ABSTRACT
Foodborne diseases affect millions of people each year. More effective treatment methods are needed to reduce incidence of food poisoning organisms in food. In the present study, the prevalence of S. aureus, E. coli and salmonella was evaluated in 100 samples of chicken fillet collected from chicken processing shops in Cairo governorate. The prevalence of S. aureus, E. coli and salmonella was 56%, 70% and 12%, respectively. The effect of marinating chicken fillet with some medicinal plants such as extracts of Moringa, lemon and green tea against S. aureus, E. coli and Salmonella was studied. The 100% lemon extract showed the best antibacterial activity decreasing count of S. aureus, E. coli and salmonella 3, 3.5, 3-log cfu/g, respectively. On the other hand, the 6% moringa extract was better than the 4% and the 2.5% green tea extract was better than the 1% in decreasing the bacterial count. This indicates the effectiveness of such extracts in controlling bacterial growth in chicken meat and can be applied as well to other meats.

KEYWORDS: Moringa Oleifera, Lemon, Green tea, chicken, meat.

INTRODUCTION
Raw meat, particularly poultry meat, remains a source of human infection with pathogenic microorganisms. It can be easily contaminated with microorganisms because fresh meat is very suitable for microbial multiplication (Hinton, 2000).

Staphylococcus aureus is a significant cause of avian diseases and may thus contaminate food because of carcasses processing (Mead and Dodd, 1990). Enterotoxin-producing S. aureus is the most common cause of foodborne human illness throughout the world (Do Carmo et al., 2004).

E. coli is responsible for 25% of the infant diarrhea in developing countries (WHO, 2000). Shiga toxin producing E. coli (STEC) was first recognized as a human pathogen in 1982 in the USA when strains of serotype O157:H7 caused two outbreaks of hemorrhagic colitis (Wells et al., 1983).

Most Salmonella found in poultry meat are non-host-specific and are capable of causing human food poisoning. Salmonellosis (gastroenteritis) is the most common food borne disease in human with an incubation period of 6 to 72 hours (Behraves, 2008). Bacterial food borne diseases are very expensive causing huge losses to the food industry and consumers. Despite methods to reduce or eliminate bacterial food borne pathogens, food poisoning is still a major concern (Shan et al., 2007).

Moringa (Moringa Oleifera) leaf is a natural ingredient reported to be high in crude protein content (Bey, 2010). Moringa leaf powder could be used as food or for medicinal and therapeutic purposes (Anwar et al., 2007). It is used for improving wound healing, gastric ulcer, diarrhea, sore throat and cancer (Grever, 2001). In many countries, Moringa leaves are used as traditional medicine for treating common illnesses (Trees for Life, 2005).

Lemon is an important medicinal plant of the family Rutaceae. It is cultivated mainly for its alkaloids, which have anticancer activities and the antibacterial potential in the crude extracts of different parts (viz., leaves, stem, root and flower) of Lemon against clinically significant bacterial strains has been reported (Kawai et al., 2000).

Citrus flavonoids have a large spectrum of biological activities including antibacterial, antifungal, antidiabetic, anticancer and antiviral activities (Burt, 2004; Ortuno et al., 2006). Lemon juices are highly useful as antibacterial agents (Vijayakumar and Wolf-Hall, 2002).

Green tea contains catechin and epicatechin, which have been extensively studied and shown to be effective.
against a wide range of food borne pathogens (Taguri et al., 2004). There have been numerous studies on polyphenols found in green tea and their health benefits. Not only is green tea an antioxidant, but is also known for its antibacterial, antmyotic, antiviral as well as antitoxic activities against bacterial hemolysins (Okubo et al., 1989).

Therefore, this study was planned to determine the prevalence of S. aureus, E. coli and Salmonella as food poisoning organisms in chicken fillet. Further, studying the antibacterial effects of some medicinal plants (Moringa Oleifera, Lemon and Green tea extracts) on contaminated chicken fillets.

