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Influence of Plant Extracts on acceptability of Chilled Poultry Meat

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ABSTRACT

Poultry meat is usually marketed at refrigerated temperatures (1 to 4 ∘C). Acceptability, Quality and Safety of refrigerated Poultry meat is the main concern for consumers and retailers. Poultry meat is contaminated from different sources as during slaughtering, during different manufacturing processes and during storage causing undesirable changes, microbial growth, spoilage and economic losses. Thus, the present study aimed to assess the effects of plant extracts (1.0 % Laurel, 1.0 % Moring and 1.0 % Olive leaf extract) on acceptability of raw Poultry breast meat stored at 1 to 4 ∘C for 16.0 days. The Data revealed that samples treated with 1.0 % laurel, 1.0 % Moringa and 1.0 % Olive extracts maintained the acceptability until 16th, 1±th, 12thdays of chilling at 1 to 4 ˚C, respectively. Compared to untreated one which got spoiled by 6th day of chilling at 1 to 4 ˚C. Samples treated with plant extracts revealed significant decrease in their keeping quality tests and marked decrease in bacterial examination (total bacterial, total coliform, total Staphylococci) revealed that plant extracts have good antioxidant and antibacterial effects. Best effect was obtained in samples treated with 1.0 % laurel extract followed by samples treated with 1.0 % Moringa and those treated with 1.0 % olive leaf extract.

Keywords: acceptability, olive leaf extract, Poultry meat, Laurel, Moringa.

INTRODUCTION

Poultry meat has nutritional characters, as low fat content and high concentration of polyunsaturated fatty acids [1-5]. Poultry meat is low calorie food for its low fat content, its muscle lipids are highly subjected to oxidation due to the high unsaturation degree. Oxidation leads to deterioration in meat color, flavor, texture, nutrient losses, and poor shelf life. Simultaneously, some internal factors as iron content, antioxidant enzymes and external Factors as stress, temperature, feeding with highly oxidized feeds, slaughtering process, storage conditions, further processing steps, etc. which plays an important role in oxidation process of

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poultry meat [3,6-10]. Poultry meat is a good protein sources, but after slaughtering, protein of these meat can be oxidized initiating a secondary lipid oxidation of products and causes loss of functional properties, acceptability and quality of meat protein [7,11].

Molecular oxygen undergoes a chain of reactions that leads to generation of free radicals. Under normal physiologic conditions a small percent of the oxygen that consumed during the metabolic reaction is changed to free radicals. These free radicals especially reactive nitrogen species and reactive oxygen species 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 [12-15].

Primarily, when the production of reactive oxygen species and reactive nitrogen species doesn't exceed the capability of endogenous antioxidant barriers in the body, it implements beneficial functions and defense against invading pathogens. In contrast, when there is an excess and low activity of antioxidant defence, it potentially causes damage of the cellular components, induces destructive autoimmune responses and causes oxidative stress [16-19].

Free radical activities in meat is so important because high levels of reactive oxygen species might reduce meat sensory quality [20,21], reduction of essential amino acids like tryptophan and phenylalanine [22,23]. 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 [24,25]. To prevent protein and fat oxidations occurring in poultry meat is the use of antioxidants [26], consumers and producers tended to the natural alternatives from plant sources [27].

Due 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 [28]. The use of natural antioxidant extracts has been reported to raise meat tenderness [29]. Plant extracts to enhance the oxidative stability and acceptability of the poultry products [30]. Plants and their extracts have variable concentrations of phenolic compounds are thus regarded as an efficient source of antioxidants for controlling oxidation reactions [31,32].

Laurusnobilis 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 [33,34]. Antimicrobial activity of laurel leaf extract has importance as a natural antioxidant as they are part of human diet and its biodegradability leads to low poisonous residue problems [35,36]. L. nobilis has powerful antimicrobial activity against 20 strains of bacteria as Staphylococcus aureus, Escherichia coli, Listeria monocytogenes and Salmonella [37,38].

