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Assessment of the effects of selected plant extracts on quality indices and shelf life of raw chilled chicken meat

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ABSTRACT

Chicken meat (Cornish Cross breed) is usually marketed at refrigerated temperature (1–4ºC). Quality and safety of refrigerated chicken meat is the main concern for consumers and retailers. Chicken meat is exposed to contamination from many sources during slaughtering and different manufacturing processes causing undesirable changes lead to microbial growth that results in spoilage and economic losses. Thus, the current study aimed to assess the effects of three different plant extracts (1% Laurel, 1% Moring and 1% Olive leaf extract) on the sensory attributes, chemical and bacteriological quality of raw chicken breast meat stored at 4 ± 1 ◦C for 16 days. Results revealed that samples treated with 1% laurel, 1% Moringa and 1% Olive extracts maintained the overall acceptability until 16th, 14th, 12thdays of cold storage, respectively. compared to control one which got spoiled after 6th day of cold storage. Samples treated with plant extracts showed significant decrease in their chemical analysis (pH, TVN and TBA) and marked decrease in bacterial counts (aerobic plate, total *coliform*, total *Staphylococci* counts) indicating that plant extracts have potent antioxidant and antibacterial effects. Best results were obtained in samples treated with 1% laurel extract followed by samples treated with 1% Moringa and finally those treated with 1% olive leaf extract.

1. INTRODUCTION

Poultry meat has many anticipated nutritional characteristics, such as low-fat content and somewhat high concentration of polyunsaturated fatty acids (Nkukwana et al., 2014). Although poultry meat is also known as low calorie food for its low-fat content, it's muscle lipids are highly subjected to oxidation due to the high unsaturation degree. Oxidation causes deterioration in meat color, flavor, texture, nutrient losses and poor shelf life. Simultaneously, some internal factors (iron content, antioxidant enzymes) and external factors (stress, temperature, feeding with highly oxidized feeds, slaughtering process, storage conditions, further processing steps, etc.) play an important role in oxidation process of poultry meat (Estévez, 2015). Furthermore, poultry meats are good protein sources, but after slaughtering, protein section of these meat can be oxidized initiating a secondary lipid oxidation of products and finally causes loss of functional properties and quality of meat protein (Estévez, 2015).

Molecular oxygen undergoes a chain of reactions that results in generation of free radicals. Under normal physiologic conditions a small percent (almost 2–5%) of the oxygen that consumed during the metabolic reaction is transformed into free radicals. These free radicals especially reactive nitrogen species (RNS) and reactive oxygen species (ROS) play a key regulatory role in homeostatic processes by interacting with fatty acids, proteins and nucleic acids. They act as transitional agents in essential oxidation–reduction reaction (Gaschler et al., 2014).

Primarily, when the production of ROS and RNS doesn't exceed the capability of endogenous antioxidant barriers in the body, it implements beneficial functions such as (modulation of skeletal muscle, control of gene expression, defense against invading pathogens and regulation of cell signaling pathways). In contrast, when there is an excess and low activity of antioxidant defense, it potentially causes damage of the cellular components, induces destructive autoimmune responses and causes oxidative stress (Barbieri and Sestili, 2012).

Understanding free radical activities in meat is so important because high levels of ROS might reduce meat sensory quality (Bartosz and Kołakowska, 2010), reduction of essential amino acids like tryptophan and phenylalanine (Ganhão et al., 2010), and loss of protein functions. As well as, degradation of polyunsaturated fatty acids section of meat lipids and diversion of oxymyoglobin [oxyMb (Fe2+)] to metmyoglobin [MetMb (Fe3+)] lead to generation of free radicals might result in deterioration of meat proteins (Suman and Joseph, 2013).

One of the key strategies to prevent protein and lipid oxidations occurring in poultry meat is the use of antioxidants. These antioxidants can be applied in fresh meat, meat products and feed (Descalzo and Sancho, 2008). Synthetic antioxidants like butylated hydroxyanisole (BHA) and), butylated hydroxytoluene (BHT) were commonly used as antioxidants in poultry meat but owing to their toxic effects, consumers and producers tended to

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the natural alternatives from plant sources (Aziz et al., 2017).

