.102	31.6±0.113	29.8±0.136	27.2±0.113	26.2±0.116
4	47.3±0.250	33.5±0.102	39.1±0.302	35.6±0.108	33.6±0.012	30.8±0.019
6	63.8±0.113	38.6±0.009	43.5±0.208	40.1±0.007	38.1±0.126	34.6±0.003
8	77.2±0.007	45.2±0.116	50.8±0.211	45.6±0.006	43.2±0.009	39.1±0.031
10	82.1±0.301	51.7±0.111	62.1±0.028	51.2±0.116	48.0±0.001	43.6±0.128
12	95.3±0.220	62.8±0.004	73.2±0.006	63.1±0.208	55.2±0.221	47.2±0.009

T1 = control zero lemongrass
T2 = positive control 150 mg α-tocopherol

4- TBA-RSValues

Antioxidant extracted from some plants can be used as alternatives to synthetic antioxidants due to high effect on inhibition of lipid oxidation **(Aguirrezábal*et al.*, 2000)**. The extent of lipid oxidation in uncooked chicken burger samples were recorded in Table (4).

The lipid oxidation levels increased in all burger samples as storage time increased. Antioxidant treated samples showed more lipid stability and differences appeared among treated chicken burger samples according to concentrations. All variables (storage time and lemongrass concentration) were venerable contributors to TBA-RS values.

On the 12thday of cold storage, TBA-RS values for uncooked samples were 1.92, 1.54, 1.49, 0.81, 0.77, and 0.53 for control, positive control, lemongrass 0.5%, 1.0%, 1.5%, and 2.0% respectively. The results demonstrated lemongrass effectiveness in reducing lipid oxidation rapidity of chicken burger throughout storage. Chicken burgerwith antioxidant treatment showed lower TBA-RS values than those of control samples. 2% lemongrass was the most effective addition for retarding lipid oxidation after 12 days of cold storage.

Consumer acceptance for chicken and meat products quality affected by lipid oxidation and its products (off-odors, off-flavors). For preventing oxidation of lipids we applied lemongrass as an alternative antioxidant both inexpensive and of natural origin. The content of lipids lowered in all samples during refrigeration storage due to lipid autoxidation and can contributed to triglycerides level changes **(Sampaio *et al.*, 2012)**. As results expressed that all four concentrations of lemongrass could be beneficially to reduce lipid oxidation velocity in chicken burger during storage. The hydrogen atom (H) of phenolic (-OH) group of phenolic compounds hinder expansion of free radicals autoxidation chain by forming more stabilized free radical for minimal oxidation process **(Falowo *et al.*, 2014)**.

Warmed over flavor (WOF) is the rapid development of oxidized flavor in cooked meat products rancid flavor caused by lipid oxidation in meat products leading to deterioration in cooked meat products quality that have been chill-stored. Warmed over flavor can be qualified by measurement of TBA-RS **(Kulkarni, 2011)**. Lipid oxidation as expressed by TBA-RS number is increased with cooking and with increasing time after cooking (Table 4). **Lee and Hendricks (1995)** reported that, when meat cooked, ironis liberated and interacts with phospholipids to catalyze lipid oxidation. Both α-tocopherol and lemongrass decreased TBA-RS values formation and the effect was dose-dependent. There was negative relationship between heme-iron content (Table 5) and TBA-RS values number (Table 4) of cooked burger. TBA-RS values of control sample was 2.92 ±0.221 mg/kg after 12 days of cold storage and dropped to 0.89 ±0.001 mg/kg, when sample treated with lemongrass (2%). The antioxidant effect of lemongrass may be due to phenolic compounds in lemongrass powder. **Kanatt*et al.* (2014)** mentioned that irradiated meat containing lemongrass extract had lower TBA-RS values. **de Moraes Barros *et al.* (2012)** reported that natural antioxidant improved lipid oxidation of fat products and meals.