Moringaoleifera leaves have high quantities of ascorbic acid, phenolic, carotenoids and flavonoids [39, 40]. So, it is considered as potent antimicrobial and antioxidant. M. oleifera leaf extract keep goat meat patties from the oxidative rancidity [35,41]. As well as it significantly extend ghee shelf life [39,42]. The leaves having antifungal and antimicrobial characteristics, therefore, have a proven history in food applications as a biopreservative and neutraceuticals [43].

Olive leaves are observed as predominantly rich sources of phenolic composites [44,45]. Their chief biological active compounds are classified into oleuropeosides, simple phenolics and flavonoids [46,47]. Phenolic compounds can prevent the growth and secretion of Staphylococcus aureus enterotoxins [8,9,48-51].

In this study, application of natural bioactive compounds from natural plants to inhibit lipid and protein oxidation, improve oxidative stability and acceptability of Poultry meat.

MATERIALS AND METHODS

Preparation of Laurel Leaf Extract (1.0 % LLE) [52].

Preparation of Moringa Leaf Extract (1.0 % MLE) [53].

Preparation of Olive Leaf Extract (1.0 % OLE)

According to the method recommended by [54].

Preparation of samples

Poultry breast meat slices (100.0 grams), two cms in thickness. Samples were placed in a separate sterile plastic bags in an icebox and carried out to the Laboratory without undue delay under complete aseptic conditions. Poultry meat samples were divided into two main groups (treated and untreated). Treated groups were subdivided into three groups (27 samples for each). First group samples were dipped in 1.0 % Laurel Leaf Extract for five minutes with proper mixing, 2ndgroup samples were dipped in 1.0 % Moringa Leaf Extract for five minutes and 3rdgroup samples in 1.0 % Olive Leaf Extract. All samples were stored chilled at 1 to 4 ∘C and examined every 48 hours (0. 2nd ,4th, 6th, 8th, 10th,12th, 14th, 16th) for acceptability. The experiment was replicated three times/day and the examination repeated every 48 hours for 16 days of chilling at 1 to 4 ˚C.

SENSORY EXAMINATION AND ACCEPTABILITY

Bacteriological investigation [19,48,49].

Chemical Examination

PH detection

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

Thiobarbituric Acid "TBA"examination

Statistical Analysis

The Data analysis by using SPSS statistical software program (SPSS for Windows version 16, Spss Inc., USA).

RESULTS

Sensory and Acceptability examination:

Poultry meat samples stored at chilling 1 to 4 ∘C revealed that untreated samples were completely spoiled by 6th day of chilling at 1 to 4 ˚C. Addition of 1.0 % Laurel Leaf Extract maintained the whole acceptability of sensory parameters until 16th day, 1.0 % Moringa Leaf Extract maintained the acceptability until 14th day while1.0 % Olive Leaf Extract conserved the acceptance of sensory parameters till 12thday of chilling at 1 to 4 ˚C (Table A).

Table A. Acceptance (color, odor and texture) of fresh Poultry breast meat samples treated with plant extracts during chilling at 1 to 4 ∘C (mean ± standard error "SE").

Groups	Acceptability of Poultry breast meat during chilling at 1 to 4 ℃								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Untreated	9.000 ± 0.00^{Aa}	6.330 ± 0.33^{Bc}	5.670 ± 0.33^{Bb}	4.000 ± 0.58^{Cc}	2.000 ± 0.00^{Dc}	1.000± 0.00^{Dc}			
1.0 % LLE	9.000 ± 0.00^{Aa}	9.000 ± 0.00^{Aa}	8.000 ± 0.00^{Ba}	7.330 ± 0.33^{Ca}	6.330 ± 0.33^{Da}	6.330± 0.33^{Da}	6.000± 0.00^{Da}	5.000± 0.00^{Ea}	4.33± 0.33^{Fa}
1.0 % 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}	
1.0 % OLE	9.000 ± 0.00^{Aa}	8.330 ± 0.33^{Aab}	7.330 ± 0.33^{Ba}	6.000 ± 0.00^{Cb}	5.330 ± 0.33^{Cb}	4.330± 0.33^{Db}	4.000± 0.00^{Dc}		

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

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).

