International
Research Journal of

FOOD AND NUTRITION

Volume 01 | Issue 01 | 2019

SciRange
PUBLICATIONS
www.scirange.com

SciRange

Open Access

International Research Journal of Food and Nutrition

Research Article

pISSN: 2663-7170, eISSN: 2663-7189

Physical, Chemical and Microbiological Changes in Refrigerated Minced Cow Meat Patties Treated with Different Concentrations of Ginger Extract

[1]O.P. Olatidoye, [2]S.S. Sobowale, [3]R.A. Oluwafemi and [4]A.O. Alabi

[1]Department of Food Technology, Yaba College of Technology, Lagos State, Nigeria
[2]Department of Food Science and Technology, Moshood Abiola Polytechnic, Abeokuta, Nigeria
[3]Department of Animal Science, Igbinedion University Okada, Edo State, Nigeria
[4]Department of Food Technology, The Polytechnic Ibadan, Saki Campus, Nigeria

ARTICLE INFORMATION

Received: December 01, 2018

Accepted: January 14, 2019

Published: February 15, 2019

Corresponding Author:
O.P. Olatidoye,
Department of Food Technology,
Yaba College of Technology,
Lagos State, Nigeria

ABSTRACT

The addition of antioxidant to food products has become an important method of increasing the shelf life of food because it helps to retard fat oxidation and improve the stability of lipid and lipid containing food which helps to prevent sensory and nutritional quality loss. Hence, the aim of this study was to evaluate the effect of ginger extracts addition on minced meat at concentration of 0.2, 0.4, 0.6 and 0.8% with regard to dry matter in order to provide a new source of natural antioxidants and/or antimicrobial agents. Some chemical, sensory and microbial characteristics of the prepared minced meat during storage for 8 days at 4°C were evaluated. The addition of these extracts and storage time had a significant effect on the minced meat throughout the storage period. Minced meat samples with 0.8% realized significant reduction towards lowering Biogenic Amines (BAs) formation, thiobarbituric acid reactive substances (TBARS) levels, volatile basic nitrogen (VBN) and total acidity % relative to control sample. The addition of ginger extracts was significantly effective in reducing histamine, tyramine and putrescine formation, thiobarbituric acid reactive substances (TBARS) levels, volatile basic nitrogen (VBN) and total acidity % relative to control sample during the storage period. Compared to control mince meat, the addition of ginger extracts was effective as antioxidant and antimicrobial agents for improving the quality and safety of mince meat. In general, these effects increase with the concentration of the extract. This study indicated that the addition of natural antioxidant extracts during minced meat processing could enhance quality and provide a safer product. The results also indicated that 0.6 and 0.8% ginger extract improved the microbiological quality and prolonged the shelf-life of the minced beef to six days of retail displayed at 4°C.

Key words: Minced cow meat, ginger extracts, chemical and sensory attributes, antioxidants, antimicrobial agents

INTRODUCTION

Shelf-life of refrigerated fresh muscle foods is determined mainly by microbiological and physical qualities during storage and handling. Reduced product quality results in reduced consumer acceptance[1]. Decontamination of fresh meat using chemical agents depends on concentration, type and exposure times[2,3]. Antioxidants are very important

to the food industry in which manufacturers strived to produce high quality food with superior texture, color, flavor and nutritional values and also to improve the shelf life of the food. However, many foods are subject to many factors that lead to quality deterioration. Among these undesirable factors, lipid auto oxidation is one of the most concerned. The need of protecting food against oxidative degradation has prompted the wide usage of food additives. Lipid oxidation and the growth of undesirable microorganisms in food products results in the development of spoilage, off flavor, rancidity and deterioration, rendering such products unacceptable for human consumption[4] and yielding many compounds that contribute to the pathogenesis of cancer, atherosclerosis, heart and allergic diseases[5,6].

Lipids play an important role in technological, nutritional and sensory function of food. However they were liable to undergo autooxidation that leads to the formation of a number of undesirable compounds. In an effort to retard this process, various antioxidants were employed. The application of synthetic antioxidants has recently been restricted because there was suspicion that they were carcinogenic. For this reason a growing interest has been paid to the research of natural antioxidants, among which spices occupy an important position[7,8,9]. The natural antioxidants found in plants have gained considerable interest for their role in preventing the auto-oxidation of fats, oils and fat containing food products[10]. The antioxidant properties of herbs, spices, plant and other food extracts were apparently related to their phenolic content, suggesting that antioxidant action was similar to that of synthetic phenolic antioxidants[11]. Due to concerns about toxicological safety of synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT), naturally derived antioxidants are perceived to be better and safer than synthetics. Moreover, natural plants were considered an important target to investigate in order to provide a new source of natural antioxidants and/or antimicrobial agents from a safety view point. Consequently, there was a practical need for the screening and selection of natural antioxidants as effective alternatives in the prevention of food deterioration[12]. Several plants with very high nutritive values exist and yet remain unexploited for human and animal benefits[13]. Therefore, the search for and development of other antioxidants and antimicrobials of natural origin were highly desirable. Lipid oxidation and microbial growth in meat products may be controlled or at least minimized by using either synthetic or natural food additives commonly used in the meat industry[14-18].

