j.Egypt.net.med.Assoc 79, no 2. 573 – 585 (2019)

IMPROVING THE SENSORY QUALITY OF BEEF MEATBALLS USING NATURAL HERBS

By

Nada A. M. Sadek, Hussein M. H. Mohamed and Mohamed M. T. Emara

Department of Food Hygiene and Control, Faculty of Veterinary medicine, Cairo University, Egypt.

ABSTRACTS

The main goal of the current study was to include the natural herbs of celery, coriander and turmeric and their combinations during formulation of beef meatballs to improve the physico-chemical and sensory quality of the product. Seven meatballs formulas were prepared; the 1st one was prepared from base batter and used as control andsix formulas were prepared by addition of celery (1%), coriander (2 %), turmeric (0.5 %), combinations of celery (0.5%) with coriander (1%), celery (0.5%), with turmeric (0.25 %) and coriander (1%) with turmeric (0.25 %). All-natural herbs and their combinations in meatballs resulted in significant reduction on the thiobarbituric acid reactive substances after processing and during storage except celery when used alone. Moreover, the sensory attributes (appearance, flavor, juiciness, tenderness and overall acceptability) of meatballs were improved after incorporation of natural herbs and their combinations. It can be concluded that addition of natural herbs to meatballs combinations resulted in noticeable improvement of lipid oxidation and sensory quality of the product. Therefore, the presented studymay encourage meat processors to use natural herbs during processing of beef products for production of high quality meat products.

Key words:

Meatballs, celery, coriander. Turmeric, lipid oxidation, sensory quality

INTRODUCTION

Lipid oxidation is one of the most important chemical changes causing deterioration in meat quality during cooking and storage leading to rancidity. It causes development of off-odors and off-flavors whereas muscle pigment oxidation has been reported to negatively affect color, appearance and acceptability of meat **(Kolakowska, 2003)**. Itis one of the major causes of deterioration in meat quality during storage, are of the greatest concerns in the meat industry because they reduce both the nutritional quality and consumer acceptability of meat products **(Buckley *et al.,* 1995; Fernández-López *et al*., 2005; Ryu *et al.,* 2005, 2006).**

Many efforts have been tried to overcome these problems; one of them is the addition of antioxidants. Since the beginning of this century, synthetic antioxidants such as butylated hydroxyl anisole (BHA) and butylatedhydroxy toluene (BHT) have been used as antioxidants in foods **(Reddy *et al*., 2005).** However, the safety of these synthetic antioxidants has been doubted due to toxicity, liver damage and carcinogenicity **(Nanditha *et al*., 2008).** Therefore, a trend about the use of natural additives in foods has been revealed for quite some time as a result of consumer demand and recently the search for natural antioxidants has been widely encouraged **(Suja *et al.,* 2005).** Natural antioxidants, with potential nutritional and therapeutic value, can be used for increasing the stability of foods by preventing lipid peroxidation **(Zia-ur-Rehman,2006).** From these natural additives, natural herbs such as celery, coriander and turmeric have gained more interest from the public and scientific point of view due to their health promoting properties.

Celery (*Apiumgraveolersdulce*) is a medicinal herb used as a food constituent and in traditional medicine. Celery extracts are extensively used as flavoring ingredients in many food products, including meat products, soups, frozen dairy desserts, candies, baked goods, gelatins, puddings, condiments and relishes, snack foods, alcoholic and non-alcoholic beverages and others **(Momin and Nair, 2001).** These extracts have several effects such as anti-inflammatory, anticancer, anti-hepatotoxic, anti-hypercholesterolemic, analgesic, anti-bacterial, and anti-spasmodic **(Modaresi *et al*., 2012).** Coriander (Coriandrumsativum L.) also called ‘‘cilantro” is an annual herbaceous plant originated from the Mediterranean and Middle Eastern regions, cultivated for its culinary, aromatic and medicinal use **(Mildner-Szkudlarz *et al*., 2009).**

The essential oil and various extracts from coriander have been shown to possess antibacterial, antidiabetic, anticancerous, ant mutagenic, antioxidant and free radical scavenging activities **(Sreelatha *et al.,* 2009; Zoubiri and Baaliouamer, 2010).** Turmeric (*Curcuma longa*) is a perennial herb which belongs to family Zingiberaceae. It is cultivated in tropical and subtropical area of the earth mostly in India, Pakistan and China.