Table 4: Effect of lemongrass powder on TBA-RS values (mg malonaldhyde/kg) in chicken burger during storage at 4°C± 1 (mean ± S.D)

Treatment / Storage Time		T1	T2	Lemon grass Concentration %			
				T3 (0.5)	T4 (1.0)	T5 (1.5)	T6 (2.0)
0	I	0.18 ±0.051	0.15 ±0.122	0.15 ±0.112	0.14 ±0.013	0.14 ±0.014	0.14±0.111
	II	0.22 ±0.025	**0.22 ±0.008**	**0.23 ±0.033**	**0.22 ±0.001**	**0.22 ±0.006**	**0.22±0.111**
2	I	0.42 ±0.109	0.22 ±0.121	0.21 ±0.113	0.20 ±0.008	0.19 ±0.111	0.19±0.113
	II	**0.39 ±0.113**	**0.31 ±0.111**	**0.30 ±0.061**	**0.28 ±0.001**	**0.25 ±0.011**	**0.23±0.121**
4	I	0.61 ±0.003	0.32 ±0.101	0.35 ±0.221	0.28 ±0.001	0.25 ±0.210	0.22±0.010
	II	**0.71 ±0.031**	**0.52 ±0.023**	**0.49 ±0.029**	**0.38 ±0.061**	**0.31 ±0.013**	**0.28±0.001**
6	I	0.89 ±0.116	0.51 ±0.009	0.49 ±0.116	0.35 ±0.108	0.31 ±0.001	0.28±0.211
	II	**0.96 ±0.025**	**0.72 ±0.031**	**0.68 ±0.222**	**0.54 ±0.021**	**0.46 ±0.008**	**0.38±0.021**
8	I	1.32 ±0.220	0.82 ±0.111	0.80 ±0.016	0.48 ±0.101	0.44 ±0.008	0.31±0.223
	II	**1.56 ±0.302**	**0.89 ±0.026**	**0.81 ±0.025**	**0.68 ±0.002**	**0.59 ±0.113**	**0.42±0.022**
10	I	1.64 ±0.231	1.09 ±0.005	0.99 ±0.152	0.63 ±0.119	0.52 ±0.113	0.39±0.118
	II	**2.31 ±0.022**	**1.41 ±0.009**	**1.33 ±0.113**	**1.18 ±0.022**	**0.79 ±0.111**	**0.71±0.009**
12	I	1.92 ±0.015	1.54 ±0.113	1.49 ±0.113	0.81 ±0.112	0.77 ±0.116	0.53±0.111
	II	**2.92 ±0.221**	**1.85 ±0.001**	**1.61 ±0.116**	**1.30 ±0.111**	**0.99 ±0.110**	**0.89±0.001**
% Fat		12.05 ±0.001	12.08 ±0.150	12.10±0.116	12.11 ±0.113	12.13 ±0.008	12.15 ±0.011

T1 = control zero lemongrass
T2 = positive control 150 mg α tocopherol
I = uncooked chicken burger
II = cooked chicken burger

5- Heme and Non-HemeIron:

WOF caused by lipid oxidation of meat products. The type of off-flavor is associated with the autoxidation of unsaturated fatty acids and iron, in one form or another is an imported catalyst.

Heme iron contents decreased progressively with treated samples (Table 6) compared with control samples which decreased more rapidly. The effectiveness of the antioxidant in preserving the heme iron values was in the following order: 2.0 > 1.0 > 1.5 > 0.5 % lemon grass > α-tocopherol > control.

Heme iron contents after 12 days of cold storage at 4^{o}C were: 7.5, 9.9, 10.3, 12.2, 13.9, and 14.7 mg/kg for control, α-tocopherol, 0.5, 1.0, 1.5, and 2.0% lemongrass respectively, corresponds to 50.33, 57.22, 59.53, 70.52, 80.34, and 84.97 % of total heme iron content.