Ginger (*Zinger officinale*) is a popular spice, grown everywhere in Nigeria. It is widely used as a spice and food seasoning due to its sweet aroma and pungent taste. It is well known to have antioxidant activity and effective antimicrobial agents. Many papers have reported ginger antioxidant activity against the oxidation of lipid in various model systems such as lard, vegetable oils, oil/water emulsion etc[19-21]. This antioxidant effect was shown to be linked to the presence of gingerol related compounds and diaryl heptanoid[12]. The main objectives of the present study were to evaluate effect of ginger addition on the physical, chemical and microbiological properties of cow meat patties during storage at 4°C for 8 days.

MATERIALS AND METHODS

Materials: Ginger rhizomes (*Zingiber officinal*) were purchased from a local market in Benin, Edo State and other chemicals used were of analytical grade and obtained from Sigma Chemical Co (St. Louis, MO).

Preparation of ginger extracts: Ginger rhizomes were ground and passed through a 60 mesh screen. Ginger extract was produced by a modified method of Byun *et al.*[22]. One hundred grams of ground ginger were defatted by shaking three times with four volumes of petroleum ether in a rotary shaker for 1 h. The residue obtained after filtration was dried overnight under a hood until all traces of petroleum ether were removed. The dried residue was extracted three times with four volumes of 90% ethanol by shaking for 1 h and filtered. The combined filtrate was concentrated in a rotavapour and placed under a hood to remove the residual ethanol. The obtained aqueous extract was frozen overnight and freeze-dried at –60°C (Dura-Dry, USA). The freeze-dried extract was stored in airtight containers at 5°C until use[23].

Preparation of mince meat: Minced meat was prepared to provide five treatment samples. Minced meat was subdivided into five equal parts and control treatment was formulated without plant extracts. The other treatments were prepared by adding the various concentrations of ginger extracts to minced meat at 0.2 to 0.8% based on dry matter and then mixed thoroughly using a meat former. The minced meat were placed on plastic foam meat trays, wrapped with polyethylene film and kept in a refrigerator at 4°C for 8 days. The effects of the addition of natural antioxidant extracts and storage time were analyzed and determined in minced meat for 0, 2, 4 and 8 days of storage time at 4°C.

Chemical analyses

pH determination: The pH of the mince meat sample was determined using a Kent pH meter (Kent Industry Measurement Limited Survey model 7020 equipment with glass electrode). A 10 g of mince meat sample was aseptically removed and homogenized with 10m of sterile distilled water. The water was decanted and its pH determined in duplicates. The pH meter was calibrated using buffer of pH 4.0 and pH 7.0

Thiobarbituric acid reactive substances (TBARS): The TBARS values were determined spectrophotometrically according to the method described by Maijala and Eerola[24]. Homogenized luncheon samples (2 g) were taken and TBARS were extracted twice with 10 mL of 0.4 M Hydrogen chloride acid. Extracts were collected and made up to 25 mL with 0.4 M Hydrogen chloride acid and then centrifuged for 5 min. After centrifugation, 1 mL of the extract was poured into a glass test-tube with a stopper. TBARS reagent (5 mL) was added and the extract was heated in a boiling water bath for 35 min. After cooling in tap-water, the absorbance of the sample was read against the appropriate blank at 538 nm. A standard curve was prepared using 1, 1, 3, 3-tetraethoxypropane (TEP).

Total acidity determination: The total acidity was obtained by direct titration with (0.1 M) NaOH and phenolphthalein as indicator[25]. Ten grams of each sample were magnetically stirred in a total volume of 100 mL distilled water for 30 min and filtered. Ten milliliter filtrate was titrated with (0.1 M) NaOH using three drops of phenolphthalein as indicator. The total acidity was calculated as 1.0 mL of (0.1 M) NaOH = 0.0090 g lactic acid.

Determination of total volatile basic nitrogen (VBN): A sample (10 g) was minced with 100 mL distilled water and washed into a distillation flask with 100 mL distilled water; then 2 g of magnesium oxide and an antifoaming agent were added. The mixture was distilled using the micro Kjeldahl distillation apparatus. Distillate was collected for 25 min into 25 mL 4% boric acid and five drops of Tashero indicator. The solution was titrated using (0.1 M) HCl to calculate the total volatile basic nitrogen in the sample in terms of mg VBN/100 g luncheon meat as described by Pearson[26].

Biogenic amines determination: Histamine, tyramine and putrescine were extracted as follows: five grams of the sample were blended with 25 mL 5% trichloroacetic acid. Filtration was achieved using whatman filter paper No. 1. Five milliliter of the extract were transferred into a suitable culture tube with 4 g NaCl and 1 mL of 50% NaOH and then shaken for 2 min. Centrifugation was carried out for 5 min at 5000 x g and the upper layer was transferred to a 50 mL separating funnel. A 15 mL of *n*-heptane was added to the upper layer extract and extracted 3 times with 1 mL portions of 0.2 N HCl. The extracts were collected in a glass stoppered tube and evaporated to dryness using a water bath at 95°C with the aid of a gentle current of air. This was followed by the formation of Dansylamines described by the method of Latorre-Moratalla *et al.*[27]. Biogenic amine concentrations were determined according to method of Sahoo[28] using the HPLC. The HPLC system was equipped with a (Waters 600) delivery system. The HPLC column was a reverse phase column 250×4 mm, 10 µm packing, (Macherey-Naggl). The detection was performed using a U.V detector at 254 nm wavelength, using a linear program of 25 min periods and 1 mL min^{-1} constant solvent flow rate. Data were integrated and recorded using Chromatography; Manger software 2010, (Waters, Milford MA 01757).