Thanks to their high phenolic content, spices, fruits, oilseeds, vegetables and grains seem to be good sources of natural antioxidants as a substitution to the synthetic ones (Shah et al., 2014). Most of these plant materials possess high chemical nutrients (carbohydrate, fat, protein), mineral contents (iron, calcium, potassium, phosphorus). Likewise, the use of natural antioxidant extracts has been reported to raise meat tenderness (Chulayo and Muchenje, 2013).

Natural antioxidants can be applied through dietary or in technological strategies to reduce oxidative reactions in muscle food. Technological strategies comprise the application of these antioxidants directly into meat and its products or through coating packaging materials with plant extracts to enhance the oxidative stability of the products (Shahidi and Zhong, 2010).

Laurus nobilis (Laurel or bay leaf) is an evergreen plant with 2–3 m high and a pair of stems. Alpha-tocopherol is the foremost isomer in its vegetative parts. Leaves comprise flavonoids, phenolic acids and isoquinoline alkaloids. Moreover, leaves and roots are rich in alpha-tocopherol and flavonoids (Farhoosh et al., 2008). Antimicrobial activity of laurel leaf extract has taken a great importance as a natural antioxidant as they are part of human diet and its biodegradability results in low poisonous residue problems (Hamdan and Masoud, 2020). L. nobilis has powerful antimicrobial activity against 20 strains of bacteria as *Staphylococcus aureus*, *Escherichia coli*, *Listeria monocytogenes* and *Salmonella* (Ouibrahim et al., 2013).

Moringa oleifera leaves (Drumstick leaves) have high quantities of ascorbic acid, phenolics, carotenoids and flavonoids (Anwar et al., 2007). So, it is considered as potent antimicrobial and antioxidant. M. oleifera leaf extract kept goat meat patties from the oxidative rancidity (Jayawardana et al., 2015). As well as it significantly extended ghee shelf life (Anwar et al., 2007). The leaves have antifungal and antimicrobial characteristics, therefore, have a proven history in food applications as a biopreservative and neutraceuticals (Das et al., 2012).

Olive leaves are observed as predominantly rich sources of phenolic composites (Silva et al., 2006). Their chief biological active compounds are classified into oleuropeosides (oleuropein and verbascoside), simple phenolics (tyrosol, hydroxytyrosol, caffeic acid, vanillic acid) and flavonoids (rutin, diosmetin, luteolin, luteolin-7- O-glucoside, diosmetin-7-O-glucoside) (Botsoglou et al., 2014). Phenolic compounds can inhibit the growth, proliferation and production of *Staphylococcus aureus* enterotoxins (Saleh et al., 2020).

In the present study, attempts were made for appreciating the potential application of natural bioactive compounds from natural plants to inhibit lipid and protein oxidation and improve oxidative stability in raw chicken meat. By this way, quality deteriorations and rancidity which are related to oxidation reactions can be minimized.

2. MATERIAL AND METHODS

2.1. Preparation of Laurel Leaf Extract (1% LLE)

Laurel leaves were collected; the unusable parts were removed then dried (in the shadow at ambient temperature) directly after washing. Final drying occurred under vacuum in an oven (at 50 ℃ for 45 min). Samples were properly powdered then kept at 25 ℃ (Tometri et al., 2020).

2.2. Preparation of Moringa Leaf Extract (1% MLE)

Moringa olifera extract was processed through air-drying then crushed into powder (2 mm sieve). Two hundred grams of dried plant samples were macerated with 800 ml ethanol-water solution (7:3) for a pair of days at room temperature. Using Whatmann no.1 filter paper, the extract was separated from residues then concentrated under less pressure using a rotary evaporator at 55 ℃. Extracts were lyophilized using freeze-drier then dried extracts were ready to be used (Falowo et al., 2017).