Meat tissues contain considerably quantities of iron linked to proteins (hemoprotein). The decreased amount of heme iron with storage time extension by means of free iron releasing from heme resulted in less retaining of heme iron and decreasing the heme pigment with increasing time of storage contributed to iron content drooping. **(Ozerand Sariçoban, 2010)**. **Purchas*et al.*, (2003)** mentioned that the meat drip at the mean time of storage has containable amounts of iron and predominately particular dissolvable heme iron. After cooking ionic iron % releasing from protein bound irons increased by heat induction **(Mei *et al.*, 1994)**. During storage period, values of heme iron content decreases and non-heme iron increased which may be due to heme breakdown resulting from the release of non-heme content. Lipid peroxidation of muscle is activated by this released iron during cold storage **(Hafiz *et al.*, 2015)**.

At the time **Byrne (2001)** reported that iron was released from heme pigments during cooking and leading to increase in non-heme iron which was responsible for lipid peroxidation.

Iron plays an important role as a peroxidant for lipid oxidation among transition metals. Via Fenton reaction the ferrous breaking lipid peroxide and hydrogen into free radicals which accelerate lipid oxidation **(Oztruck *et al.*, 2007)**. In this study, lemongrass exhibited higher ion-chelating effect of ferrous than that inpositive control (α-tocopherol) via chelating and/or deactivating transitioned metals which could promote the reaction of Fenton and decomposition of hydroperoxides.

Table 5: Effect of lemongrass on heme and non heme iron contents in cooked chicken burger samples during cold storage at 4°C± 1 (mean ± S.D)

Treatment / Storage Time		T1	T2	Lemon grass Concentration% T3 (0.5)	T4 (1.0)	T5 (1.5)	T6 (2.0)
	l	14.9±0.012	17.0±0.009	17.3±0.021	17.8±0.132	17.8±0.016	17.8±0.001
0	**ll**	**6.3 ±0.001**	**4.2±0.001**	**3.9±0.212**	**3.4±0.116**	**3.4±0.115**	**3.4±0.331**
	l	13.2±0.019	16.5±0.121	16.6±0.011	16.8±0.009	16.9±0.001	16.9±0.032
2	**ll**	**8.0±0.110**	**4.7±0.113**	**4.6±0.003**	**4.4±0.152**	**4.3±0.001**	**4.3±0.009**
	l	11.6±0.008	14.9±0.001	15.3±0.220	15.1±0.111	16.2±0.008	16.5±0.022
4	**ll**	**9.6±0.003**	**6.3±0.101**	**5.9±0.003**	**6.1±0.121**	**5.0±0.116**	**4.7±0.003**
	l	9.7±0.113	13.8±0.320	14.1±0.008	14.6±0.003	15.9±0.011	16.0±0.001
6	**ll**	**11.5±0.111**	**7.4±0.28**	**7.1±0.116**	**6.6±0.001**	**5.3±0.003**	**5.2±0.026**
	l	8.9±0.201	11.6±0.019	12.0±0.014	14±0.008	15.4±0.008	15.7±0.019
8	**ll**	**12.3±0.022**	**9.6±0.116**	**9.2±0.313**	**7.2±0.001**	**5.8±0.216**	**5.5±0.222**
	l	8.1±0.003	10.8±0.021	11.9±0.001	12.8±0.022	15.0 ±0.013	15.3±0.016
10	**ll**	**13.1±0.131**	**10.4±0.131**	**9.3±0.215**	**8.4±0.016**	**6.2±0.121**	**5.9±0.001**
	l	7.5±0.001	9.9±0.012	10.3±0.001	12.2±0.005	13.9±0.005	14.7±0.022
12	**ll**	**13.7±0.008**	**11.3±0.009**	**10.9±0.009**	**9.0±0.113**	**8.2±0.001**	**6.5±0.321**

- **heme iron in chicken meat 18.1 mg/kg** **l =heme iron**
- **Non heme iron in chicken meat 3.1 mg/kg** **ll = Non heme iron**
- **Total iron in chicken meat 21.2 mg/kg**

T1 = control zero lemongrass

T2 = positive control 150 mg *α*-tocopherol

6- Warmed-Over Flavor (WOF) Evaluation:

Quantities of free iron were released during cooking and storage of meat products. Free iron and negative charged phospholipids caused specific oxidation that generated WOF during cold storage **(Graf and Panter, 1991)**. Data shown in Table (4) demonstrates the high effect of lemongrass onTBA-RS formation in cooked chicken burger. WOF in precooked samples is caused by the degradation products of lipid hydroperoxides such as aldehydes, malondialdehyde, heptanal and hexanal.