Microbiological evaluation of minced meat: Appropriate diluents of each tube were placed on the following media in duplicate; plate count agar (Difco Co., Ltd.) for total aerobic count; reinforced clostridial medium (Oxoid, CM 0149) for total anaerobic count; malt extract agar (Oxoid, CM 0059) for total yeast and mould count.

Statistical analysis: The conventional statistical methods were used to calculate means and standard deviations. All the measurements were replicated three times and the data are presented as Mean±SD. The effects of natural antioxidant extracts addition and storage period were analyzed and the obtained data were subjected to analysis of variance (one way ANOVA) according to PC-STAT, Version IA Copyright 1985, the University of Georgia (PC-STAT, 1985).

RESULTS AND DISCUSSION

pH changes: The effect of ginger extracts on the pH values of mince meat stored at 4°C for 8 days is shown in Table 1. At time zero, the pH of the control and all tested samples had the same value (5.55). Control samples, generally, had higher pH values than the other samples throughout the storage time. The pH values of the control and mince meat containing ginger antioxidant extracts were significantly ($p<0.05$) increased gradually throughout the storage period. During storage time (2-8 days) it was noticed that the pH value of the control samples was higher (6.32) than the other tested samples. At the 8th day mince meat containing 8% ginger

Table 1: Effect of ginger extract on pH changes and TBARS value of mince meat samples during storage at 4°C for 8 days

Meat samples	Day 0	Day 2	Day 4	Day 6	Day 8
pH values					
Control	5.55±0.012^{t}	5.96±0.012a^{s}	6.10±0.015a^{r}	6.20±0.010a^{q}	6.32±0.002a^{p}
0.2%	5.55±0.012^{t}	5.94±0.010b^{s}	5.99±0.006a^{r}	6.12±0.006b^{q}	6.18±0.006b^{p}
0.4%	5.55±0.012^{t}	5.92±0.002c^{s}	5.97±0.006b^{r}	6.10±0.006c^{q}	6.15±0.001c^{p}
0.6%	5.55±0.012^{t}	5.90±0.006d^{s}	5.95±0.001c^{r}	6.00±0.019d^{q}	6.10±0.006d^{p}
0.8%	5.55±0.012^{t}	5.88±0.002e^{s}	5.90±0.006d^{r}	5.98±0.006e^{q}	6.08±0.001e^{p}
TBARS values (malonaldehyde mg kg^{-1} meat)					
Control	2.25±0.2^{t}	3.88±0.012	5.25±0.015	6.40±0.010	7.25±0.020
0.2%	0.88±0.02^{t}	0.29±0.010	0.40±0.006	0.51±0.006	0.58±0.006
0.4%	1.07±0.06^{t}	0.25±0.006	0.35±0.006	0.45±0.006	0.51±0.006
0.6%	0.99±0.03^{t}	0.22±0.006	0.32±0.006	0.40±0.019	0.48±0.006
0.8%	0.55±0.00^{t}	0.19±0.006	0.28±0.006	0.36±0.006	0.41±0.006

All values determinations±standard deviation (SD) are mean of triplicate. Means within column and row with different letters are significantly different ($p<0.05$)

Table 2: Effect ginger extracts on total acidity (% lactic acid) in meat patties stored at 4°C for 8 days

Meat samples	Day 0	Day 2	Day 4	Day 6	Day 8
Control	0.34±0.012e	0.40±0.012d	0.44±0.015c	0.55±0.010b	0.61±0.020a
0.2%	0.34±0.012e	0.38±0.010d	0.40±0.006c	0.51±0.006b	0.58±0.006a
0.4%	0.34±0.012e	0.32±0.006d	0.35±0.006c	0.45±0.006b	0.51±0.006a
0.6%	0.34±0.012e	0.28±0.006d	0.32±0.006c	0.40±0.019b	0.48±0.006a
0.8%	0.34±0.012e	0.24±0.006d	0.28±0.006c	0.36±0.006b	0.41±0.006a

All values determinations±standard deviation (SD) are mean of triplicate. Means within column and row with different letters are significantly different ($p<0.05$)

extract had the lowest (6.08) pH value. Similar findings in pork patties and in ground buffalo meat containing BHA/BHT antioxidants during refrigerated and frozen storage, respectively have been reported by Sahoo[28], Hayam *et al.*[29] and Jay[30]. Also, similar reports were in lamb patties containing natural plant extract during refrigerated storage[30]. The increase in pH may be due to the accumulation of metabolites by bacterial action in meat and deamination of proteins[31]. Bacteria, upon exhaustion of stored glucose, utilize amino acids released during protein breakdown and, as a product of amino acid degradation, ammonia accumulates and pH rises[32].

