

EFFECT OF NATURAL ANTIOXIDANTS ON THE STABILITY OF OSTRICH MEAT DURING STORAGE

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ABSTRACT

Meat from the ostrich is becoming increasingly popular throughout the world. The healthy red meat of ostrich make them very important for many livestock industries. Chemical composition of ostrich meat, in this investigation, indicated low fat content (1.5 %) combined with high protein content (22.4 %). The effect of natural antioxidants, i.e. ascorbic acid (AA), α -tocopherol (Toc) and rosemary herb (Ros) on the lipid oxidation stability of ostrich steaks were studied. The combined of AA + Ros, Toc + Ros and AA + Toc were more effective on reducing the thiobarbituric acid (TBA) and peroxide values. After 21 days of storage at 4°C, TBA was 0.858, 0.903, 0.915, 1.256, 1.452, 1.493 and 2.741 mg malonaldehyde / Kg with ostrich steaks treated by AA+ Ros, Toc + Ros, AA + Toc, AA, Toc, Ros and untreated sample (control), respectively. The corresponding value with peroxide was 3.62, 3.75, 3.85, 4.06, 4.36, 3.95 and 5.00 meq / Kg fat, respectively. Antioxidants also, showed insignificant effects on acidity as oleic acid. The efficient role of AA, Toc and Ros showed an improve of the colour stability of ostrich steaks. The stability increased with the combined addition of the antioxidants. The treated sample with AA + Ros was found to contain low metmyoglobin (Met Mb) (10.51 %) followed by AA + Toc (10.86 %), Toc + Ros (10.99 %), AA (11.09 %), Ros (11.36 %), Toc (13.05 %) and untreated sample (21.02 %). The microbial quality of steaks was improved by the addition of different antioxidants. The microbial counts were sufficiently low during the storage period in steaks with rosemary alone or with rosemary + AA or Toc. In conclusion, the addition of some natural antioxidants had an positive effect on; aroma quality, rancidity and discolouration of refrigerated ostrich meat.

INTRODUCTION.

Ostrich (*Struthio Camelus*) is the largest of all birds and belong to order Ratitae. Ostrich breeding, a long-developed industry in South Africa, has also spread to Australia, North America and more recently to European countries (Sales, 1996). Meat from the ostrich is becoming increasingly popular throughout the world. The healthy red meat of ostrich make them very important for many livestock industries.

Meat is highly vulnerable to oxidative changes which result in the development of off-flavor and rancidity. Lipid oxidation is the major factor reducing quality and acceptability of meat and fat products (Morrissey et al., 1998). Colour changes in cooked products during refrigerated storage have been linked to oxidation phenomena, and several factors such as the characteristics and amount of fat, the packaging and the presence of antioxidants have been reported (Jo et al., 2000).

In recent years, researchers have focused on the potential role of dietary antioxidants in promoting health and reducing the risk of heart disease, cancer, cataracts, and other degenerative diseases of aging (IMFN, 2000). Exogenous antioxidants can be used to prolong shelf-life and ensure quality of products. Numerous studies have indicated that lipid

oxidation may be controlled or at least minimized through the use of antioxidants (Escalante et al., 2003). The addition of antioxidants to processed meats is often carried out to counteract the negative effects that processing aids. However, due to concerns about toxicological safety of synthetic antioxidants (Chen et al., 1992), it may be desirable to replace these conventional antioxidants with natural antioxidative substances. The vitamins particularly vitamin A in the form of beta-carotene, vitamin C, as ascorbic acid and vitamin E as tocopherols and tocotrienols function as independently active natural dietary antioxidants (IMFN, 2001). In the last years, many researchers have evaluated the antioxidant properties extracted from different plants (Ibanez et al., 2003). Rosemary is popular Labiatae herbs with a verified potent antioxidant activity. The antioxidant activity of rosemary is mainly related to phenolic diterpenes which are considered effective free-radical scavengers (Dorman et al., 2003).

The aim of the present study was to investigate the effect of natural antioxidants (vitamins C, E and rosemary herb) on the stability of refrigerated ostrich steak meat during storage.

MATERIALS AND METHODS

Materials:

Ostrich meat: Iliofibularis was obtained from the Egyptian Company of Ostrich breeding, Cairo, Egypt.

Chemicals: All chemicals used were "Analar" grade from Sigma Chemical Co.

Antioxidants: Rosemary powder (*Rosmarinus officinalis*) were obtained from Medicine Plant and Agriculture Seeds Haraz Company, Cairo, Egypt, L-ascorbic acid and DL- α -tocopherol were purchased from Sigma Chemical Co

Preparation of ostrich steaks meat:

Steaks from Iliofibularis (1.5 cm in thickness) were removed from the ostrich carcasses that had been stored at 4°C for 1 day postmortem. The steaks were dipped for 10 min in solutions of: (1) 0.05 % L-ascorbic acid (AA), (2) 0.08 % DL- α -tocopherol (Toc), (3) 0.05 % rosemary, (4) 0.05 % L-ascorbic acid + 0.08 % DL- α -tocopherol, (5) 0.05 % L-ascorbic acid + 0.05 % rosemary and (6) 0.08 % DL- α -tocopherol + 0.05 % rosemary as well as untreated samples (control). The different samples were packaged in plastic film under vacuum and stored at 4°C. Samples for chemical, microbiological and sensory evaluation had been taken at 0, 7, 14 and 21 days of storage.