MATERIALS AND METHODS

Collection of Samples

A total of 100 chicken breast fillet samples were collected from chicken processing shops in Cairo governorate and transported to the laboratory in ice box without delay to be examined.

Preparation of Food Homogenate

Sample preparation was applied according to APHA (1992). Twenty-five grams of each examined chicken fillet samples were transferred to 225 ml of sterile buffered peptone water 0.1% then homogenized by stomacher for 2 minutes to provide a homogenate of 1/10 dil. The isolation and enumeration of Staphylococcus aureus (S. aureus) was carried out according to FDA (2001), count of Escherichia coli (E. coli) was according to APHA (1992) and isolation of Salmonella spp. was according to FDA (2007).

Preparation of Plant extracts

a. Moringa extract

According to Bichi et al., (2012), 10 g of Moringa Oleifera leaves powder was added to 200 ml distilled water and blended in high speed mixer for 30 minutes at 150 rpm to extract the active ingredients then filtered through Whatman filter paper and the filtrate was made up to 500 ml with distilled water in sterile beaker. This stock solution was used to formulate product at two concentrations: 4 and 6% aqueous suspension to be used in the experimental study.

b. Lemon extract

Samples were cut into halves using sterile knife and the liquid was squeezed individually in sterile container.

This extract was marked as 100% concentrated juice extract. Concentration of 50% was prepared by diluting the 100% extract with right volume of sterilized distilled water (Owhe-Ureghe et al., 2010).

c. Green tea extract

Ten grams of ground dry green tea was added to 100 ml of distilled water and heated at 30- 40°C for 45 min with a magnetic stirrer (DELTa Model HM- 101, Industries LTD). The mixture was then filtered with Whatman paper and the filtrate was used as green tea extract at concentrations 1 and 2.5% aqueous suspension (Sarah et al., 2010).

Preparation of bacterial cultures

S. aureus (ATCC 29213), E. coli (ATCC 8739) and Salmonella enterica (ATCC14028) were kindly supplied by the Department of Food Hygiene, Animal Health Research Institute, Dokki, Giza. From frozen cultures, the bacteria were activated with two successive passages in 9 ml of tryptic soy broth (TSB) (Oxoid) and incubated at 37°C for 18 h. For each individual bacterial strain, 1 ml of the stock inoculum was added to 100 ml of TSB and incubated with shaking at 37°C for 18 - 24 h to reach a final concentration of approximately 10^5 CFU/mL (determined by plating serial dilutions on TBX for E. coli, Baired Parker for S. aureus and XLD for Salmonella enterica agar). Nine ml of this inoculum was added to 25 ml of sterile saline to give approximately 10^{1} CFU/mL (Corry et al. 2007).

Preparation of the experimental food model

Raw chicken breast fillets (boneless) were washed 10 times with distilled water and rinsed twice in sterile water, then cut into pieces of 5 cm x 5 cm using a sterile knife. The pieces were kept in sterile open petri dishes and exposed to UV (at 254 nm) for 30 min on each side and then frozen at -20°C for 24 hrs (Valtierra-Rodriguez el., 2010).

Inoculation of the experimental food model

Chicken breast fillet samples were divided into 4 groups as shown in Table (1).