Thiobarbituric acid reactive substances (TBARS): The data presented in Table 1 show the changes of TBARS values in the mince meat containing ginger extracts stored at 4°C for 8 days. The ginger extracts were effective as antioxidants and lowered TBARS values than the control samples throughout the storage period. The effectiveness of the added ginger extracts as antioxidants inhibiting lipid oxidation throughout storage time could be shown in the following order of decreasing TBARS values: 8% > 6% > 4% > 2%. Results also show that the 8% extract was the most effective antioxidant and 2% ginger extract had the lowest effect. This can indicate that the ginger extract used as antioxidants was effective against TBARS formation when incorporated into mince meat. Similar finding in lamb meat containing some natural plant extracts during refrigerated storage have been reported[28,30,33,34]. Chen *et al.*[34] reported that dried herbs and their essential oils were successfully used to reduce lipid oxidation in meat products. Polyphenolic extracts are excellent electron and proton donors and their intermediate radicals are quite stable due to electron delocalization phenomena and owing to the lack of positions attackable by oxygen[35]. In the present study, since the ginger extracts used in preparing mince meat contain bioactive substances such as phenolic compounds[36-39]; these substances could cause an inhibition of the chain reactions during lipid oxidation. Therefore, it was possible to conclude that in general, the higher concentration of applied ginger extract, the less malonaldehyde was formed. The oxidative stability effect of ginger presumably was related to their gingerol related compounds. The higher concentration of these compounds could better inhibit lipid oxidation.

Total acidity: Total acidity (% lactic acid) of all the tested mince meat samples stored for 8 days at 4°C were of the same acidity % at zero time of storage (Table 2). Total acidity percentage was observed to increase throughout the storage period. The initial amount of total acidity in mince meat increased with increasing storage time was reported[40]. Higher acidity of meat may be a positive indicator of storability due to the inhibition of microbial growth by acid and can improve the storability of the luncheon meat treated with natural extracts[41].

Table 3: Effect ginger extracts on volatile basic nitrogen in meat patties stored at 4°C for 8 days

Meat samples	Day 0	Day 2	Day 4	Day 6	Day 8
Control	0.032±0.002e	0.037±0.006d	0.044±0.025c	0.050±0.006b	0.059±0.002a
0.2%	0.032±0.002e	0.042±0.015d	0.048±0.010c	0.055±0.006b	0.065±0.006a
0.4%	0.032±0.002e	0.045±0.002d	0.050±0.006c	0.058±0.001b	0.069±0.006a
0.6%	0.032±0.002e	0.051±0.003d	0.056±0.003c	0.062±0.006b	0.075±0.003a
0.8%	0.032±0.002e	0.062±0.001d	0.065±0.001c	0.071±0.002b	0.078±0.002a

All values determinations±standard deviation (SD) are mean of triplicate. Means within column and row with different letters are significantly different ($p<0.05$)

Table 4: Effect ginger extracts on the concentration of biogenic amines in mince meat stored at 4°C for 8 days

Meat samples	Day 0	Day 2	Day 4	Day 6	Day 8
Histamine concentration (mg kg^{-1})					
Control	ND	4.10a	6.22a	9.34a	11.22a
0.2%	ND	2.89b	4.03b	5.21b	6.36b
0.4%	ND	2.09c	4.11b	5.09c	6.21bc
0.6%	ND	1.67d	3.74c	4.89d	6.10bc
0.8%	ND	1.02e	2.11d	3.55e	5.44c
Tyramine concentration (mg kg^{-1})					
Control	ND	5.38a	7.84a	9.21a	13.34a
0.2%	ND	3.94b	5.89b	7.44b	9.04b
0.4%	ND	2.66c	4.61c	6.88c	8.33c
0.6%	ND	1.72d	3.68d	5.33d	7.43d
0.8%	ND	1.21e	2.44e	4.77e	4.61e
Putrescine concentration (mg kg^{-1})					
Control	ND	6.14a	8.22a	10.32a	12.58a
0.2%	ND	4.16b	5.53b	7.11b	7.90b
0.4%	ND	3.84c	5.12c	6.88c	7.44c
0.6%	ND	3.22d	4.81d	6.02d	6.40d
0.8%	ND	2.78e	3.51e	5.11e	6.55d

Control: Patties without any extract, ND: Not Detected, M±SD: Mean±Standard Deviation, Letters a-e to show significant differences ($p<0.05$) between columns, Letters w-z to show significant differences ($p<0.05$) between rows

Volatile Basic Nitrogen (VBN): The volatile basic nitrogen (VBN) could be used as a quality indicator for fish and meat products[42] and is associated with the amino acid decarboxylase activity of microorganism during storage. Changes in VBN value during storage are shown in Table 3. At zero time of the storage period, the VBN of mince meat samples showed no significant differences between the control sample and the studied samples. During storage at 4°C and storage for 8 days of the mince meat samples, the VBN % tended to increase gradually. The control sample had higher VBN % than samples with 0.2, 0.3 and 0.4% ginger extract. Addition of ginger extract caused decrease in VBN% and thus improvement of mince meat characters can occur. In pork sausages, green tea powder could partly substitute nitrite and resulted in lower TBARS value and decreased volatile basic nitrogen contents compared to samples prepared with nitrite alone[43].