Chemical analysis:

Moisture, protein, and ash in ostrich meat (Iliofibularis) assessment were determined according to AOAC (1995). Fat was extracted by the method described by Bligh, and Dyer (1959). Thiobarbituric acid (TBA) was colorimetrically measured as mg malonaldehyde / Kg as mentioned by Okayama (1987). Peroxide value (PV) was determined according to the method of AOAC (1995). Free fatty acids of extracted fat (as % of oleic acid) was determined according to Pearson (1968). Meat

pigments was measured as metmyoglobin % (Met Mb) by the method of Zaika *et al* (1976).

Microbiological analysis:

Viable bacterial count of ostrich meat samples was carried out according to Okayama (1987).

Sensory evaluation:

Sensory evaluation of raw and cooked (for 10 min.) ostrich steaks were assessed by the method described by Djenane *et al* (2001). Flavour scores preferred to the intensity of off odours associated to meat spoilage: 1 = non, 2 = slight, 3 = smell, 4 = moderate, and 5 = extreme. In determining odour, samples were smelled immediately just after cooking. Discolouration of uncooked meat scores referred to percentage of discoloured surface: 1 = non, 2 = 0 – 10 %, 3 = 11 – 20 %, 4 = 21 – 60 %, and 5 = 61 – 100 %. Results were expressed as the predominant score given by panelists.

Statistical analysis:

Data were subjected to statistical analysis using computerized analysis of variance and Duncan's multiple range test procedures with SAS (1998).

RESULTS AND DISCUSSION

Chemical composition of ostrich meat (Iliofibularis):

Data in Table (1) shows the chemical composition of ostrich meat (Iliofibularis). It could be noticed that ostrich meat had low fat content (1.5 %) and high protein content (22.4 %) calculated on wet basis, while, moisture and ash contents were 75.0 and 1.1 %, respectively. These data of ostrich meat does not differ from the range of moisture (69.5 – 76.5 %), protein (19.5 – 23.4 %) and ash (1.0 – 1.5 %) content summarised for raw mammalian and poultry muscle (Paleari *et al.*, 1998). The proximate chemical composition of the same cut were 76.96, 21.65, 1.95 and 1.20 % for moisture, protein, fat and ash, respectively as reported by (Hoffman *et al.*, 2005). Jones *et al.*, (1995) found that the values of 0.94 and 76.55 %, respectively for intramuscular fat and moisture content in the iliofibularis. The low intramuscular fat content might be the reason for the popular public belief that ostrich meat is low in cholesterol content. On the other hand, Hoelscher *et al.*, (1988) concluded that cholesterol content does not increase with an increase in intramuscular fat content.

Table (1): Chemical composition of ostrich meat (Iliofibularis).

Component	% (wet weight) \pm SE
Moisture	75.0 \pm 1.3
Protein	22.4 \pm 1.4
Fat	1.5 \pm 0.5
Ash	1.1 \pm 0.2

According to *Harris et al., (1994)* cholesterol content of cooked ostrich meat was similar to values obtained from beef and chicken. However, cholesterol content was always found to be lower than that of the corresponding turkey, and markedly lower than the bovine (*Paleari et al., 1998*). They added also, the obtained data of different tests of ostrich meat could be influenced by breeding, feeding and the slaughtering of the bird.

Effect of antioxidants on chemical composition of ostrich steaks meat (*Iliofibularis*):

Chemical analysis of ostrich steaks treated by natural antioxidants (AA, Toc and Ros) or its mixtures were studied during storage period at 4°C for 21 days.

1 - Thiobarbituric acid (TBA) number:

Data presented in Table (2) revealed that, TBA of untreated sample (control) increased significantly ($P < 0.01$) during storage at 4°C up to 21 days. On the other hand TBA values of treated samples with antioxidants increased with low level during storage, compared with control samples as shown in Table (2). It could be observed also, a significant ($P < 0.01$) reduction in TBA as affected by antioxidants either in separate or in mixture forms, compared with untreated ones (control). Moreover, the effectiveness of different antioxidants on TBA in ostrich meat could be arranged as following order: AA + Ros came in the first order, followed by Toc + Ros, AA + Toc, AA, Toc and Ros. These results indicated also, that the mixture of antioxidants gave a significant ($P < 0.01$) reduction of TBA, compared with added separate antioxidants. Moreover, the mixture of AA + Ros had a significant effective on reducing the lipid oxidation than other antioxidants under investigation. Results demonstrated that antioxidants or its mixtures are effective in retarding lipid oxidation in ostrich meat steaks.