From prehistoric time it is mostly used as a house hold therapy to manage several physiological ailments **(Lai,J. 2012)**. Turmeric is a prompt source of bioactive compounds like antioxidants, polyphenols and flavonoids, which may be the substitute of antibiotics used in food and food products. The use of celery, coriander and turmeric as natural herbs in meat products still limited. Moreover, most of the previous research was concentrating on the use of extracts of these herbs **(Salem *et al.,* 2010; Peiretti *et al.,* 2012),** however the use of

natural herbs instead of water or oil extracts can save the chemicals and the time consumed during extraction. Therefore, the main goal of the current study was to include the natural herbs of celery, coriander and turmeric during formulation of beef meatballs to improve sensory quality of these balls during frozen storage for 3 monthsat -18 ºC and examined each month for sensory quality, pH and thiobarbituric acid as well as total volatile base nitrogen.

MATERIAL AND METHODS

Experimental design:

A three replicate based experiment (three independent replicates) was carried out to investigate the effect of celery (1%), coriander (2 %), turmeric (0.5 %), combination of coriander (1%) with celery (0.5%), coriander (1%) with turmeric (0.25 %),celery (0.5%), with turmeric (0.25 %) on the physicochemical and sensory characteristics of beef meatballs. Moreover, the treated beef meatballs were stored for 3 months at -18 ºC and examined each month for sensory quality, pH and thiobarbituric acid as well as total volatile base nitrogen.

Preparation of ingredients:

Imported deep frozen boneless beef chucks (MINISTÉRIO DA AGRICULTURA, Brazil) were purchased from a local supplier in Cairo, Egypt during the first third of shelf life. The chucks were kept frozen at -18 ºC until use. Fresh beef fat was obtained after slaughter from a slaughterhouse (Cairo, Egypt), washed and kept frozen at -18 ºC until use. Sodium tripolyphosphate and seasonings mix. were obtained from LobaChemie, Mumbai, India. Moreover, the sodium chloride was obtained from a local market at Cairo,Egypt. Immediately before processing of the meatballs, the beef and fat were ground through a 4.5-mm plate grinder (Seydelmann NW 114 E; Stuttgart, Deutschland, Germany).

Herbal preparation:

Fresh celery and coriander plants were purchased from a local grocery at Cairo, Egypt. Each plant was washed, soaked in water and vinegar, washed, left to dry and chopped finely and frozen. The turmeric powder was purchased from local markets at Cairo, Egypt. Both the frozen herbs and turmeric powder were added to the meat base formula.

Preparation of different meat formulas:

A simple traditional formulation was prepared and used as a base batter as follows: 70 % lean beef meat, 20 % beef fat, 1.8 % sodium chloride, 8 % water, 0.3 % sodium tripolyphosphate and 0.05 % seasonings mix. Seven formulas were prepared; the 1st one was prepared from

base batter and used as control andsix formulas were prepared by addition of celery (1%), coriander (2 %), turmeric (0.5 %), combination of celery (0.5%) with coriander (1%), celery (0.5%), with turmeric (0.25 %) and coriander (1%) with turmeric (0.25 %). The ground meat and fat of each formula were mixed with other ingredients by hand for 5 min. The mixture of each formula was formed into meatballs of about 50 g each by hand. The formed meatballs were placed in plastic packaging films, held at - 40 ºC for 30 min and then placed in plastic containers and stored at -18 ºC for 3 months. Three independent replicates were prepared from each formula.

Analysis of beef meatballs:

After 24 hrs freezing, the meatballs were analyzed for proximate chemical composition (moisture, protein, fat and ash), shear force, instrumental color evaluation, deterioration criteria (pH, thiobarbituric acid, TBA, and total volatile base nitrogen, TVBN) and sensory attributes (appearance, flavor, juiciness, tenderness and overall acceptability).

Storage of beef meatballs:

The meatballs of different formulas were stored at -18 ºC for 3 months. During storage, the meat balls were investigated every month for sensory attributes and deterioration criteria (pH, TBA and TVBN values).

Analytical methods:

Determination of thiobarbituric acid value.

Five grams from each muscle sample were homogenized with 15 ml deionized distilled water using a stomacher (Lab blender 400) for 10 seconds at the highest speed. One milliliter of the homogenate was mixed with 50 µlbutylated hydroxyl anisole (7.2%) and one ml each of 15mM 2-thiobarbituric acid and 15% trichloroacetic acid. The mixture was vortexed, incubated in a boiling water bath for 15 minutes to develop color, then cooled under running water for 10 minutes, vortexed again, and centrifuged for 15 min. at 2500 rpm.