Biogenic amines (Bas): Table 4 shows the effect of adding ginger extracts to mince meat stored at 4°C for 8 days on the formation of biogenic amines. The production of biogenic amines during the storage or processing of food products is an extremely complex phenomenon depending on several variables, such as the growth of microorganisms, several extrinsic and intrinsic factors during the manufacturing process such as formulation, some physico-chemical parameters and proteolytic and decarboxylase activities which interact with each other[44,45]. It was observed that storage time had a significant effect ($p<0.05$) on the formation of all the estimated biogenic amines. Histamine concentrations varied from 4.26 to 11.04 mg kg^{-1} in the control sample during storage at 4°C for 8 days. Data in Table 1 show that histamine concentrations of all the mince meat samples increased significantly ($p<0.05$) with storage time. Ginger extracts were effective in producing lower histamine concentrations than control samples over the storage period. The permitted level of tyramine in foods is 100-800 mg kg^{-1}, while 1080 mg kg^{-1} is toxic. Results show that 0.8% ginger extract was the most effective while 0.2% ginger was the least effective. Tyramine concentrations in the present study, were found in the safe range and lower than the permitted level. The tyramine contents in the mince meat containing the tested extracts were still less than the control level at day 8. Eerola *et al.*[46] observed that tyramine concentration in sausages increased during 7 days of storage at 4°C. The reduction in tyramine formation through natural antioxidant extracts is important

Table 5: Effect of ginger extract on Aerobic plate count, mould and yeast count of minced meat samples during storage at 4°C for 8 days

Meat samples	Day 0	Day 2	Day 4	Day 6	Day 8
Aerobic plate count (log cfu g $^{-1}$)					
Control	5.10±0.2	5.96±0.02	6.10±0.15	6.20±0.01	6.32±0.02
0.2%	5.10±0.2	5.94±0.01	5.99±0.15	6.12±0.06	6.18±0.06
0.4%	5.10±0.2	5.92±0.02	5.97±0.15	6.10±0.06	6.15±0.01
0.6%	5.10±0.2	5.90±0.06	5.95±0.01	6.00±0.01	6.10±0.06
0.8%	5.10±0.2	5.88±0.02	5.90±0.06	5.98±0.06	6.08±0.01
Anaerobic plate count (log cfu g^{-1})					
Control	5.10±0.2	2.66±0.02	2.90±0.15	3.20±0.01	3.82±0.02
0.2%	5.10±0.2	2.24±0.01	2.44±0.15	2.72±0.06	2.98±0.06
0.4%	5.10±0.2	1.92±0.02	2.30±00.15	2.51±0.06	2.66±0.01
0.6%	5.10±0.2	1.20±0.06	1.95±0.01	2.21±0.01	2.40±0.06
0.8%	5.10±0.2	0.78±0.02	0.91±0.06	ND	ND
Mould and yeast counts (log cfu g^{-1})					
Control	2.25±0.2	2.88±0.01	3.25±0.015	3.50±0.01	3.85±0.02
0.2%	2.25±0.2	2.60±0.01	3.01±0.006	3.21±0.06	3.55±0.06
0.4%	2.25±0.2	2.45±0.06	2.85±0.006	2.85±0.06	3.21±0.06
0.6%	2.25±0.2	2.50±0.06	2.62±0.006	2.40±0.09	3.04±0.06
0.8%	2.25±0.2	2.41±0.06	2.55±0.006	2.65±0.06	2.81±0.06

All values determinations±standard deviation (SD) are mean of triplicate. Means within column and row with different letters and numbers are significantly different ($p<0.05$)

with respect to human health because tyramine causes migraine, headaches, increased blood pressure and an increase in noradrenalin. The addition of the ginger extracts in the preparation of the mince meat stored at 4°C for 8 days significantly affected ($p<0.05$) the formation of putrescine. Thus, the addition of ginger extracts was found to be effective in reducing the formation of Putrescine. This reduction could also be due to the antimicrobial activities of the natural extracts. Putrescine formation depends on the total aerobic count where a high total aerobic count results in high putrescine formation[47]. Therefore, it can be stated that the addition of natural plant extracts to mince meat resulted in a marked significant reduction in histamine, tyramine and putrescine formation.