Table (2): Changes in TBA (as mg malonaldehyde / kg meat) of ostrich steaks as affected by antioxidants during storage at 4°C.*

Storage period (day)	TBA (malonaldehyde mg/kg meat)						
	Treatments						
	Control	AA	Toc	Ros	AA+Toc	AA+Ros	Toc+Ros
0	0.342 ^s	0.342 ^s	0.342 ^s	0.342 ^s	0.342 ^s	0.342 ^s	0.342 ^s
7	0.859 ^j	0.603 ^o	0.682 ^m	0.713 ^l	0.501 ^q	0.452 ^r	0.499 ^q
14	1.923 ^b	0.821 ^k	0.883 ⁿ	0.912 ^t	0.636 ^m	0.502 ^q	0.565 ^p
21	2.741 ^a	1.256 ^e	1.452 ^d	1.493 ^c	0.915 ^t	0.858 ^r	0.903 ^q

* Means having different superscript (a,b,c,...s) within each a raw or those within each column are significant different at ($P < 0.01$).

AA: Ascorbic acid.

Toc: α - tocopherol.

Ros: Rosemary.

Lipid oxidation is one of the major causes of meat quality deterioration. The oxidation deterioration of the polyunsaturated lipid of foods leads through formation of hydroperoxides to short-chain aldehydes, ketones and other oxygenated compounds, which are considered to be responsible for the development of rancidity in stored foods (*Grau et al., 2000*). TBA test determines the amount of malonaldehyde (MDA), a major secondary by product of lipid oxidation in a sample. *Okayama et al., (1987)* suggested that

AA exerted a definite pro-oxidant action in ground beef. They added that the addition of α -tocopherol showed a reduction rate of lipid oxidation in ground beef. Similar results were obtained in turkey (Nam *et al.*, 2003). Positive relation was observed between the level of α -tocopherol and reducing rancidity in both cooked and uncooked patties of lamb and chicken (Abu Salem and Saad, 1991). The level of α -Toc (200 ppm) resulting the lowest TBA level which were packaged under vacuum and storage up to 270 days at -20°C . However dietary vit. E supplementation of cattle delayed lipid oxidation in beef (Lynch *et al.*, 1999). On the other hand the addition of rosemary extracts significantly ($P < 0.05$) improved the oxidative stability. Rosemary contains many compounds with antioxidants properties, such as rosmaridiphenol, rosmariquinone, rosmanol and carnosol, which identified as phenolic type compounds (Houlihan and Ho, 1985). These compounds scavengers free radical similar to butylated hydroxyanisole (BHA) butylated hydroxytoluene (BHT) or tertiary butylated hydroxyquinon (TBHQ). The addition of rosemary improved oxidative stability of meat as reported by Escalante *et al.* 2001 and Fang and Wada (1993) speculated that rosemary extract may chelate metal ions, such as Fe^{+2} , resulting in reduced rate of formation of activated oxygen. Estevez *et al.*, (2005) reported the high effectiveness of antioxidants from natural resources against oxidative reactions that showed similar activity to those from synthetic origin.

Antioxidant synergism in food systems has been studied in the recycling of α -Toc and AA. Wong *et al.*, (1995) found that the components of rosemary extract may be used as a substitute for ascorbic acid to enhance that antioxidative activity of α -Toc. They reported also, samples of cooked beef containing herbal extract (Ros and Sago) exhibited a lower levels of malonaldehyde, compared with control samples. Escalante *et al.*, (2001) demonstrated that rosemary either alone or with ascorbic acid, was highly effective in inhibiting lipid oxidation (TBA) in beef patties. O'Sullivan (2004) revealed that, a mixture of α -Toc and rosemary extract showed a stronger antioxidant effect than either of α -Toc or Ros extract alone.

2 - Peroxide value (PV):

Data in Table (3) show the effect of antioxidants on peroxide values of ostrich steaks during storage at 4°C . It could be noticed that a significant gradual increases in peroxide values was detected in all samples either with or without antioxidants during storage. Peroxide values of untreated sample (control) was higher than that treated with different levels of antioxidants among all storage period. Mixtures of antioxidants had a higher effects on peroxide, compared with separate antioxidants. Meanwhile, the mixture of AA + Ros had a higher significant effect on reducing the lipid oxidation, followed by Toc + Ros and AA + Toc, compared with separate antioxidants.

These results are in accordance with that of Korimova *et al.*, (1998), who reported that rosemary extracts effectively inhibited the formation of PV in meat products. On the other hand, Verma and Sahoo (2000) noted that PV decreased as the α -tocopherol acetate level increased in the meat samples (ground chevon) up to 10 ppm and beyond that again it increased. This indicates that addition of α -tocopherol acetate more than 10 ppm level

to the meat sample is not advantageous in terms of lipid peroxidation. *Juntachote et al., (2006)* reported that the stability of the cooked ground pork treated with the various antioxidants was in the following decreasing order: commercial antioxidant mixture (0.3 % citric acid + 0.5 % ascorbic acid + 0.02 % α -tocopherol) > dried galangal powder > dried holy basil powder > ethanolic extracts of galangal > ethanolic extracts of holy basil control.