### Table (1): Experimental groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Treatment</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group (1)</td>
<td>Control group: fillets pieces were each inoculated with different concentrations of Moringa Oleifera, Lemon and Green tea extracts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group (2)</td>
<td>Fillets pieces inoculated with 100 μl of 10^2  cfu/mL of S. aureus</td>
<td>no extract</td>
<td>4%</td>
<td>6%</td>
<td>100%</td>
</tr>
<tr>
<td>Group (3)</td>
<td>Fillets pieces inoculated with 100 μl of 10^2  cfu/mL of E. coli</td>
<td></td>
<td>Moringa oleifera</td>
<td>Moringa oleifera</td>
<td>1 %</td>
</tr>
<tr>
<td>Group (4)</td>
<td>Fillets pieces inoculated with 100 μl of 10^2  cfu/mL of Salmonella enterica</td>
<td></td>
<td>50% lemon extract</td>
<td>100% lemon extract</td>
<td>2.5% Green tea extract</td>
</tr>
</tbody>
</table>
The fillets pieces were incubated with different bacterial inoculum as indicated in Table (1) at room temperature for 30 min in a well aerated sterile bottle to allow bacterial attachment (Murari et al., 2012). Inoculated chicken fillet pieces were individually dipped in the different concentrations of the different extracts for 5 minutes, then left to dry in the laminar flow for 15 minutes. Microbial growth was assessed on the experimentally inoculated chicken fillet at zero day and every two days after incubation at 4°C until the signs of spoilage were detected (S. aureus according to FDA (2001), E. coli according to APHA (1992) and Salmonella enterica according to FDA (2007)). These experimental procedures were repeated three times.

Sensory evaluation
Sensory analysis (taste, color and odor) was assessed according to the descriptive sensory method of Hedonic ASTM, (1969) as shown in Table (2).

Table (2): Sensory evaluation of chicken fillets.

<table>
<thead>
<tr>
<th>Sensory attributes description score</th>
<th>Sensory attributes description score</th>
</tr>
</thead>
<tbody>
<tr>
<td>natural flavor, color and odor of fillet 5</td>
<td>natural flavor, color and odor of fillet 5</td>
</tr>
<tr>
<td>No sensible change in natural flavor, color and odor 4</td>
<td>No sensible change in natural flavor, color and odor 4</td>
</tr>
<tr>
<td>Sensible discoloration, Slightly sour odor and incipient rancidity in flavor 3</td>
<td>Sensible discoloration, Slightly sour odor and incipient rancidity in flavor 3</td>
</tr>
<tr>
<td>no natural color, moderately off-odor and off-flavor 2</td>
<td>no natural color, moderately off-odor and off-flavor 2</td>
</tr>
<tr>
<td>Sharply sour and extremely rancid flavor/odor, extremely discolored 1</td>
<td>Sharply sour and extremely rancid flavor/odor, extremely discolored 1</td>
</tr>
</tbody>
</table>

RESULTS
Prevalence of S. aureus, E. coli and Salmonella in examined chicken fillet samples
S. aureus, E. coli and Salmonella were recovered from 100 samples of chicken fillet with incidence rates of 56%, 70% and 12 %, respectively.

Count of S. aureus (log_{10} cfu/g) ranged from 1.78 to 2.54 with average of 2.10±0.03 and E. coli (log_{10} cfu/g) ranged from 1.30 to 6 with average of 3.03±0.19.

S. aureus count in chicken fillet marinated with Moringa Oleifera through 8 days of incubation
Count of S. aureus in group 1 and group 2B1 (4%) decreased by the 2nd day of incubation. In group 2B1, S. aureus decreased by 0.5 log cfu/g then increased until the end of incubation. Meanwhile, in group 2B2 (6%), S. aureus count decreased on the 2nd day of incubation and continued till the 4th day by one log cfu/g then began to increase from the 6th day till the end of incubation (Fig. 1).

![Fig (1): Mean S. aureus count in chicken fillet marinated with Moringa Oleifera through 8 days of incubation. M; Moringa Oleifera.](image)

E. coli count in chicken fillet marinated with Moringa Oleifera through 8 days of incubation
Count of E. coli as illustrated in Fig. 2, in the control group decreased by 2nd day then increased again after the 4th day till the end of incubation, while in 4% Moringa-treated fillets it decreased by the 2nd day and 4th day of incubation by 0.5 log cfu/g then remained nearly stable till the end of incubation. Moreover, in 6% Moringa-treated fillets, E. coli count decreased from the 2nd day of incubation until the end of the incubation by 1.5 log cfu/g.
Salmonella count in chicken fillet marinated with Moringa Oleifera through 8 days of incubation

In Fig. 3, count of Salmonella in the control group showed slight decrease by the 2nd day then continued to increase from the 4th day until the end of incubation. While with 4% Moringa-treated Salmonella, the count decreased by the 2nd day by 0.3 log cfu/g then increased by the 4th day until the end of incubation. In contrast, the 6% Moringa decreased the Salmonella count from the second day till the end of incubation by one log cfu/g.