Bacteriological investigation of Poultry breast meat samples:

Untreated group revealed highest Aerobic Bacterial Count (TBC), Coliform Count (TCC) and Staphylococci Count (TSC). Treated samples revealed significant gradual decrease in all these counts during chilling at 1 to 4˚C. Counts were the lowest in samples treated with 1.0 % laurel extract followed by those treated with 1.0 % moringa extract and finally samples treated with 1.0 % olive extract. Our Data revealed that 1.0 % Laurel Leaf Extract, 1.0 % Moringa Leaf Extract and 1.0 % Olive Leaf Extract have a positive impact in decreasing all previously mentioned counts in treated samples compared to untreated one indicating their potent antibacterial effect (Tables B,C, &D).

Samples treated with1.0 % Laurel extracts revealed the highest reduction percentage of TBC 99.980 % and 99.990% at 6th and 8th day, respectively. Samples treated with 1.0 % Olive Leaf Extract revealed the highest reduction % of TCC 99.870 % and 99.990 % at 6thand 8thday,respectively.Smples treated with laurel extract revealed the highest reduction percent of TSC 99.52% and 99.930 % at 6thand 8thday,respectively.

Table B. Pattern of Aerobic Plate Count (log10 cfu/g) in Poultry breast meat samples treated with plant extracts during chilling at 1 to 4 ∘C (mean ± standard error "SE").

Acceptability of Poultry breast meat during chilling at 1 to 4 °C								
Zero day	**2nd day**	**4th day**	**6th day**	**8th day**	**10th day**	**12th day**	**14th day**	**16th day**
9.000 ± 0.00^{Aa}	6.330 ± 0.33^{Bc}	5.670 ± 0.33^{Bb}	4.000 ± 0.58^{Cc}	2.000 ± 0.00^{Dc}	1.000± 0.00^{Dc}			
9.000 ± 0.00^{Aa}	9.000 ± 0.00^{Aa}	8.000 ± 0.00^{Ba}	7.330 ± 0.33^{Ca}	6.330 ± 0.33^{Da}	6.330± 0.33^{Da}	6.000± 0.00^{Da}	5.000± 0.00^{Ea}	4.33± 0.33^{Fa}
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}	
9.000 ± 0.00^{Aa}	8.330 ± 0.33^{Aab}	7.330 ± 0.33^{Ba}	6.000 ± 0.00^{Cb}	5.330 ± 0.33^{Cb}	4.330± 0.33^{Db}	4.000± 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).

Table C. Pattern of Coliform Count (log10 cfu/g) in Poultry breast meat samples treated with plant extracts during chilling at 1 to 4 ∘C (mean ± standard error "SE").

Groups	Total Coliform Count (log10 cfu/g) in Poultry breast meat samples treated with plant extracts during chilling at 1 to 4 ∘C								
	Zero day	**2nd day**	**4th day**	**6th day**	**8th day**	**10th day**	**12th day**	**14th day**	**16th day**
untreated	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}				
1.0 % 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}
1.0 % 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}	
1.0 % 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 D. Pattern of *Staphylococci* Count (log10 cfu/g) in Poultry meat samples treated with plant extracts during chilling at 1 to 4 ∘C (mean ± standard error "SE")

Groups	Total Staphylococci Count (log10 cfu/g) in Poultry meat samples treated with 3 different plant extracts during chilling at 1 to 4 °C								
	Zero day	**2nd day**	**4th day**	**6th day**	**8th day**	**10th day**	**12th day**	**14th day**	**16th day**
Untreated	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}				
1.0 % 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}
1.0 % 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}	
1.0 % 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).