Table (3): Changes in peroxide value (mq. / Kg extract fat) of ostrich steaks as affected by antioxidants during storage at 4°C.*

Storage period (day)	Peroxide value (mq. / Kg extract fat)						
	Treatments						
	Control	AA	Toc	Ros	AA+Toc	AA+Ros	Toc+Ros
0	0.45 ^t	0.45 ^t	0.45 ^t	0.45 ^t	0.45 ^t	0.45 ^t	0.45 ^t
7	1.70 ^m	0.95 ^p	0.99 ^o	0.90 ^q	0.85 ^r	0.80 ^s	0.82 ^r
14	3.40 ^h	2.60 ^j	2.72 ⁱ	2.51 ^k	2.43 ^j	2.34 ^m	2.40 ⁱ
21	5.00 ^a	4.06 ^c	4.36 ^b	3.95 ^d	3.85 ^e	3.62 ^g	3.75 ^f

* Means having different superscript (a,b,c,...t) within each a raw or those within each column are significant different at (P < 0.01).

AA: Ascorbic acid.

Toc: α - tocopherol.

Ros: Rosemary.

3 – Free fatty acid (as oleic acid %):

Data in Table (4) indicated that the free fatty acids (as % oleic acid) of extracted fat from ostrich meat (with or without antioxidants) increased gradually with significant levels as the storage period increase up to 21 days. On the other hand, addition of antioxidant either separate or in mixtures caused a significant reduction in the free fatty acids (oleic acid), compared with untreated ones (control) among all storage period. Moreover, there is no significant (P < 0.01) differences were observed between the different types of antioxidants used in this investigation. There is a proportional relation between lipolysis and storage periods in different samples. Initiation and accumulation of lipolysis may be related to the presence of microorganisms, which could play an important role through the lipolytic activity (*Demeyer et al., 1974*), although muscle and adipose tissue lipases may also be active. This means that hydrolysis of lipids could occur during storage, which may lead to a noticeable loss of flavor compounds since it is expected that lipids are the source of many flavor compounds and some of them may be also formed from amino acid (*Halvarson, 1973*).

Table (4): Changes in oleic acid content (%) of extracted fat from ostrich steaks treated by antioxidant during storage at 4°C.*

Storage period (day)	Oleic acid %						
	Treatments						
	control	AA	Toc	Ros	AA+Toc	AA+Ros	Toc+Ros
0	0.28 ⁱ	0.28 ⁱ	0.28 ⁱ	0.28 ⁱ	0.28 ⁱ	0.28 ⁱ	0.28 ⁱ
7	0.41 ^g	0.37 ^h	0.38 ^h	0.37 ^h	0.36 ^h	0.35 ^h	0.36 ^h
14	0.74 ^d	0.68 ^{ef}	0.70 ^e	0.68 ^{ef}	0.67 ^{ef}	0.66 ^f	0.67 ^{ef}
21	0.92 ^a	0.88 ^{bc}	0.90 ^{bc}	0.88 ^{bc}	0.87 ^{bc}	0.86 ^c	0.87 ^{bc}

* Means having different superscript (a,b,c,...i) within each a raw or those within each column are significant different at (P < 0.01).

AA: Ascorbic acid.

Toc: α - tocopherol.

Ros: Rosemary.

These results demonstrated that antioxidants or its mixtures are effective in retarding lipid oxidation in ostrich steak meat.

4 - Metmyoglobin (Met Mb):

Data in Table (5) shows the changes of pigment content (metmyoglobin %) of ostrich steak meat during storage at 4°C. Data revealed that a significant ($P < 0.01$) gradual increases in Met Mb was observed in all samples either with or without antioxidants as the storage period increased. The present investigation demonstrate the efficient role of AA, Toc and Ros to improve the colour stability of ostrich steaks. The increases in Met Mb in treated samples with antioxidants was significantly ($P < 0.01$) lower than that of control sample among all storage periods. Results indicated also the mixtures of antioxidants had a higher pigmificant effect on reducing the Met Mb than antioxidants added separately. These results emonstrated that antioxidants or its mixtures are effective in retarding Met Mb in ostrich steak meat Thus, it could be stated that dipped of ostrich steaks in the mixture of antioxidants can help in minimizing Met Mb accumulation in meat tissues during the storage period.