2.3. Preparation of Olive Leaf Extract (1% OLE)

Olive leaves were collected from olive trees during fruit ripening period, leaves were cleaned from exterior matter then washed properly and dried in hot air-oven (for 24 h at 40 ˚C). In a blender, dried leaves were ground in order to form a powder. Afterwards, 100 g of this powder were macerated in absolute ethanol (1000 ml) then allowed to extract for a period of 48 h (Dub and Dugani, 2013). The subsequent mixture (dark green brown in color) was then filtered. The filtrate was concentrated under reduced pressure in a rotary evaporator yielding the extracted compounds. The non-soluble parts of plant sample were usually discarded.

2.4. Preparation of samples

Fresh chicken breast meat slices (100 ± 10 g), 2 cm in thickness were collected from different local distributors in Toukh, Qalubyia governorate, Egypt. Samples were placed in separate sterile plastic bags in an icebox and transferred to the laboratory without undue delay under complete aseptic conditions (Elhadi et al., 2017). Chicken breast meat samples were divided into 2 groups (treated and control group). Treated groups were subdivided into three groups (27 samples for each one). First group samples were dipped in 1% LLE for 5 min with proper mixing, 2^{nd}group samples were dipped in 1% MLE for 5 min and 3^{rd}group samples in 1% OLE. All samples (treated and control) were stored at 4 ± 1 ◦C and examined every 2 days (0. 2^{nd}, 4^{th}, 6^{th}, 8^{th}, 10^{th},12^{th}, 14^{th}, 16^{th}) for sensory, chemical and bacteriological parameters. The scheme was replicated 3 times/day and the examination repeated every 2 days for 16 days of cold storage.

2.5. Sensory Evaluation and Overall Acceptance

Each sample was evaluated by 10 well- trained panelists. Everyone served chicken sample (100 ± 10 g) for each plant extract, they were asked to evaluate the sensory qualities (color, odor and texture). Samples were coded with random numbers; panelists were not acquainted about the experimental approach. They were requested to give a score indicating the overall acceptance of each sample (color, odor and texture)). A nine-point descriptive scale was used, score 9 was the highest, while score 1 was the lowest one (Horwitz, 2020).

2.6. Bacteriological Examination

Ten grams of treated chicken breast meat sample was homogenized with 90 mL of peptone water 0.1% under complete aseptic conditions. Ten-fold serial dilutions were prepared for each sample. Aerobic Plate count (APC) was carried out using Plate Count Agar (PCA) after incubation for 24 h at 37 ◦C. Total *Coliform* Count (TCC) was estimated using Violet Red Bile (VRB) agar medium after incubation 24 h at 37 ◦C and Total *Staphylococci* Count

(TSC) was evaluated using Baird Parker agar medium with incubation for 48 h at 37 ◦C.

2.7. Chemical Examination

2.7.1 pH measurement (Pearson, 2006)

Accurately 10 g of sample were blended with 10ml of neutralized distilled water. Homogenate was left for 10 minutes at room temperature with frequent shaking. By using an electrical pH meter, pH value was set (Bye model 6020, USA). Calibration of pH meter with two buffer solutions of previously known pH (alkaline pH 7.01, acidic pH 4.01) then, pH electrode was washed by neutralized water and introduced into homogenate after temperature correction system was adjusted.

2.7.2 Total Volatile Nitrogen content (TVN) (mg/100 g)

TVN was analyzed according to the technique recommended by Food and Agriculture Organization (FAO, 1980) as follows:

In a clean dry beaker, 10g of sample and 30 ml of distilled water were added and thoroughly mixed together by using a blender for 2 minutes. Then, 2 drops of 0.02 M HCl were added to carry pH value to 5.2. Homogenate was gradually heated to 70°C, cooled to room temperature and filtered. The outer ring of Conway unit was loaded with 1ml of saturated potassium carbonate (KCO3) and 2ml of sample extract. Conway unit was rotated gently, and the dish was covered then incubated at 36°C for 2 hours. By using methyl red indicator (T1 ml), HCl in the internal ring was titrated against 0.01M NaOH. TVN calculated as following:

TVN/l00g = 26.88 x (2-T1)

T1 = volume of NaOH consumed in titration process

2.7.3 Thiobarbituric Acid Number "TBA" evaluation

TBA number was expressed as milligrams of malondialdehyde equivalents for each kilogram of samples (ES, 2006). Accurately 10 g of sample were placed in a distillation flask then blended with 50 ml of distilled water. Exactly 2.5ml of hydrochloric acid previously diluted in 47.5 water were added with small parts of antifoaming agents. Distillation flask was heated for 10 minutes from the beginning of boiling for distillation of 50 ml. Five ml of the distilled solution were placed in a covered tube, then 5 ml of previously prepared Thiobarbituric acid (prepared through dissolving 0.2883 Thiobarbituric acid in trichloroacetic acid 90 % then completed to 100 ml). The tube was covered and boiled for 35 minutes on water bath, then cooled gradually by water for 10 minutes. The absorbance of sample was measured by using a spectrophotometer under wavelength 538nm (UNICAM969AA Spectronic, USA).

TBA value= absorbance of sample x 7.8 (malonaldehyde (mg) /Kg)

2.8. Statistical Analysis

Data analysis was carried by using SPSS statistical software program (SPSS for Windows version 16, SPSS Inc., USA). Data are presented as (Mean ± S.E). S.E = Standard error (SE). Significant difference was set at $p < 0.05$.

3. RESULTS

3.1. Sensory Evaluation and Overall Acceptance:

Results of overall acceptance of chicken meat samples stored at 4 ◦C revealed that control samples were completely spoiled after 6th day of cold storage. Addition of 1% LLE maintained the whole acceptability of sensory parameters until 16th day, 1% MLE maintained the acceptability until 14th day while 1% OLE conserved the overall acceptance of sensory parameters until 12thday of cold storage (Table, 1).

3.2. Bacteriological Examination of chicken breast meat samples

Control group showed the highest Aerobic Plate Count (APC), Total *Coliform* Count (TCC) and Total *Staphylococci* Count (TSC). Treated samples showed significant gradual decrease in all these counts during cold storage period at 4 ˚C. Counts were the lowest in samples treated with 1% laurel extract followed by those treated with 1% moringa extract and finally samples treated with 1% olive extract. Our results showed that 1% LLE, 1% MLE and 1% OLE have a positive impact in decreasing all previously mentioned counts in treated samples compared to control one indicating their potent antibacterial effect (Table 2, 3, 4).

Table 1 Pattern of overall acceptance (color, odor and texture) of fresh chicken breast meat samples treated with 3 different plant extracts during chilling storage period at 4 ◦C (mean ± SE).

	Overall acceptance of fresh chicken breast meat treated with 3 different plant extracts during cold storage at 4 °C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Control	9.00 ± 0.00 ^{Aa}	6.33 ± 0.33^{Bc}	5.67 ± 0.33 ^{Bb}	4.00 ± 0.58 ^{Cc}	2.00 ± 0.00 ^{Dc}	1± 0.00 ^{Dc}			
1% LLE	9.00 ± 0.00 ^{Aa}	9.00 ± 0.00 ^{Aa}	8.00 ± 0.00 ^{Ba}	7.33 ± 0.33 ^{Ca}	6.33 ± 0.33 ^{Da}	6.33± 0.33 ^{Da}	6.00± 0.00 ^{Da}	5.00± 0.00^{Ea}	4.33± 0.33 ^{Fa}
1% MLE	9.00± 0.00 ^{Aa}	8.00± 0.00 ^{Bb}	8.00± 0.00 ^{Ba}	7.00± 0.00^{Cab}	7.00± 0.00 ^{Ca}	6.00± 0.00 ^{Da}	5.00± 0.00^{Eb}	4.33± 0.33 ^{Fa}	
1% OLE	9.00 ± 0.00 ^{Aa}	8.33 ± 0.33^{Aab}	7.33 ± 0.33 ^{Ba}	6.00 ± 0.00^{Cb}	5.33 ± 0.33^{Cb}	4.33± 0.33 ^{Db}	4.00± 0.00 ^{Dc}		