Microbial changes: Meat is prone to both microbial and oxidative spoilage and therefore it is important to use a preservative with both antioxidant and antimicrobial properties[48]. The growing concern about the safety of foods has led to the development of natural antimicrobials to control food-borne pathogen[49]. Table 5 shows the effect of adding natural plant extracts to the prepared meat patties stored at 4°C for 8 days on Aerobic Plate Count (APC). Results presented in Table 5. Showed that addition of different levels of ginger extract decreased the initial microbial count (0 day) partially and slowed down the growth during the storage period with increase in the concentrations ginger extract. A remarkable increased was observed in APC throughout the storage period especially in the control at 6 and 8th days from 6.32-7.57 Log CFU g^{-1}, respectively. It has been reported by Insausti *et al.*[50] that meat spoilage cannot be said to occur until Total Viable Count (TVC) counts reach 10^6-10^8 cfu g^{-1} which is the limit of microbiological acceptability. In general, a significant decrease was noticed for all tested meat sample in their aerobic plate count during the storage period (2-8 days). It was worth noting that sample containing 0.8% ginger extract gave the lowest APC and the patties with 0.2% ginger extract had the highest compared the other samples. Thus, the results show that the Aerobic Plate Count (APC) decreased significantly with the increase in the concentration of the natural plant extracts during storage at 4°C for 8 days. Igbinosa *et* al.[51] concluded that Jatropha curcas stem bark could be a potential source of active antimicrobial agents. Also, Hayam *et al.*[52] opined that natural plant extract could also be a potential antioxidant and antimicrobial agent in lamb meat patties. Jitoe *et al.*[42] and Zia-ur-Rehman *et al.*[53] found that ginger has antioxidant activity and effective antimicrobial agents. Mould and yeast counts of the prepared meat patties containing natural plant extract during storage for 8 days at 4°C are given in Table 5. It was observed that the addition of the natural plant extracts and the storage time had a significant effect on the mould and yeast counts. The control samples had the highest mould and yeast counts throughout the storage period. In general, the meat samples containing the natural plant extract increased in their mould and yeast counts at the end of storage period. Meat patties containing 0.2% ginger extract were noticed to have the highest mould and yeast counts. A higher reduction in mould and yeast counts was observed in the patties containing 0.8% ginger extract during the storage time. Thus, addition of the natural

extracts reduced the mould and yeast counts in the prepared meat patties. Spices and herbs used in food stuffs for enhancing flavor or color attributes, generally have antimicrobial as well as antioxidant activities[53-57]. The addition of 0.8% natural plant extract was found to be more effective in reducing APC and mould and yeast counts in the tested meat patties. The microbiological quality of meat products purchased by the consumer depends on factors such as the quality of the raw materials, materials used or added during processing operations to the products as extraneous contaminants, sanitation during processing and packaging. At concentration of 0.6 and 0.8%, ginger extract significantly reduced aerobic counts in the samples. The bactericidal effects of 0.8% ginger extract in laboratory media was determined on various microorganisms which are commonly encountered in food industry as reported by various authors[42,51-54,56].

CONCLUSION

Comparison of control and treated minced meat patty samples during storage at 4°C for 8 days showed that the addition of the ginger extracts contained high level of total phenolic compounds and was effective as antioxidant and anti microbial agents for improving quality and safety of mince meat. The results show that ginger extract was effective against the formation of biogenic amines (histamine, tyramine and putrescine), TBARS levels, VBN% and acidity %; hence improvement of the stored meat samples characters can occur. The addition of ginger extracts to meat resulted in a significant reduction in histamine, tyramine and putrescine formation. Thus, the use of natural antioxidants is important to preserve the quality of meat products and prevent their oxidative deterioration in order to produce mince meat of high quality and safety.