S. aureus count in chicken fillet marinated with lemon juice through 8 days of incubation

Count of S. aureus in the control group showed slight decrease during the 2nd and 4th days of incubation then began to increase till the end of incubation. While in 50% lemon-treated, count of S. aureus decreased from the 2nd day of storage until the 6th day by 2 log cfu/g then slightly increased till the end of incubation. Moreover, in 100% lemon-treated, S. aureus count decreased 3 log cfu/g during incubation till the 6th day of incubation then slight increase was detected (Fig. 4).
**Fig (4):** Mean *S. aureus* count in chicken fillet marinated with lemon juice through 8 days of incubation. L; lemon juice.

*E. coli* count in chicken fillet marinated with lemon juice through 8 days of incubation

*E. coli* count in control group slightly decreased from 2\textsuperscript{nd} day of storage till 4\textsuperscript{th} day then increased again till the end of incubation. While with adding 50% lemon juice, count decreased during till the 6\textsuperscript{th} day of incubation by about 3 log cfu/g in contrast to 3.5 log cfu/g decrease in 100% lemon treated group till also 6\textsuperscript{th} day then the count increased at the 8\textsuperscript{th} day of incubation as illustrated in Fig. 5.

**Fig (5):** Mean *E. coli* count in chicken fillet marinated with lemon juice through 8 days of incubation. L; lemon juice.

*Salmonella* count in chicken fillet marinated with lemon juice through 8 days of incubation

In Fig. 6, *Salmonella* count in the control group showed no significant decrease from the 2\textsuperscript{nd} day of incubation till the 4\textsuperscript{th} day then increased again till the end of incubation. While with adding 50% lemon juice, *Salmonella* decreased till the 6\textsuperscript{th} day of incubation by about 2 log cfu/g. With 100% lemon juice, the count decreased by 3 log cfu/g till also the 6\textsuperscript{th} day then increased till the end of incubation.
Fig (6): Mean Salmonella count in chicken fillet marinated with lemon juice through 8 days of incubation. Salm; Salmonella, L; lemon juice.

S. aureus count in chicken fillet marinated with green tea through 8 days of incubation
Fig. 7 shows decrease of S. aureus count in control group, 1% and 2.5% green tea treated groups from the 2nd day till the 4th day then the count increased from the 6th day till the end of incubation. This decrease in 1% and 2.5% green tea were nearly similar with about 0.5 log cfu/g as compared to the control.

Fig (7): Mean S. aureus count in chicken fillet marinated with green tea through 8 days of incubation. GT; green tea.

E. coli count in chicken fillet marinated with green tea through 8 days of incubation
In Fig. 8, E. coli count was stable in the control group on the 2nd day then increased from the 4th day till the end of incubation. E. coli count decreased with 2.5% green tea from the 2nd till the 4th day of incubation with about 1 log cfu/g more than the decrease with the 1% green tea treated which was 0.5 log cfu/g, then the count increased from 6th day till the end of incubation for both concentrations.
Salmonella count in chicken fillet marinated with green tea through 8 days of incubation

Salmonella count in the control group showed nonsignificant decrease on the 2nd day and 4th day then increased from the 6th day till the end of incubation. While 1% green tea treated group showed decreased count of Salmonella by the 2nd day till the 4th day of incubation by 0.5 log cfu/g then increased thereafter till the end of incubation. Moreover, with 2.5% green tea Salmonella decreased from the 2nd day till the 4th day of incubation by 1 log cfu/g then the count increased thereafter till the end of incubation.