Mean values with different superscript Capital letters in the same row are significantly different at (P<0.05). Mean values with different superscript Small letters in the same column are significantly different at (P<0.05). **Score system: 9** = Excellent. **8** = Very very good. **7** = Very good. **6** = Good. **5** = Medium. **4** = Fair. **3** = Poor. **2** = Very poor. **1** = Very very poor

Table 2 Pattern of Aerobic Plate Count (log10 CFU/g) of fresh chicken breast meat samples treated with 3 different plant extracts during chilling storage period at 4 ◦C (mean ± SE).

	Aerobic Plate Count (log10 CFU/g) of chicken breast meat samples treated with 3 different plant extracts during chilling storage period at 4 ◦C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Control	5.68± 4.17 ^{Ca}	5.92±4.37 ^{Ca}	6.20± 5.17 ^{Ca}	6.81± 5.43 ^{Ba}	7.19± 6.23 ^{Aa}				
1% LLE	5.45± 4.31 ^{Bc}	5.26± 4.28 ^{Cc}	4.11± 3.28 ^{Db}	3.13± 2.17 ^{Db}	3.01± 2.14 ^{Db}	2.45± 2.02 ^{Db}	2.25± 2.02 ^{Db}	3.50± 2.31^{Db}	5.53± 4.51 ^{Aa}
1% MLE	5.51± 4.34^{Bbc}	5.38±4.17 ^{Cb}	4.14± 3.25 ^{Db}	3.18± 2.20 ^{Db}	3.11± 2.03 ^{Db}	2.53± 2.14 ^{Db}	4.33± 3.20 ^{Db}	5.60± 4.36 ^{Aa}	
1% OLE	5.59± 4.23 ^{Ab}	5.44± 4.23 ^{Bb}	4.19± 3.14 ^{Cb}	3.33± 2.17 ^{Cb}	3.24± 2.31 ^{Cb}	4.16± 3.23 ^{Ca}	5.49± 4.35 ^{Ba}		

Mean values with different superscript Capital letters in the same row are significantly different at (P<0.05). Mean values with different superscript Small letters in the same column are significantly different at (P<0.05).

Table 3 Pattern of Total *Coliform* Count (log10 CFU/g) of fresh chicken breast meat samples treated with 3 different plant extracts during chilling storage period at 4 ◦C (mean ± SE).

	Total *Coliform* Count (log10 CFU/g) of chicken breast meat samples treated with 3 different plant extracts during chilling storage period at 4 ◦C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Control	4.80± 3.46^{Ca}	5.14± 4.02^{BCa}	5.29± 4.28^{BCa}	5.53± 4.20^{Ba}	5.57± 5.28^{Aa}				
1% LLE	4.57± 3.28^{Ac}	4.30± 3.28^{Cd}	3.60± 3.11^{Eb}	2.75± 2.14^{EFb}	2.45± 2.08^{Fb}	2.25± 2.02^{Fb}	2.15± 2.02^{Fc}	4.20± 3.31 ^{Db}	4.43± 3.57^{Ba}
1% MLE	4.68± 3.14 ^{Ab}	4.47± 3.14^{Bc}	4.13± 3.11^{Cb}	2.80± 2.57^{Db}	2.65± 2.08^{Db}	2.35± 2.02^{Db}	4.19± 3.14^{Cb}	4.50± 3.57 ^{Ba}	
1% OLE	4.72± 3.28^{Aab}	4.57± 3.43^{Bb}	4.23± 3.28^{Db}	3.7± 2.11^{Eb}	2.50± 2.02^{Eb}	3.19± 3.14^{Da}	4.40± 3.23^{Ca}		

Mean values with different superscript Capital letters in the same row are significantly different at (P<0.05). Mean values with different superscript Small letters in the same column are significantly different at (P<0.05).