Chemical Examination

Differences in pH mean value between untreated and treated samples are significant (P<0.05) (Table D) untreated group revealed the highest pH 6.880 ± 0.01 at 6th day of chilling at 1 to 4 ˚C compared to treated groups which revealed lower pH., samples treated with laurel extract revealed the lowest pH value 5.920 ± 0.01 followed by samples treated with Moringa Leaf Extract 6.010± 0.020 and finally Olive Leaf Extract 6.130± 0.020. 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

Poultry meat samples with significant differences when compared to untreated group that means it decreased protein oxidation in Poultry breast meat. Highest TVN values were recorded in untreated group 19.870± 0.050 at 6th day of chilling at 1 to 4 °C while lowest one was recorded in sample treated with 1.0 % laurel extract 10.130 ± 0.050 followed by1.0 % Moringa Leaf Extract 11.520 ± 0.080 then,1.0 % Olive Leaf Extract 14.490± 0.050. (Table E).

By the same way, an increase in TBA value was observed in untreated group and lowered TBA values in treated groups with a highly significant difference when compared to untreated one. Highest TBA value was recorded in untreated group 0.86± 0.01 at 6th day of chilling at 1 to 4 °C compared to 0.330± 0.010,0.390± 0.010 and 0.500± 0.010 which recorded in samples treated by 1.0 % laurel, 1.0 % moringa and 1.0 % olive extract, respectively (Table F & G).

Table E. Effect of plant extracts on PH value applied in Poultry breast meat samples during chilling at 1 to 4 °C (mean ± standard error "SE").

Groups	PH values of Poultry breast meat samples during chilling at 1 to 4 °C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Untreated	5.700 ± 0.01^{Ea}	6.100 ± 0.02^{Da}	6.180 ± 0.02^{Ca}	6.880 ± 0.01^{Ba}					
1.0 % LLE	5.630 ± 0.00^{Ic}	5.700 ± 0.01^{Hd}	5.800 ± 0.02^{Gd}	5.920 ± 0.01^{Fa}	6.010 ± 0.02^{Ea}	6.140 ± 0.02^{Dc}	6.260 ± 0.02^{Cc}	6.380 ± 0.03^{Bb}	6.610 ± 0.04^{Aa}
1.0 % MLE	5.650 ± 0.01^{Hb}	5.740 ± 0.01^{Gc}	5.880 ± 0.01^{Fc}	6.010 ± 0.02^{Ec}	6.140 ± 0.03^{Dc}	6.320 ± 0.02^{Cb}	6.410 ± 0.01^{Bb}	6.510 ± 0.02^{Aa}	
1.0 % OLE	5.660 ± 0.01^{Gb}	5.780 ± 0.01^{Fb}	5.960 ± 0.01^{Eb}	6.130 ± 0.02^{Db}	6.290 ± 0.01^{Cb}	6.480 ± 0.02^{Ba}	6.690 ± 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 F. Effect of plant extracts on TVN value (mg/100 g) applied in Poultry breast meat samples during chilling at 1 to 4 °C (mean ± standard error "SE").

Groups	TVN values of Poultry breast meat samples during chilling at 1 to 4° C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Untreated	3.120 ± 0.03^{Ea}	8.860 ± 0.12^{Da}	14.940 ± 0.07^{Ca}	19.870 ± 0.05^{Ba}					
1.0 % LLE	2.910± 0.02^{Hb}	5.210± 0.03^{Gd}	8.470± 0.05^{Fd}	10.130± 0.05^{Ed}	12.970± 0.12^{Dd}	17.480± 0.19^{Cc}	19.660± 0.10^{Bc}	21.680 ± 0.18^{Ab}	21.910 ± 0.23^{Aa}
1.0 % MLE	2.950 ± 0.02^{Gb}	5.490 ± 0.03^{Fc}	9.250 ± 0.07^{Ec}	11.520 ± 0.08^{Dc}	14.580 ± 0.14^{Cc}	19.840 ± 0.06^{Bb}	22.250 ± 0.19^{Ab}	22.360 ± 0.15^{Aa}	
1.0 % OLE	3.070 ± 0.02^{Fa}	6.060 ± 0.02^{Eb}	11.820 ± 0.07^{Db}	14.490 ± 0.05^{Cb}	18.510 ± 0.13^{Bb}	22.850 ± 0.09^{Aa}	23.070 ± 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 G. Effect of plant extracts on TBA (mg of malondialdehyde / kg)applied in Poultry breast meat samples during chilling at 1 to 4 °C(mean ± standard error "SE").