Sensory evaluation of the chicken fillet after 8 days of incubation with different extracts

Change in the sensory characters in the control groups 2A, 3A, 4A during preservation at 4°C began from day 2 with score (3) and day 3 with score (2) and score (1) at 6th day of incubation. Adding of different concentrations of Moringa olifera and green tea changed the fillet color to slightly greenish with score (4). On the contrary, lemon extract did not result in any color change with score (4).

DISCUSSION

Raw meat, particularly poultry meat, remains an important source of human infection with pathogenic microorganisms. It can easily be contaminated with microorganisms because fresh meat is very suitable for
microbial multiplication. Poultry meat has high water activity, rich in nutrients and readily utilisable low molecular weight substances and is a source of carbon and energy by means of glucose, lactic acid, amino acids, creatines, metal and soluble phosphorus (Hinton 2000).

*S. aureus* prevalence in chicken fillet was 56%. This is nearly similar to Kitai et al., (2005) (65.8%), Javadi and saeid (2011) (65%) and Martins et al., (2013) (62%) but higher than that obtained by Kozaciki et al., (2012) (17.9%), Bhaisare et al., (2014) (11.25%), Schaumburg et al., (2014) (3%) and Khaled et al., (2015) (3.3%). The presence of *S. aureus* in food commonly indicates contamination that may be directly introduced by workers who have skin lesions contaminated with *S. aureus*, or sneezing, coughing, or unclean hands and contaminated utensils and equipment. The hazard develops into toxin formation when raw materials and products are exposed to temperatures between 10°C and 21.1°C for more than 12 hrs or to temperatures greater than 21.1°C for more than 3 hrs (FDA, 2001), so its presence indicates poor sanitation during processing.

*E. coli* prevalence in chicken fillet was 70%. This count was closely similar to Bhaisare et al., (2014) (70.2%), Odwar et al., (2014) (78%) and Edris et al., (2015) (70%) but higher than that obtained by Vaidya et al., (2005) (14.57%) and Khaled et al., (2015) (10%) and lower than that obtained by Huong et al., (2009) (100%) and Saikia and Joshi (2010) (98%). Presence of *E. coli* in high numbers indicates fecal or sewage pollution. This is also due to improper slaughtering techniques, contaminated surfaces and/or handling of the meat by infected food handlers (Nel et al., 2004).

*Salmonella* prevalence in chicken fillet was 12%. This is nearly similar to Kozaciniski et al., (2006) (10.60%) and Kozaciki et al., (2012) (7.5%). Higher results were obtained by Thai et al., (2012) (42.9 %). Saed et al., (2013) (22%) and Bhaisare et al., (2014) (33.16%). Lower results were reported by Rabie et al., (2012) (4%), Anju et al., (2014) (4.44%) and Khaled et al., (2015) (3.3%). The primary reservoir of *Salmonella* is the intestinal tract of animals and birds, which contaminate the muscles and organs during slaughtering (Paiaio et al., 2013). Poultry and poultry products are the most potential source of *Salmonella*-food poisoning in man (Lynch et al., 2006) that can be transmitted to humans through handling of raw products or through consumption of undercooked poultry meat (Kimura et al., 2004).

Due to uncontrolled use of antibiotics and their side effects such as anaphylaxis, digestive problems, teeth and bone staining, fungal infections and photosensitivity according to the World Health Organization. And overuse of prescription antibiotics which can lead to the development of antibiotic-resistant strains of bacteria, many medical experts are taking a new look at natural, safe antibiotic alternatives.

During the last few decades, the global interest in the study of various medicinal plants has increased rapidly due to their antibacterial and antioxidant activities, low toxicity and the potential to be a cheaper alternative to costly synthetic drugs (Chew et al., 2012). Therefore, such plants should be investigated to better understand their properties, safety and efficiency.