Table 4 Pattern of Total *Staphylococci* Count (log10 CFU/g) of fresh chicken meat samples treated with 3 different plant extracts during chilling storage period at 4 ◦C (mean ± SE)

	Total *Staphylococci* Count (log10 CFU/g) of chicken meat samples treated with 3 different plant extracts during chilling storage period at 4 ◦C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Control	5.23± 4.17^{Ba}	5.39± 4.25^{Ba}	5.59± 4.23^{Ba}	6.13± 5.14^{Ba}	6.50± 5.11^{Aa}				
1% LLE	5.11± 4.08^{Ac}	4.26± 3.23^{Cb}	4.14± 2.57^{DEb}	3.65± 2.86^{EFb}	3.35± 2.86^{Fb}	2.80± 2.57^{Fb}	2.25± 2.02^{Fc}	4.22± 3.11^{CDb}	5.42± 3.88 ^{Ba}
1% MLE	5.13± 4.17^{Ac}	4.28± 3.25^{Cb}	4.14± 3.17^{CDb}	3.65± 2.86^{CDb}	3.50± 2.57^{CDb}	2.35± 2.08^{Eb}	4.13± 3.20^{CDb}	4.51± 4.65^{Ba}	
1% OLE	5.18± 4.8^{Ab}	4.28± 3.17^{Cb}	4.18± 3.17^{CDb}	3.70± 3.11^{Db}	3.66± 3.27^{Db}	4.18± 3.20^{CDa}	4.53± 3.14^{Ba}		

Mean values with different superscript Capital letters in the same row are significantly different at (P<0.05). Mean values with different superscript Small letters in the same column are significantly different at (P<0.05).

Samples treated with 1% Laurel extract showed the highest reduction percentage of APC 99.98% and 99.99% at 6th and 8th day, respectively. Samples treated with 1% OLE showed the highest reduction % of TCC 99.87% and 99.99% at 6thand 8thday, respectively. Samples treated with 1% laurel extract showed the highest reduction percent of TSC 99.52% and 99.93% at 6thand 8thday, respectively, (Table, 5).

3.3. Chemical Examination of chicken breast meat samples

Differences in pH mean value between control and treated samples are significant (P<0.05) (Table, 6) Control group showed the highest pH 6.88 ± 0.01 at 6th day of cold storage compared to treated groups which showed lower pH, samples treated with laurel extract showed the lowest pH value5.92 ± 0.01 followed by samples treated with MLE 6.01± 0.02 and finally OLE 6.13± 0.02. PH decreased may be owing to the antioxidant effect of plant extracts as mentioned before pH is one of the factors that is associated with lipid oxidation in meat.

Used plant extracts resulted in decrease of TVN values in chicken meat samples with significant differences when compared to control group that means it decreased protein oxidation in chicken breast meat. Highest TVN values were recorded in control group 19.87± 0.05 at 6th day of cold storage while lowest one was recorded in sample treated with 1% laurel extract 10.13 ± 0.05 followed by1% MLE 11.52 ± 0.08 then,1% OLE 14.49± 0.05, (Table, 7).

By the same way, an increase in TBA value was observed in control group and lowered TBA values in treated groups with a highly significant difference when compared to control one. Highest TBA value was recorded in control group 0.86± 0.01 at 6th day of cold storage compared to 0.33± 0.01,0.39± 0.01 and 0.50± 0.01 which recorded in samples treated by 1% laurel, 1%moringa and 1% olive extract, respectively, (Table, 8)

Table 5 Reduction percentages of bacterial counts of different plant extracts applied in fresh chicken breast meat samples during cold storage at 4 ◦C

Reduction percentages of bacterial counts of different plant extracts applied in chicken breast meat samples during cold storage at 4 ◦C					
APC					
group	Zero day	2nd day	4th day	6th day	8th day
1% LLE	33.09	71.89	99.45	99.98	99.99
1% MLE	25.00	58.92	99.28	99.98	99.99
1% OLE	13.24	52.43	99.03	99.96	99.99
TCC					
1% LLE	28.75	79.31	97.93	99.86	99.99
1% MLE	14.38	67.24	95.52	99.85	99.99
1% OLE	10.00	60.34	92.07	99.87	99.99
TSC					
1% LLE	50.00	93.42	97.63	99.52	99.93
1% MLE	43.48	93.80	97.63	99.52	99.90
1% OLE	19.57	92.91	96.95	99.48	99.87