Pigment in meat is very important for consumers. When the colour of meat changes from bright red (oxymyoglobin) to brown (metmyoglobin), consumers discriminate against that product (Mitsumoto *et al.*, 1991). The oxidation of oxymyoglobin to metmyoglobin is the chemical process that causes discoloration (Schaefer, 2002). The formation of Met Mb from Oxy Mb is positively correlated to lipid oxidation (Yin *et al.*, 1993). The protection of water-soluble Mb against oxidation by a lipid-soluble antioxidant is interesting. Free radicals are neutralized by antioxidants before lipid oxidation propagates among highly unsaturated fatty acid in cellular and subcellular membranes (Machlin, 1984). This delay in production of lipid oxidation breakdown products (e.g. peroxidase) may indirectly prolong the life of Oxy Mb. Lynch *et al.* (1999) and Verma and Sahoo (2000) reported that vitamin E improved the colour stability of beef and (ground chevon). In addition, Shivas *et al.*, (1984) and Mitsumoto *et al.*, (1991) suggested that display life was extended when AA was added to ground beef. On the other hand, Escalante *et al.*, (2001) reported that rosemary, either alone or with ascorbic acid, was highly effective in inhibiting Met Mb formation in beef patties.

Table (5): Changes in metmyoglobin formation (%) of ostrich steaks as affected by antioxidants during storage at 4°C.*

Storage period (day)	Metmyoglobin (%)						
	Treatments						
	Control	AA	Toc	Ros	AA+Toc	AA+Ros	Toc+Ros
0	5.15 ^f	5.15 ^f	5.15 ^f	.15 ^f	5.15 ^f	5.15 ^f	5.15 ^f
7	9.87 ^h	7.13 ^r	7.94 ^m	7.19 ^o	7.03 ^u	7.00 ^d	7.10 ^p
14	15.99 ^b	9.93 ⁱ	10.89 ^q	10.21 ^l	9.82 ⁱ	9.69 ^m	9.96 ⁱ
21	21.02 ^a	11.09 ^g	13.05 ^c	11.36 ^d	10.86 ^q	10.51 ^h	10.99 ⁱ

* Means having different superscript (a,b,c,...r) within each a raw or those within each column are significant different at ($P < 0.05$).

AA: Ascorbic acid.

Toc: α - tocopherol.

Ros: Rosemary

Microbiological evaluation of ostrich steaks meat (*Iliofibularis*):

Consumers use colour of meat, as an indicator of freshness, but it is not a good indicator of freedom from microbial spoilage. In fact, discoloration occurs prior to microbial spoilage in fresh meat products (Schaefer, 2002). From product wholesomeness perspective, microbial spoilage is more important than the lack of an appealing colour. A long-standing challenge in meat science has been to extend the stability of the desirable bright red colour of fresh beef to more fully capture the marketing opportunity that exists prior to the time of microbial spoilage. Discoloration of fresh beef products has been very premature, relative to microbial spoilage (Schaefer, 2002). The changes in viable bacterial counts of ostrich steaks with and without natural antioxidants (AA, Toc and Ros) are shown in Table 6. Data showed that viable bacterial counts of all samples gradually increased during storage. At 7, 14 and 21 days, the bacterial counts of untreated samples (control) were higher than those treated samples with antioxidants. Results indicated also the microbial counts were sufficiently low during the storage period in steaks with rosemary alone (2.5×10^3) and with Ros + AA (2.1×10^3) or Ros+Toc (2.5×10^3). Similar results obtained by Kesurreccion and Reynolds (1990) who reported that the microbial counts of frankfurters treated with Ros extract or mixture of Ros + Toc were sufficiently low during the first 3 weeks of the tested period. On the other hand, the viable bacterial counts did not affected significantly with addition of AA, Toc, or their mixtures to beef steak (Okayama et al., 1987). However, Shivas et al., (1984). reported that microbial counts are not affected by AA treatment.

In general, under aerobic conditions there is no obvious change in the meat until the bacterial count density exceeds 10^8 /g, when spoilage odours and ammonia begin to be detected (Kilsby 1982), and a microbial count of 10^7 /g is an acceptable upper limit during the storage of meat, and that it can be regarded as the safety / quality limit.

Sensory evaluation of ostrich steaks meat (*Iliofibularis*):

It could be noticed that, the panelists were able to clearly detected the differences in aroma quality, oxidative rancidity and changes in colour of ostrich steaks treated with antioxidants, compared with untreated samples after 14 and 21 days of storage at 4°C. On the other hand, the presence of antioxidants either in separate or in mixture form extended the changes in odour and colour of ostrich meat with score (1) even after 21 days of storage. Moreover, untreated samples reached the highest value corresponding to smell (score 3) off odour and 10 – 20 % of discolouration (score 3), as early as 21 days. These results agreed with those obtained by (Barbut et al., (1985), who found that Ros inhibited undesirable odour appearance in Turkey sausage storage at 4°C. Also, coincided with those recorded by Escalante et al., (2001) who showed that Ros alone or with AA, extended the fresh patties beef meat odour during storage time. Organoleptic evaluation revealed that the level of Toc (200 ppm) led to slow rancidity in cooked lamb patties which were packaged under atmospheric pressure (Abu – Salem and Saad, (1991). Results of sensory evaluation were in paralld with those found for lipid oxidation as revealed by the TBA, PV and for Met Mb formation discussed before.

Table (6): Changes in viable bacterial counts (c.f.u / g) of ostrich steaks as affected by antioxidants during storage at 4°C.