To evaluate lemongrass on WOF development in cooked samples kept under possible consumer home refrigerator abuse conditions, samples were stored uncovered on a plate at 4°C ±1. The evaluation showed that TBA-RSvalues raised from 0.22 after 2 days to 2.92 after 12 days of cold storage, for control sample and from 0.22 to 0.89mg MDA/kg for the test sample containing 2% lemongrass powder. Thus our results indicated that

lemongrass leaves powder may be useful as additive to delay onset of WOF in precooked chicken burger (Table4, 6).

Table 6: Sensory scores in cooked chicken burger during storage at 4° C.

Treatments / Storage days	Lemongrass (%)					
	T1	**T2**	**T3 (0.5)**	**T4 (1.0)**	**T5 (1.5)**	**T6 (2.0)**
0	4.37a	4.60a	4.63a	4.61a	4.63a	4.64a
2	3.49b	3.87b	3.97b	4.31a	4.41a	4.42a
4	2.30a	3.61b	3.69b	4.02b	4.11a	4.25b
8	1.93a	3.44b	3.50c	3.94c	4.98c	4.01d
10	1.33b	2.68c	3.16c	3.71c	3.72a	3.90a

-Mean in the same row with different superscripts are significantly different at p≤ 0.05
T1 = control zero lemongrass
T2 = positive control 150 mg *α* tocopherol

IV. Conclusion

This study examined the interaction effects of two factors: addition of antioxidant factor, and storage time/condition factor. The current results exhibited the effectiveness of lemongrass as a noteworthy food bioactive compounds source in food products/industry as a natural additive with antioxidant activity retarding lipid oxidation, improving the overall organoleptic characteristics for more consumer satisfaction and extending shelf-life of raw/cooked chicken burger during cold storage at 4^{o}C for 12 days. Lemongrass treatment could interact positively to reduce the harmful influence of storage time factor and lipid oxidation promoters as compared with control samples' shelf-life and total acceptability. The highest effect was achieved by 2% lemongrass followed by lower concentrations in descending order due to its highly valuable effectiveness of the phenolic compounds antioxidant activity. Lemongrass in food technology challenges for replacing the commercial and synthetic antioxidants (ofadverse health effectuations) with equivalent or even better natural antioxidants, supplying chicken and meat products with good alternatives for functional healthy food products.