Table 6 Effect of 3 different plant extracts on pH value applied in fresh chicken breast meat samples during storage period at 4 ˚C (mean ± SE).

	pH values of fresh chicken breast meat samples treated with 3 different plant extracts during storage period at 4˚ C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Control	5.70 ± 0.01^{Ea}	6.10 ± 0.02 ^{Da}	6.18 ± 0.02 ^{Ca}	6.88 ± 0.01 ^{Ba}					
1% LLE	5.63 ± 0.00^{Ic}	5.70 ± 0.01^{Hd}	5.80 ± 0.02^{Gd}	5.92 ± 0.01 ^{Fa}	6.01 ± 0.02^{Ea}	6.14 ± 0.02 ^{Dc}	6.26 ± 0.02 ^{Cc}	6.38 ± 0.03 ^{Bb}	6.61 ± 0.04 ^{Aa}
1% MLE	5.65 ± 0.01^{Hb}	5.74 ± 0.01^{Gc}	5.88 ± 0.01 ^{Fc}	6.01 ± 0.02^{Ec}	6.14 ± 0.03 ^{Dc}	6.32 ± 0.02^{Cb}	6.41 ± 0.01 ^{Bb}	6.51 ± 0.02 ^{Aa}	
1% OLE	5.66 ± 0.01 ^{Gb}	5.78 ± 0.01 ^{Fb}	5.96 ± 0.01^{Eb}	6.13 ± 0.02 ^{Db}	6.29 ± 0.01^{Cb}	6.48 ± 0.02 ^{Ba}	6.69 ± 0.02 ^{Aa}		

Mean values with different superscript Capital letters in the same row are significantly different at (P<0.05). Mean values with different superscript Small letters in the same column are significantly different at (P<0.05)

Table 7 Effect of 3 different plant extracts on TVN value (mg/100g) applied in fresh chicken breast meat samples during storage period at 4 ˚C (mean ± SE).

	TVN values (mg/100g) of chicken breast meat samples treated with 3 different plant extracts during storage period at 4˚ C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Control	3.12 ± 0.03^{Ea}	8.86 ± 0.12^{Da}	14.94 ± 0.07^{Ca}	19.87 ± 0.05^{Ba}					
1% LLE	2.91± 0.02^{Hb}	5.21± 0.03^{Gd}	8.47± 0.05^{Fd}	10.13± 0.05^{Ed}	12.97± 0.12^{Dd}	17.48± 0.19^{Cc}	19.66± 0.10^{Bc}	21.68 ± 0.18^{Ab}	21.91 ± 0.23^{Aa}
1% MLE	2.95 ± 0.02^{Gb}	5.49 ± 0.03^{Fc}	9.25 ± 0.07^{Ec}	11.52 ± 0.08^{Dc}	14.58 ± 0.14^{Cc}	19.84 ± 0.06^{Bb}	22.25 ± 0.19^{Ab}	22.36 ± 0.15^{Aa}	
1% OLE	3.07 ± 0.02^{Fa}	6.06 ± 0.02^{Eb}	11.82 ± 0.07^{Db}	14.49 ± 0.05^{Cb}	18.51 ± 0.13^{Bb}	22.85 ± 0.09^{Aa}	23.07 ± 0.13^{Aa}		

Mean values with different superscript Capital letters in the same row are significantly different at (P<0.05). Mean values with different superscript Small letters in the same column are significantly different at (P<0.05)

Table 8 Effect of 3 different plant extracts on TBA value (mg of malondialdehyde / kg) applied in fresh chicken breast meat samples during storage period at 4 ˚C (mean ± SE).