Storage period (day)	Total bacterial counts (c.f.u / g)						
	Treatments						
	Control	AA	Toc	Ros	AA+Toc	AA+Ros	Toc+Ros
0	9.3×10^4	9.3×10^4	9.3×10^4	9.3×10^4	9.3×10^4	9.3×10^4	9.3×10^4
7	1.9×10^5	1.6×10^5	1.8×10^5	9.8×10^4	1.8×10^5	9.9×10^4	10.1×10^4
14	1.2×10^5	1.1×10^5	1.2×10^5	1.2×10^5	1.2×10^5	1.3×10^5	1.3×10^5
21	3.2×10^4	3.1×10^4	3.1×10^4	2.5×10^4	2.4×10^4	2.1×10^4	2.5×10^4

AA: Ascorbic acid.

Toc: α - tocopherol.

Ros: Rosemary.

In conclusion, it could be concluded that the use of natural antioxidant mixtures in ostrich meat such as AA + Toc, AA + Ros and Toc + Ros especially at the level 0.05 % L-ascorbic acid, 0.05 % rosemary extract and 0.08 % DL- α - tocopherol effectively reduced oxidative deterioration of lipid, retard development of rancidity, minimized as possible metmyoglobin formation and microbiological deterioration of meat, stored at 4°C for 21 days.

REFERENCES

- Abu - Salem., M. Ferial and M. M. Saad (1991). An inhibition of TBA formation in cooked and uncooked lamb and chicken patties using Alpha - Tocopherol. 37 th International Congress of Meat Sci., and Techn., vol., 2 Kulmbach, Germany.
- AOAC. (1995). "Official methods of analysis" 14 th ed. Association of Official Analytical Chemists Washington. D.C.
- Barbut, S., Josephson, D. B., and A. J., Maurer (1985). Antioxidant properties of rosemary oleoresin in turkey sausage. *J. Food Sci.*, 50, 1356 - 1359, 1363.
- Bligh, E. C. and W. J. Dyer (1959). A rapid method of total lipid extraction and purification. *Com. J. Biochem. Physic.* 37: 911 - 917.
- Chen, C. H., A. M. Pearson and J. I. Gray (1992). Effects of synthetic antioxidants (BHA, BHT AND PG) on the mutagenicity of IQ - like compounds. *Food Chemistry*, 45, 177 - 183.
- Demeyer, D., J. Hoozee and H. Mesdom (1974). Specificity of lipolysis during dry sausage ripening. *J. Food Sci.*, 39, 293 - 296.
- Djenane, D., Sanchez - Escalante, A., Beltran, J. A. and P., Roncales (2001). Ability of α - Tocopherol, taurine and rosemary, in combination with vitamin C, to increase the oxidative stability of beef steaks packaged in modified atmosphere. *Food Chemistry* (submitted).
- Dorman, H. J. D, A. Peltoketo, R. Hiltunen and M. J. Tikkanen, (2003). Characterisation of the antioxidant properties of de - odourised aqueous extracts from selected Lamiaceae herbs, *Food Chemistry* 83, 255 - 262.
- Escalante, A. S., D. Dienane, G. Torrescano, J. A. Beltran and P. Roncales (2001). The effects of ascorbic acid, taurine, carnosine and rosemary powder on colour and lipid stability of beef patties packaged in modified atmosphere. *Meat Sci.*, 58 (4): 421 - 429.