The effect of Moringa Oleifera is due to the presence of some phytochemicals, but most importantly due to the activity of a short polypeptide named 4 a-Lrhamnosylxy benzyl-isothiocyanate (Guevara et al., 1999) and the rare combination of zeatin, quercetin, kaempferol among many other phytochemical compounds (Bukar et al., 2010). These compounds might be responsible for the significant decrease in the count of *S. aureus*, *E. coli* and *Salmonella* in the Moringa treated chicken fillet samples.

This results match those of Hitzschky et al., (2010) who studied the antibacterial effects of aqueous extracts of Moringa seeds (Moringa Oleifera) at concentrations of 1:5 and 1:10 in volumes of 50, 100, 150 and 200 μL against Staphylococcus aureus, Escherichia coli (isolated from the organism and the aquatic environment) and Salmonella enteritidis. Antibacterial activity (inhibition > 13 nm) against *S. aureus* and *E. coli* isolated from the white leg shrimp was detected in aqueous extracts of Moringa but the antibacterial effects on *Salmonella enteritidis* was not demonstrated.

Adeyemi et al., (2013) studied the antimicrobial effect of Moringa Oleifera on smoke-dried catfish. The treatments were the control, 1%, 2% and 3% (w/v) Moringa Oleifera Marinade. At all levels of treatment, bacterial counts for *S. aureus* and *E. coli* decreased as compared to the control samples. The 3% concentration exhibited the highest antibacterial potency. Zeid (2014) studied the effect of Moringa leaf powder (0.5, 0.75, 1%) in beef burger and showed that addition of Moringa at any level improved the stability characteristics and microbial quality of beef burger without affecting the sensory characteristics. Tolba et al., (2014) studied the effects of 2, 4, 6% of Moringa Oleifera leaves extract on the microbial contamination of experimentally inoculated fresh fish fillets with 10² cfu/g of *S. aureus*. They found that 6% Moringa was more effective as compared to 2% or 4% in reduction of *S. aureus* count where it was reduced by 1 log cfu/g within the first 5 days of the experiment.

The higher concentration of the Moringa extract (6%) showed was better than the lower concentration (4%) in decreasing the count of *S. aureus*, *E. coli* and *Salmonella* with average (1 log cfu/g) which helped increasing shelf life of chicken meat. This could be enhanced as well by...
the effects of low temperature on reducing bacterial growth.

The effect of lemon juice is mainly due to the essential oils known to penetrate the cell membrane and mitochondrial membranes, thereby increasing permeability of the organelles, which lead to ion leakage (Raybaudi-Massilia et al., 2006). Citrus species also contain a group of flavonoids including polymethoxy flavones, flavone glycosides and limonoids that enhance antimicrobial activity (Ladaniya, 2008). Citrus flavonoids have broad spectrum of biological activities including antibacterial, antifungal, anti-diabetic, anticancer and antiviral activities (Burt, 2004, Ortuno et al., 2006). The results reported here are similar to those shown by El-Khawas et al., (2015) where lemon juice (2% citric acids) reduced S. aureus by 2 log cfu/g and significantly reduced Salmonella (2 log cfu/g) and E. coli (3 log cfu/g) counts. Kumar et al., (2012) showed similarly that lemon juice inhibited the growth of S. aureus, E. coli and Salmonella with inhibition zones of 19.33±1.24, 20.0±0.81 and 21.66±0.47, respectively, but differ from Murali et al., (2012) who reported that lemon killed Salmonella after 36 hrs of incubation with a 5-log reduction in growth within 1 hr of incubation.

Lemon extract at 100% concentration showed the best antibacterial activity that decreased count of S. aureus, E. coli and salmonella with 3, 3.5, 3 log cfu/g, respectively. On the other hand, 50% Lemon extract was less effective where it decreased the count of S. aureus, E. coli and salmonella with 2, 3, 2 log cfu/g, respectively.