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References

[1]. Acton M., Salgues C., Renerre M. (1993). Etude des relations oxidatives entre les lipids membranaires et la myoglobin in vitro. Science Alimentaire, 13 : 261-264.
[2]. Aguirrezábal, M. M., Mateo, J., Domınguez, M. C., & Zumalacárregui, J. M. (2000). The effect of paprika, garlic and salt on rancidity in dry sausages. Meat science, 54(1), 77-81.
[3]. Ahn, J., Grün, I. U., & Mustapha, A. (2007). Effects of plant extracts on microbial growth, color change, and lipid oxidation in cooked beef. Food Microbiology, 24(1), 7-14.
[4]. Amarowicz, R., Pegg, R. B., Rahimi-Moghaddam, P., Barl, B., & Weil, J. A. (2004). Free-radical scavenging capacity and antioxidant activity of selected plant species from the Canadian prairies. Food chemistry, 84(4), 551-562.
[5]. Byrne, D. V., Bredie, W. L. P., Bak, L. S., Bertelsen, G., Martens, H., & Martens, M. (2001). Sensory and chemical analysis of cooked porcine meat patties in relation to warmed-over flavour and pre-slaughter stress. Meat Science, 59(3), 229-249.
[6]. Clark, E. M., Mahoney, A. W., & Carpenter, C. E. (1997). Heme and total iron in ready-to-eat chicken. Journal of Agricultural and Food Chemistry, 45(1), 124-126.
[7]. de Moraes Barros, H. R., de Castro Ferreira, T. A. P., & Genovese, M. I. (2012). Antioxidant capacity and mineral content of pulp and peel from commercial cultivars of citrus from Brazil. Food Chemistry, 134(4), 1892-1898.
[8]. Devatkal, S. K., & Naveena, B. M. (2010). Effect of salt, kinnow and pomegranate fruit by-product powders on color and oxidative stability of raw ground goat meat during refrigerated storage. Meat science, 85(2), 306-311.
[9]. Devatkal, S. K., Narsaiah, K., & Borah, A. (2010). Anti-oxidant effect of extracts of kinnow rind, pomegranate rind and seed powders in cooked goat meat patties. Meat Science, 85(1), 155-159.
[10]. Djenane, D, L. Montaes, P. Roncales, 2005. Nuevas perspectivas para la conservacion natural de la carne. Eurcarne, 133:53-180.
[11]. Engy F. Zaki, Abdel Aziz Nadir, Ibrahim Mohamed Fouad Helmy ,Nahed M. Abdel Maguid 2018. Antioxidant and antimicrobial effects of Lemongrass (Cymbopogon citrates) oil on the quality characteristics of Camel burger "camburger" under refrigerated storage. Int. J.Curr. Microbiol. App. Sci 7 (3) 3623- 3631.
[12]. Falowo, A. B., Fayemi, P.O., Muchenje, V. (2014). Natural antioxidants against lipid-protein oxidative deterioration in meat and meat products. A Review.Food Res. Int., 64,171-181.
[13]. Graf, E., & Panther, S. S. (1991). Inhibition of Warmed- over Flavor Development by Polyvalent Cations. Journal of food science, 56(4), 1055-1058.
[14]. Hafiz A. O., Hassan, Z., & Abdul Manap, M. N. (2015). Effect of Slaughtering Methods on Meat Quality Indicators, Chemical Changes and Microbiological Quality of Broiler Chicken Meat during Refrigerated Storage. IOSR Journal of Agriculture and Veterinary Science, 8(9), 12-17.
[15]. Hasim, Falah S, Ayunda RD, Faridah DN. Potential of lemongrass leaves extract (Cymbopogon citratus) as prevention for oil oxidation. Journal of Chemical and Pharmaceutical Research. 2015; 7(10):55-60.
[16]. Hyam M. Ibrahim, Ferial M. Abu Salem, 2013. Effect of adding Lemongrass and Lime Peel Extracts on Chicken Patties Quality. Journal of Applied Sciences Research, 9 (8): 5035-5047.