- Escalante, A., D. Djenane, G. Torrescano, J. A. Beltran and P. Roncales (2003). Antioxidant action of borage, rosemary, oregano and ascorbic acid in beef patties packaged in modified atmosphere. *J. of Food Sci.*, 68, 339 – 344.
- Estevez, M., Ramirez, R., Ventanas, S and R. Cava (2005). Sage and rosemary essential oils versus BHT for the inhibition of lipid oxidative reactions in liver pate. *Food Sci., and Tech.*,
- Fang, X., and S. Wada (1993). Enhancing the antioxidant effect of α – Tocopherol with rosemary in inhibiting catalyzed oxidation caused by Fe^{+2} and hemoprotein. *Food Res., International*, 26, 405 – 411.
- Grau, A., F. Guardiola, A. Boatella and R. Codony (2000). Measurement of 2-thiobarbituric acid values in dark chicken meat through derivative spectrophotometer. *J. Agric., Food Chem.*, 48, 1155 – 1159.
- Halvarson, H. (1973). Formation of lactic acid, volatile fatty acids and neutral. Volatile monocarbonyl compounds in swedish fermented sausage. *J. Food Sci.*, 38, 310.
- Harris, S. D., C. A. Morris, S. G. May, T. C. Jackson, L. M. Lucia, D. S. Hale, R. K. Miller, J. T. Keeton, J. W. Savell and G. R. Acuff (1994). Ostrich Meat Industry Development. A&M Reports to the AOA. Final report to America Ostrich Association, August 1994. Texas Agricultural Extension Service, College Station, TX, USA.
- Hoelscher, L. M., J. W. Savell, S. B. Smith and H. R. Cross (1988). Subcellular distribution of cholesterol within muscle and adipose tissue of beef loin steaks. *J. Food Sci.*, 53, 718 – 722.
- Hoffman, L. C., M. Joubert, T. S. Brand and M. Manley (2005). The effect of dietary fish oil rich in n – 3 fatty acids on the organoleptic, fatty acid and physicochemical characteristics of ostrich meat. *Meat Sci.*, 70, (1): 45 – 53.
- Houlihan, C. M. and C. T. Ho (1985). Natural Antioxidants. Ch. 6. In *Flavor Chemistry of Fats and Oils*, D. B. Min and T. H. Smouse, (Ed.), 117. American Oil Chemists Society Champaign, IL.
- Ibanez, E, A. Kubatova, F. J. Senorans, S. Cavero, G. Reglero and S. B. Hawthorne (2003). Subcritical water extraction of antioxidant compounds from rosemary plants, *J. of Agric., Food Chemistry* 51, 375 – 382.
- IMFN (2000). Institute of Medicine, Food and Nutrition Board. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Dietary Reference Intakes for vitamin C, vitamin E, Selenium, and Carotenoids. Washington, D. C., National Academy Press.
- IMFN (2001). Institute of Medicine, Food and Nutrition Board. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. for vitamin A, vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Washington, D. C. National Academy Press
- Jo, C., S. K. Jin and D. U. Ahn (2000). Color changes in irradiated cooked pork sausage with different fat sources and packaging during storage. *Meat Sci.*, 55, 107 – 113.
- Jones, S. D. M., W. M. Robertson and D. Brereton (1995). The ostrich as a meat animal. *Canadian Ostrich*, 4:18 – 20.

- Juntachote, T., E. Berghofer, S. Siebenhandl and F. Bauer (2006). The antioxidative properties of holy basil and galangal in cooked ground pork. *Meat Sci.*, 72, 446 – 456.
- Kesurrection, A. V. A., and A. E., Reynolds (1990). Evaluation of natural antioxidants in frankfurters containing chicken and pork. *J. of Food Sci.*, 55, 629 – 631.
- Kilsby, D. C. (1982). In: *Meat microbiology* [Brown, M. H. (Ed.)], Applied Science Publishers, London, New York, 387.
- Korimova, L., D. Mate and P. Turek (1998). Influence of natural antioxidants on heat – untreated meat products quality. *Czech J. Food Sci.*, 18(4): 124 – 128.
- Lynch, M. P., J. P. Kerry, D. J. Buckley, C. Faustman and P. A. Morrissey. (1999). Effect of dietary vitamin E supplementation on the colour and lipid stability of fresh, frozen and vacuum packaged beef. *Meat Sci.*, 52, (1) 95 – 99.
- Machlin, L. J. (1984). Vitamin E. In L. Machlin (Ed), *Handbook of vitamins* (p. 99). New York: Marcel Dekker.
- Mitsumoto, M., Cassens, R. G., Schaefer, D. M. and K. K., Scheller (1991). Pigment stability improvement in beef steak by ascorbic acid application. *J. Food Sci.*, 56, 857 – 858.
- Morrissey, P. A., P. J. A. Sheehy, K. Galvin, j. p. Kerry and D. J. Buckley (1998). Lipid stability in meat and meat products. *Meat Sci.*, 4, S73 – S86.
- Nam, K. C., B. R. Min, H. Yan, E. J. Lee, A. Mendonca, I. Wesley and D. U. Ahn, (2003). Effect of dietary vitamin E and irradiation on lipid oxidation, colour, and volatiles of fresh and previously frozen turkey breast patties. *Meat Sci.*, 65: 513 – 521.
- O'sullivan, C. M., A. M. Lynch, P. B. Lynch, D. J. Duckley and J. P. Kerry (2004). Use of antioxidants in chicken nuggets manufactured with and without the use of salt and / or sodium tripolyphosphate: Effect on product quality and shelf – life stability. *International J. Poultry Sci.*, 3 (5): 345 – 353.
- Okayama, T., T. Imai and M. Yamanous (1987). Effect of ascorbic acid and alpha – tocopherol on storage stability of beef steaks *Meat Sci.*, 21, 267 – 273.
- Paleari, M. A., S. Camisasca, g. Beretta, P. Renon, P. Corsico, G. Bertoto and G. Crivelli (1998). Ostrich meat: physico – chemical characteristics and comparison with Turkey and Bovine meat. *Meat Sci.*, 48(3/4): 205 – 210.
- Pearson, D. (1968). Application of chemical methods for the assessment of beef quality. III. Methods related to fat spoilage *J. Sci., Food. Agric.*, 19, 553.
- Sales, T. (1996). Histological, Biophysical, Physical and Chemical Characteristics of Different Ostrich Muscles. *J. Sci., Food Agric.*, 70, 109 – 114.
- SAS. (1998). *SAS / STAT user's Guide Release 6.03 Edition*, SAS Institute inc., Cary, Nc, USA
- Schaefer, D. M. (2002). Fresh beef marketing opportunities due to dietary vitamin E. National Cattlemen's Beef Association and the Cattlemen's Beef Board.