The bacterial growth inhibitory effects of green tea are mainly related to their polyphenolic components including epicatechin, epicatechin gallate, epigallocatechin, and epigallocatechin gallate against various Gram-positive and Gram-negative bacteria (Blanco et al., 2005, Zhao et al., 2002). Green tea leaves extract can prevent the attachment of pathogenic bacteria on the host cell membrane. Thus, green tea extract inhibits the adhesion of bacteria on host cell surface membranes and acts as a potential antiadhesive agent (Lee et al., 2009). Further, Epigallocatechin gallate can reverse methicillin resistance of Methicillin resistant S. aureus (MRSA) by inhibiting the synthesis of Penicillin Binding Protein 2 (PBP2) (Yam et al., 1998). Higher green tea extract (2.5%) was better than the 1% concentration where it decreased the count of E. coli and Salmonella with average 1 log cfu/g and of low value on S. aureus count. Our results are nearly similar to Takabayashi et al., (2004) and Yee et al., (2002) who reported that green tea extract did not kill Salmonella enteritidis in chicken fillet even after 36 hrs, even though it showed decreased total bacterial count. Archana and Abraham (2011) assessed the antimicrobial activity based on measuring the inhibition zones. The organisms found to be sensitive to fresh green tea extracts with zones of inhibition 6 and 14 with E. coli and S. aureus, respectively. Maksun Radj, Rafael Adi Agustama (2013) showed that the inhibition zone diameter of green tea extracts for S. aureus ATCC 25923 and MRSA were 18.970±0.287 mm.

The use of the Moringa and green tea extracts affected the color of the chicken fillet, while lemon extract showed no significance difference up to 4th days of storage time. Sensory characteristics remained within good levels with the three extracts. Adeyemi et al., (2013) marinated catfish fillet with Moringa Oleifera (1, 2, 3%) and sensory scores showed no significance difference among the treatments in terms of color, flavor, juiciness and overall acceptability of fish samples. Najeeb et al., (2014) stated that the appearance, flavor, juiciness and overall acceptability value of the restructured chicken slices containing Moringa leaf powders (1%) were not affected and were safely stored without much loss in quality up to 20 days under refrigeration with lower microbial counts. Hazra et al., (2012) concluded that the use of crude extract of Moringa Oleifera leaves (1, 1.5 and 2%) had significant antioxidant and antimicrobial effects and improved the organoleptic quality by enhancing the tenderness and juiciness in cooked ground buffalo meat. Sarah et al., (2010) reported slightly bitter and greeny flavor with greenish-yellowish color for 5% and 2.5% green tea extract treatments at all sampling times. The discoloration changes of fish fillets dipped in 2.5% and 5% steadily increased with time in storage. This might be implicated to the possibly penetration of chlorophyll pigments and their subsequent interference with other biochemical active compounds in fillets of sturgeon, which caused an undesirable change in meat color. Anna et al., (2019) showed that chicken breast muscles marinated with lemon juice improve acceptability of sensory characteristics (reduction of brightness due to acid and increase of juiciness and tenderness) compared to control.

The results here showed that there is a high level of E. coli isolation from chickens examined in this study indicating possible fecal pollution or sewage contamination of water used for market washing of the fillet or contamination during slaughtering, handling or processing of the meat or infected workers.

Our results indicate the effectiveness of the Moringa Oleifera, lemon and green tea extracts in association with the low temperature of incubation in controlling bacterial growth in chicken meat for days and can be applied as well to other meats. However, the overall results for all the extracts used indicated that 4-5 days are the maximum days for storage of marinated chicken fillet at 4°C after which there will be an increase of bacterial growth. Such growth would cause fast spoilage that cannot be noticed due to the color of the extract or its odor that could be of health hazard if processed for consumption.
REFERENCES