[17]. Jaramillo-Flores, M. E., González-Cruz, L., Cornejo-Mazon, M., Dorantes-Alvarez, L., Gutierrez-Lopez, G. F., & Hernandez-Sanchez, H. (2003). Effect of thermal treatment on the antioxidant activity and content of carotenoids and phenolic compounds of cactus pear cladodes (Opuntia ficus-indica). Food science and technology international, 9(4), 271-278.
[18]. Johnston, J.E., H.A. Sepe, C.L. Miano, R.G. Brannan and A.L. Aiderton, 2005. Money inhibits lipid oxidation in ready- to eat ground beef patties. Meat Sci., 70: 627- 631.
[19]. Kanatt, S. R., Chawla, S. P., & Sharma, A. (2014). Antioxidant and radio-protective activities of lemon grass and star anise extracts. Food bioscience, 6, 24-30.
[20]. Krzywicki, K. (1982). The determination of heme pigment in meat. Meat Science, 7, 29.
[21]. Kulkarni, S., DeSantos, F. A., Kattamuri, S., Rossi, S. J., & Brewer, M. S. (2011). Effect of grape seed extract on oxidative, color and sensory stability of a pre-cooked, frozen, re-heated beef sausage model system. Meat science, 88(1), 139-144.
[22]. Lee, B. J., & Hendricks, D. G. (1995). Protective effect of phytic acid against lipid peroxidation in beef round muscle. Journal of Food Science, 60(2), 241-244.
[23]. Lee, B. J., Hendricks, D. G., & Cornforth, D. P. (1998). Antioxidant effects of carnosine and phytic acid in a model beef system. Journal of Food Science, 63(3), 394-398.
[24]. Lee, S. C., Kim, J. H., Jeong, S. M., Kim, D. R., Ha, J. U., Nam, K. C., & Ahn, D. U. (2003). Effect of far-infrared radiation on the antioxidant activity of rice hulls. Journal of agricultural and food chemistry, 51(15), 4400-4403.
[25]. Marin, F. R., Frutos, M. J., Perez-Alvarez, J. A., Martinez-Sanchez, F., & Del Rio, J. A. (2002). Flavonoids as nutraceuticals: structural related antioxidant properties and their role on ascorbic acid preservation. In Studies in natural products chemistry (Vol. 26, pp. 741-778). Elsevier.
[26]. Mei, L., AD Crum and E.A. Decker, 1994. Development of lipid oxidation and inactivation of antioxidant enzymes in cooked pork and beef. Food Lipids, 1:273-83.
[27]. Mitsumoto, M., O'Grady, M. N., Kerry, J. P., & Buckley, D. J. (2005). Addition of tea catechins and vitamin C on sensory evaluation, colour and lipid stability during chilled storage in cooked or raw beef and chicken patties. Meat Science, 69(4), 773-779.
[28]. Naveena, B. M., Muthukumar, M., Sen, A. R., Babji, Y., & Murthy, T. R. K. (2006). Improvement of shelf-life of buffalo meat using lactic acid, clove oil and vitamin C during retail display. Meat Science, 74(2), 409-415.
[29]. Nunez de Gonzalez, M.T., R.M. Boleman, R.K. Miller, J.T. Keeton and K.S. Rhee, 2008. Antioxidant properties of dried plum ingredients in raw and precooked pork sausage. J. Food Sci., 73: H63-71.
[30]. Olorunnisola, S. K., Asiyanbi, H. T., Hammed, A. M., & Simsek, S. (2014). Biological properties of lemongrass: An overview. International Food Research Journal, 21(2), 455.
[31]. Ozer, O., & Sariçoban, C. (2010). The effects of butylated hydroxyanisole, ascorbic acid, and α-tocopherol on some quality characteristics of mechanically deboned chicken patty during freeze storage. Czech Journal of Food Sciences, 28(2), 150-160.
[32]. Öztürk, M., Aydoğmuş-Öztürk, F., Duru, M. E., & Topçu, G. (2007). Antioxidant activity of stem and root extracts of Rhubarb (Rheum ribes): An edible medicinal plant. Food Chemistry, 103(2), 623-630.
[33]. Pearson, S. (1981) Chemical Analysis of Food. Edinburgh, London Melbourne and New York.
[34]. Purchas R.W., Simcock D.C., Knight T.W., Wilkinson B.H.P. (2003). Variation in the form of iron in beef and lamb meat and losses of iron during cooking and storage. International Journal of Food Science and Technology, 38: 827- 837.
[35]. Renerre, M., Anton, M., & Gatellier, P. (1992). Autoxidation of purified myoglobin from two bovine muscles. Meat science, 32(3), 331-342.
[36]. Sampaio, G. R., Salanha, T., Soares, R.A.M., Torres, E.A.F.S. (2012) . Effect of natural antioxidant combinations on lipid oxidation in cooked chicken meat during refrigerated storage.. Food Chemistrey 135, 1383-1390.
[37]. Stockey, L. L. (1970). Ferrozine---a new spectrophotometric reagent for iron. Analytical chemistry, 42(7), 779-781.
[38]. Tiwari, M., Dwivedi, U.N. and Kakkar P. 2010. Suppression of oxidative stress and pro-inflammatory mediators by Cymbopogon citratus D. Stapf extract in lipopolysaccharide stimulated murine alveolar macrophages. Food and Chemical Toxicology 48: 2913–2919.
[39]. Zhang, H., Wu, J., & Guo, X. (2016). Effects of antimicrobial and antioxidant activities of spice extracts on raw chicken meat quality. Food Science and Human Wellness, 5(1), 39-48.

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