- Shivas, S. D., Kropf, D. H., Hunt, M. C., Kastner, C. L., Kendall, J. L. A. and A. D., Dayton (1984). Effects of ascorbic acid on display life ground beef. *J. of Food Protection* 47, 11.
- Verma, S. P. and J. Sahoo (2000). Improvement in the quality of ground chevon during refrigerated storage by tocopherol acetate preblending. *Meat Sci.*, 56, 403 – 413.
- Wong, J. W. K, Hashimoto, and T, Shibamoto (1995). Antioxidant activities of rosemary and sage extracts and vitamin E in a model system. *J. of Agric., and Chem.*, 43, 2707 – 2712.
- Yin, M. C., Faustman, C., Riesen, J. W. and S. N. Williams (1993). The effects of α -tocopherol and ascorbate upon oxymyoglobin and phospholipid oxidation. *J. Food Sci.*, 58, 1273 – 1276.
- Zaika, L.L., T. E., Zell, J. L. Smith, S. A. Palumbo. and J. C. Kissinger (1976). The role of nitrite and nitrate in Lebanon Bologna, a fermented sausage. *J. Food Sci.*, 41, 1457.

تأثير مضادات الأكسدة الطبيعية على ثبات لحم النعناع أثناء التخزين
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ازداد الطلب فى الأونة الأخيرة على لحم النعناع فى كثير من دول العالم، ويرجع ذلك الى أهمية الغذائية من حيث محتواة من البروتين والدهون والعناصر المعدنية وقد أوضحت هذه الدراسة أن لحم النعناع كان منخفضا فى نسبة الدهن (١٥%) ومرتفعا فى نسبة البروتين (٢٢٤%). وفى هذا البحث تم دراسة تأثير مضادات الأكسدة الطبيعية مثل حمض الأسكوربيك والفاثوكفيرول ونبات حصى لبنان على مدى ثبات أكسدة الدهن فى لحم النعناع. وقد لوحظ أن مخاليط كل من حمض الأسكوربيك مع حصى لبنان وأيضا التوكوفيرول مع حصى لبنان وكذلك حمض الأسكوربيك مع التوكوفيرول كانت أكثر تأثيرا فى خفض محتوى اللحم من حمض الثيوباربيتوريك وقيم البيروكسيد. وبعد ٢١ يوم من التخزين على درجة حرارة ٤م لوحظ أن محتوى حمض الثيوباربيتوريك كان ٨٥٨، ٩٠٣، ٩١٥، ٢٥٦، ٤٥٢، ٤٩٣، ٢٧٤١ ملجم مالونالدهيد / كجم لحم نعناع معاملة بكل من (حمض الأسكوربيك + حصى لبنان) و(الفاثوكفيرول + حصى لبنان) و(حمض الأسكوربيك + الفاثوكفيرول) و(حصى لبنان) و(كنترول غير معاملة) على التوالى. وكانت القيم المقابلة للبيروكسيد هى ٣٦٢، ٣٧٥، ٣٨٥، ٤٠٦، ٤٣٦، ٣٩٥، ٥٠٠ ميكروجرام/كجم دهن. بالإضافة الى ذلك فان مضادات الأكسدة الطبيعية المستخدمة أظهرت تأثيرات منخفضة على الحموضة كحمض أوليك.

كما أوضحت الدراسة أهمية الدور الذى تقوم به مضادات الأكسدة المستخدمة فى تحسين ثبات اللون للحم النعناع المستخدم وقد زادت درجة ثباته مع اضافة مخاليط مضادات الأكسدة. حيث لوحظ أن اللحم المعامل بمخلوط حمض الأسكوربيك مع حصى لبنان كان محتواة من صبغة الميثيموجلوبين (١٠٥١%) يلية اللحم المعامل بحمض الأسكوربيك مع الفاثوكفيرول (١٠٨٦%) ثم الفاثوكفيرول مع حصى لبنان (١٠٩٩%) ثم حمض الأسكوربيك (١١٠٩%) و حصى لبنان (١١٣٦%) و الفاثوكفيرول (١٣٠٥%) وكان اللحم الغير معامل (٢١٠٢%).

وقد أظهرت الدراسة أن الجودة الميكروبيولوجية للحم النعناع المستخدم تحسنت بأضافة مضادات الأكسدة المختلفة والمستخدمه فى هذا البحث حيث كان العدد الكلى للبكتريا أكثر انخفاضاً أثناء فترات التخزين للحم مع حصى لبنان فقط أو مع حصى لبنان اذا اضيف إليها حمض الأسكوربيك أو الفاثوكفيرول. وبصفة عامة فان اضافة بعض مضادات الأكسدة لطبيعية كان لها تأثير ايجابى على الصفات الحسية وثبات اللون للحم النعناع المبرد