Groups	TVN values of Poultry breast meat samples during chilling at 1 to 4° C								
	Zero day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day
Untreated	3.120 ± 0.03^{Ea}	8.860 ± 0.12^{Da}	14.940 ± 0.07^{Ca}	19.870 ± 0.05^{Ba}					
1.0 % LLE	2.910± 0.02^{Hb}	5.210± 0.03^{Gd}	8.470± 0.05^{Fd}	10.130± 0.05^{Ed}	12.970± 0.12^{Dd}	17.480± 0.19^{Cc}	19.660± 0.10^{Bc}	21.680 ± 0.18^{Ab}	21.910 ± 0.23^{Aa}
1.0 % MLE	2.950 ± 0.02^{Gb}	5.490 ± 0.03^{Fc}	9.250 ± 0.07^{Ec}	11.520 ± 0.08^{Dc}	14.580 ± 0.14^{Cc}	19.840 ± 0.06^{Bb}	22.250 ± 0.19^{Ab}	22.360 ± 0.15^{Aa}	
1.0 % OLE	3.070 ± 0.02^{Fa}	6.060 ± 0.02^{Eb}	11.820 ± 0.07^{Db}	14.490 ± 0.05^{Cb}	18.510 ± 0.13^{Bb}	22.850 ± 0.09^{Aa}	23.070 ± 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)

DISCUSSION

Sensory evaluation is quick, efficient and easy method for getting an idea about acceptance and quality of the product. it depends on organoleptic characteristics as color, odor , texture and product acceptability [55-57]. Table (A) revealed that sensory evaluation of treated samples was improved and extended shelf-life during chilling at 1 to 4 ˚C. The obtained Data revealed that the best sensory quality was achieved in Poultry samples treated with 1.0 % laurel extract, good enhancement of sensory quality in Poultry samples treated with 1.0 % moringa extract followed by those treated with1.0 % olive extract as compared to untreated samples and these Data are similar to those results mentioned by [13,17,54,58]. According to their results laurel leaf extract used to extend shelf life of meat with improving the sensory parameters without causing undesirable odor or taste. The Data came in agreement with those mentioned by [41] which suggested addition of moringa extract to extend the shelf life of meat without any alteration in sensory quality of meat and those results of [50,59-61] their results revealed that 1.0 % olive leaf extract can maintain sensory parameters of meat when applied in poultry meat samples and retard microbial growth due to its antimicrobial effect.

The Data revealed that 1.0 % laurel extract has a potential applicability as a natural substitute to synthetic food preservatives to improve food safety and extend its shelf life confirming results in current study which agreed with those obtained by [62-64,69] they suggested application of natural plant extracts like moringa extract in meat and meat products contributing to its polyphenols content which are beneficial in antioxidant and antimicrobial functions.

Da Silveira SM, et al. [65] demonstrated that laurel extract applied in fresh sausages at concentration of 0.10 g/100.0 g can provide additional protection of the product against microbial growth, thus increasing its shelf life. The extract causes an obvious decline in pH, TVN and TBA having a potent antioxidant effect and these results are the same Data obtained in our study which came in the same line with [66] they revealed that pH, TVN and TBA values of Poultry patties were significantly decreased in samples treated with 100.0 grams of moringa leaf powder / kg. The Data are constant with those of [67,68] they 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 poultry samples with Olive Leaf Extract indicating that Olive Leaf Extract is a powerful source of polyphenols having both antioxidant and antibacterial properties capable of decreasing microbial growth and increasing meat shelf-life similar to results revealed by[36,50,59-61,69].

CONCLUSION

Extracts of 1.0 % laurel, 1.0 % moringa and 1.0 % olive leaves maintained the sensory attributes of Poultry breast meat samples during chilling at 1 to 4 ˚C, possess considerable amounts of phenolic compounds exhibiting potent antimicrobial and antioxidant properties extend meat shelf life. So, addition of these plant extracts to meat and its products could improve the quality and acceptability of consumers.

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