	TBA values of chicken breast meat samples treated with 3 different plant extracts during storage period at 4 ˚C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Control	0.05± 0.01^{Ea}	0.26± 0.01^{Da}	0.59 ± 0.02^{Ca}	0.86± 0.01^{Ba}					
1% LLE	0.04± 0.00^{Ha}	0.10± 0.01^{Gc}	0.20± 0.01^{Fd}	0.33± 0.01^{Ed}	0.58± 0.02^{Dd}	0.74± 0.02^{Cc}	0.82± 0.02^{Bc}	0.94± 0.01^{Aa}	0.97± 0.01^{Aa}
1% MLE	0.04± 0.01^{Ha}	0.12± 0.01^{Gbc}	0.26± 0.01^{Fc}	0.39± 0.01^{Ec}	0.67± 0.01^{Dc}	0.85± 0.01^{Cb}	0.97± 0.01^{Bb}	1.09± 0.06^{Aa}	
1% OLE	0.05± 0.00^{Ga}	0.15± 0.01^{Fb}	0.32± 0.02^{Eb}	0.50± 0.01^{Db}	0.75± 0.02^{Cb}	0.99± 0.01^{Ba}	1.05± 0.01^{Aa}		

Mean values with different superscript Capital letters in the same row are significantly different at (P<0.05). Mean values with different superscript Small letters in the same column are significantly different at (P<0.05)

4. DISCUSSION

Sensory evaluation is quick, efficient and easy method for getting an idea about acceptance and overall quality of the product. It depends on organoleptic characteristics as color, odor , texture and product overall acceptability (Haq et al., 2013). Table (1) showed that sensory evaluation of treated samples was improved and extended shelf-life during cold storage period (4±1°C). The obtained results showed that the best sensory quality was achieved in chicken breast meat samples treated with 1% laurel extract, good enhancement of sensory quality in chicken samples treated with 1% moringa extract followed by those treated with 1% olive extract as compared to control samples and these results are similar to those obtained by Tometri et al., (2020), according to their results laurel leaf extract can be used to extend shelf life of meat with improving the sensory parameters without causing undesirable odor.

The obtained results showed that addition of 1% moringa extract could extend the shelf life of chicken meat without any alteration in sensory quality of meat and these results came in agreement with those recorded by Jayawardana et al. (2015).

It was evident from our study that 1% olive leaf extract can maintain sensory parameters of chicken meat when applied in meat samples and retard microbial growth due to its antimicrobial effect and these results are constant with those recorded by Saleh et al. (2020).

The result showed that 1% laurel extract has a potential applicability as a natural substitute to synthetic food preservatives to improve chicken meat quality and extend its shelf life due to its antibacterial effect and these results agreed with those obtained by Efenberger-Szmechtyk et al. (2021).

The present study demonstrated that 1% laurel extract addition to chicken breast meat samples caused an obvious decline in pH, TVN and TBA of samples due to its potent antioxidant effect and these results are similar to those obtained by da Silveira et al. (2014).

The results in our study revealed that pH, TVN and TBA values of chicken breast samples were significantly decreased in samples treated with 1% MLE and came in the same line with those recorded by Elhadi et al. (2017).

The obtained results are constant with those recorded by Rubel et al. (2020), who conveyed that olive leaf extract can be used for meat preservation due to its antimicrobial and antioxidant effects thanks to its phenolic content. Marked reduction in pH. TVN and TBA in chicken samples treated with 1% OLE indicating that 1% OLE is powerful source of polyphenols having both antioxidant and antibacterial properties capable of decreasing microbial growth and increasing chicken meat shelf-life similar to results obtained by Saleh et al. (2020).

5. CONCULOSIONS

Extracts of 1% laurel, 1% moringa and 1% olive leaves maintained the sensory attributes of chicken breast meat samples during storage at chilling temperature, possess considerable amounts of phenolic compounds exhibiting potent antimicrobial and antioxidant properties enabling them to extend meat shelf life. Extracts had been shown to cause significant decrease in pH, TVN and TBA values compared to control samples. So, it is suggested that addition of these plant extracts to meat and its products as natural preservatives could improve the overall quality and serve consumer needs as alternative to synthetic ones.

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