REFERENCES

1. Lee, J.I., E.H. Shin, C.R. Kim and K.H. Kim, 1996. Reducing microbial populations on refrigerated pork hams treated with acetic acid. Korean J. Food Nutr., 9: 484.
2. Marshall, D.L. and C.R. Kim, 1996. Microbiological and sensory analyses of refrigerated catfish fillets treated with acetic and lactic acids. J. Food Qual., 19: 317-329.
3. Kim, C.R., J.O. Hearnsberger, A.P. Vickery, C.H. White and D.L. Marshall, 1995. Extending shelf life of refrigerated cat fish fillets using sodium acetate and monopotassium phosphate. J. Food Protect., 58: 644-647.
4. Bozin, B., N. Mimica-Dukic, I. Samojlik and E.A. Jovin, 2007. Antimicrobial and antioxidant properties of rosemary and sage (*Rosmarinus officinalis* L. and *Salvia officinalis* L., Lamiaceae) essential oils. J. Agric. Food, 55: 7879-7885.
5. Mielnik, M.B., S. Signe, E. Bjorg and S. Grete 2008. By-products from herbs essential oil production as ingredient in marinade for turkey thigh. Food Sci. Technol., 41: 93-100.
6. Tang, S., J.P. Kerr, D. Sheehan, D.J. Buckley and P.A. Morrissey 2001. Antioxidative effect of added tea catechins on susceptibility of cooked red meat, poultry and fish patties to lipid oxidation. Food Res. Int., 34: 651-657.
7. Bozkurt, H., 2006. Utilization of natural antioxidants: Green tea extract and Thymbra breakfast sausage manufactured with mechanically debond chicken meat. Poult. Sci., 73: 442-450.
8. Mitsumoto, M., M.N. O'Grady, J.P. Kerry and D.J. Buckley, 2005. Addition of tea catechins and vitamin C on sensory evaluation, color and lipid stability during chilled storage in cooked or raw beef and chicken patties. Meat Sci., 69: 773-779.
9. Valko, M., D. Leibfritz, J. Moncol, M.T. Cronin, M. Mazur and J. Telser, 2007. Free radicals and antioxidants in normal physiological functions and human disease. Int. J. Biochem. Cell Biol., 39: 44-84.
10. Reddy, V., A. Urooj and A. Kumar, 2005. Evaluation of antioxidant activity of some plant extracts and their application in biscuits. Food Chem., 90: 317-321.
11. Lai, S.M., J.I. Gray, D.M. Smith, A.M. Booren, R.L. Crackel and D.J. Buckley, 1991. Effects of oleoresin rosemary, Tertiary butyl-hydroquinone and sodium tripolyphosphate on the development of oxidative rancidity in restructured chicken nuggets. J. Food Sci., 56: 616-620.
12. Kikuzaki, H. and N. Nakatani, 1993. Antioxidant effects of some ginger constituents. J. Food Sci., 58: 1407-1410.
13. Oladele, P.E. and A.A. Oshodi, 2007. Nutritional potential of berlandier nettle spurge (*Jatropha catharetica*) seed. Pak. J. Nutr., 6: 345-348.
14. Gray, J.J., E.A. Gomaa and D.J. Buckley, 1996. Oxidative quality and shelf life of meats. Meat Sci., 43: 111-123.
15. Mielnik, M.B., K. Abby and G. Skrede, 2003. Synthetic antioxidants control lipid oxidation in mechanically deboned turkey meat. Meat Sci., 65: 1147-1155.
16. Sallam, K.H.I., M. Ishioroshi and K. Samejim, 2004. Antioxidant and antimicrobial effects of garlic in chicken sausage. Lebensm. Wiss Technol., 37: 849-855.
17. Estevez, M. and R. Cava, 2006. Effectiveness of rosemary essential oil as an inhibitor of lipid and protein oxidation: Contradictory effects in different types of frankfurters. Meat Sci., 72: 348-355.
18. Takacsova, M., K. Kristianova, D.V. Nguyen and M.N. Dang, 2000. Antioxidant activity of ginger extract in ground pork patties. Czech J. Food Sci., 18: 155-156.
19. Yanishlleva, N.V., A.E. Marinov and J. Pokorny, 2006. Natural antioxidants from herbs and spices. Eur. J. Lipid Sci. Technol., 108: 776-793.
20. Madsen, H.L. and G. Bertelsen, 1995. Spices as antioxidants. Trends Food Sci. Technol., 6: 271-277.

21. Mansour, E.H. and A.H. Khalil, 2000. Evaluation of antioxidant activity of some plant extracts and their application to ground beef patties. Food Chem., 69: 135-141.
22. Byun, M.W., J.W. Lee, C. Jo and H.S. Yook, 2001. Quality properties of sausage made with gamma-irradiated natural pork and lamb casing. Meat Sci., 59: 223-228.
23. Egan, H., R.S. KirK and R. Sawyer, 1987. Pearson's Chemical Analysis of Foods. 8th Edn., Longman Scientific and Technical, pp: 708.
24. Maijala, R.L. and S.H. Eerola, 1993. Contaminant Lactic acid bacteria of dry sausage produced histamine and tyramine. Meat Sci., 35: 387-395.
25. Deabes, M.M., 2000. Studies on Some Biogenic Amines in Some Meat and Fish Products with Respect to Other Quality Attributes. M.Sc. Thesis, Food Science and Technology Deptartment, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.
26. Pearson, D., 1976. The Chemical Analysis of Foods. 7th Edn., Living Stone: Churchill, pp: 19, 23-24.
27. Latorre-Moratalla, M.L., T. Veciana-Nogues, S. Bover-Cid, M. Garriga and T. Aymerich *et al*., 2008. Biogenic amine in traditional fermented sausage produced in selected European countries. Food Chem., 107: 912-921.
28. Sahoo, J., 1995. Effect of pre-blending and vacuum packaging on the quality of ground buffalo meat, Ph.D. Thesis submitted to Deemed University, IVRI, Izatnagar, India.
29. Hayam, M.I., A.A. Abou-Arab and F.M. Abu Salem, 2011. Antioxidant and antimicrobial effects of some natural plant extracts added to lamb patties during storage. Grasasy Aceites, 62:139-148.
30. Jay, J.M., 1996. Antioxidants. In: Modern Food Microbiology, 4th Edn., CBS Publishers and Distributors, New Delhi, India, pp: 265-266.
31. Gill, C.O., 1983. Meat spoilage and evaluation of the potential storage life of fresh meat. J. Food Protect., 46: 444-452.
32. Estevez, M., D. Morcuende, J. Ventanas and R. Cava, 2004. Effect of the Addition of Sage and Rosemary Extracts on the Oxidative Stability of Different Types of Liver Pates. In: Proceedings of 50th ICOMST, Helsinki, Finland, pp: 194-195.
33. Formanek, Z., J.P. Kerry, F.M. Higgins, D.J. Buckley, P.A. Morrissey and J. Farkas, 2001. Addition of synthetic and natural antioxidants to α-tocopheryl acetate supplemented beef patties: Effects of antioxidants and packaging on lipid oxidation. Meat Sci., 58: 337-341.
34. Chen, X., C. Jo, J.I. Lee and D.U. Ahn, 1999. Lipid oxidation,volatiles and color changes of irradiated pork patties as affected by antioxidants. J. Food Sci., 64: 16-19.
35. Djenane, D., L. Montanes and P. Roncales, 2005. Nuevas perspectivas para la conservacion natural de la carne. Eurocarne, 133: 153-180.
36. El Diwani, G., S. El Rafie and S. Hawash, 2009. Protection of biodiesel and oil from degradation by natural antioxidants of Egyptian Jatropha. Int. J. Environ. Sci. Technol., 6: 369-378.
37. Stoilova, I., A. Krastanov, A. Stoyanova, P. Denev and S. Gargova, 2007. Antioxidant activity of a ginger extract (*Zingiber officinale*). Food Chem., 102: 764-770.
38. El-Halawany, A.M.A., 2002. Pharmacognostical Study of Simmondsia Chinenisis (Link) Schneider Family Buxaceae (Simmondsiaceae) Cultivated in Egypt. M.Sc. Thesis Pharmaceutical Science (pharmacognosy), Pharmacognosy Department, Faculty of Pharmacy, Cairo University.
39. Fuzzati, N., 2004. Analysis methods of ginsenosides. J. Chromatogr. B, 812: 119-133.
40. AL-Bachir, M., 2005. The irradiation of spices, packaging materials and luncheon meat toimprove the storage life of the end products Int. J. Food Sci. Technol., 40: 197-204.
41. AL-Bachir, M. and A. Mehio, 2001. Irradiated luncheon meat: Microbiological, chemical and sensory characteristics during storage. Food Chem., 75: 169-175.
42. Choi, S.H., H.C. Kwon, D.J. An, J.R. Park and D.H. Oh, 2003. Nitrite contents and storage properties of sausage added with green tea powder. Korean J. Food Sci. Anim. Resour., 23: 299-308.
43. Jitoe, A., T. Masuda, I.P. Tengah, D.N. Suprapta, I.W. Gara and N. Nakatan, 1992. Antioxidant activity of tropical ginger extract and analysis of the contained curcuminoids. J. Agric. Food Chem., 40: 1337-1340.
44. Suzzi, G. and F. Gardini, 2003. Biogenic amines in dry fermented sausages: A review. Int. J. Food Microbiol., 88: 41-54.
45. Georgnaras, I., G.A. Dykes and A. von Holy, 1995. Biogenic amine formation by chicken-associated spoilage and pathogenic bacteria. Lett. Appl. Microbiol., 21: 164-166.
46. Eerola, S., A.X.R. Sagues, L. Lilleberg and H. Aalto, 1997. Biogenic amines in dry sausages during shelf-life storage. Zeitung Lebensmittel for Unters Forsch A., 255: 351-355.
47. Ruiz-Capillas, C. and F. Jimenez-Colmenero, 2004. Biogenic amines in meat and meat products. Crit. Rev. Food Sci. Nutr., 44: 489-499.
48. Kanatt, S.R., R. Chander and A. Sharma, 2008. Chitosan and meat mixture: A new preservative for meat products. Food Chem., 107: 845-852.
49. Nevas, M., A.R. Korhonem, M. Lindorom, P. Turkki and H. Korkeela, 2004. Antibacterial efficiency of fish spices essential oil against pathogenic and bacterial. J. Food Protect., 67: 199-202.
50. Insausti, K., M.J. Beriain, A. Parroy, P. Alberti, C. Gorraiz, C. Alzuek and M.J. Alzueta, 2001. Shelf life of beef from local Spanish cattle breed stored under modified atmosphere. Meat Sci., 57: 273-781.
51. Igbinosa, O.O., E.O. Igbinosa and O.A. Aiyegoro, 2009. Antimicrobial activity and phytochemical screening of the stem bark extract from *Jathropha curcas* (Linn). Afr. J. Pharm. Pharmacol., 3: 58-62.

52. Hayam, M.I., A.A. Abou-Arab and F.M. Abu Salem, 2010. Addition of some natural plant extracts and their effect on lamb patties quality. J. Food Technol., 8: 134-142.
53. Zia-ur-Rehman, S., A.M. Salariya and F. Habib, 2003. Antioxidant activity of ginger extract in sunflower oil. J. Sci. Food Agric., 83: 624-629.
54. Baydar, H., O. Sagdic, O. Gulcan and T. Karadogan, 2004. Antibacterial activity and composition of essential oils from *Origanum*, *Thymbra*, an *Satureja* species with commercial importance in Turkey. Food Control, 15: 169-172.
55. Sagdic, O. and M. Ozcan, 2002. Antibacterial activity of Turkish spice hydrolysis. Food Control, 14: 141-143.
56. Vinci, G. and M.L. Antonelli, 2002. Biogenic amines: quality index of freshness in red and white meat. Food Control, 13: 519-524.
57. Yanishlieva, N.V. and E.M. Marinova, 2001. Stabilization of edible oils with natural antioxidant. Eur. J. Lipid Sci. Technol., 103: 752-767.