The absorbance of the resulting supernatant was measured at 531 nm using Unico 1200 (USA) series spectrophotometer against a blank containing one ml of deionized water and 2 ml of 2-thiobarbituric acid-trichloroacetic acid solution. The reading was multiplied by 7.8 to obtain the value of TBARS expressed as milligrams of malonaldehyde per kilogram of sample **(Du and Han, 2002).**

Sensory evaluation:

The guidelines of **AMSA (1995)** were followed during sensory evaluation. For sensory evaluation, 9 experienced panelists (from both sexes in the age range of 30 to 45 years) were chosen from the staff members of the Department of Food Hygiene and Control at Faculty of Veterinary Medicine, Cairo University, Egypt. Moreover, they received a preparatory session prior to testing so that each panelist could thoroughly discuss and clarify each attribute to be evaluated. All testing was carried out under controlled conditions. Tap water was provided between samples to cleanse the palate. Three blocks from each formula were cooked at 180 ºC in a forced draught oven (Heraeus D-63450 Hanau, Germany) to a core temperature 75ºC and maintained warm in the oven until testing within 3 -8 min. The cooking temperature was monitored by a needle thermocouple probe attached to a previously calibrated hand-held thermometer (Hanna HI 985091-1; Pasadena, TX, USA). From the center of each block, rectangular pieces of approximately 1.5 cm - 2 cm were cut and served at room temperature. Each panelist evaluated three replicates of all formulas in a randomized order and asked to assigns a numerical value between 1 and 9 for following attributes: appearance, flavor, juiciness and tenderness where 9 denote extremely acceptable and 1 denotes extremely unacceptable. At the end of evaluation of the given sample, each panelist was asked to give a score for overall acceptability from 1 (dislike very much) to 9 (like very much).

Statistical analysis:

Statistical data analysis for the three independent replicates was carried out using SPSS statistics 17.0 for windows. The difference between means of values of Thiobarbituric acid reactive substances were determined using one-way analysis of variance (ANOVA) and multiple comparisons of means were done using Post Hoc (least square difference test, LSD) procedure. Scores of different sensory attributes were compared among different treatments using General linear Model (GLM) and multiple comparisons of means were done using Post Hoc (LSD) procedure to show differences among treatments. Fixed factor was the treatments. Differences were considered significant at the $P< 0.05$ level.

RESULTS AND DISCUSSION

Lipid oxidation:

The thiobarbituric acid reactive substances (TBARS) values of meat balls treated with different natural herbs and their combinations are presented in (Table 1). The TBARS values of celery 1% were not significantly ($P > 0.05$) different from those of control at 0- time and

during freezing storage. However, the TBA values of meat balls treated with turmeric 0.5 %, coriander 2 % and combinations of coriander 1% with celery 0.5%, coriander 1% with turmeric 0.25 % and celery 0.5%, with turmeric 0.25 % were significantly ($P < 0.05$) lower than those of control non-treated meat balls. These results indicated that the celery does not exhibit antioxidant activities. Meanwhile, coriander and turmeric revealed antioxidant characteristics.Moreover,antioxidant activities have been observed when celery was combined with coriander and turmeric and this may be attributed to the antioxidant activities of coriander and turmeric. The TBARS values of meatballs treated with celery alone were not in agreement with those of **Jung *et al.* (2011) and Naglaa *et al*. (2015)** who recorded a distinct antioxidant activity for celery leaves and essential oils**.**

The antioxidant activities of different herbs and their extracts were recorded by different authors. In this respect the antioxidant activity of rosemary extracts when added to refrigerated and frozen pork sausage at concentration of 500-3000 ppm was reported by **Sebranek *et al*. (2005).** Antioxidant characteristics of rosemary oil added to different meat products were reported by **Yu *et al.* (2002), Peiretti e*t al.*, 2012 and Karpinski and Tymosszczk, 2013).** Stronger antioxidant activities were recorded by **Nugboon and Intrarapichet (2015)** for holy basil, Vietnamese coriander and green pepper corn in comparison to turmeric when used at concentration of 0.2% during pork meat-balls formulations throughout storage. Natural antioxidant properties in sea food were revealed after addition of essential oils and plant extracts of oregano, thyme, tea, grapefruit seed, lemon, lemon grass, turmeric, cinnamon and rosemary **(Pezeshk *et al.* (2015)**.

The antioxidant activities of turmeric powder at 3.5% concentrate was reported in rabbit burger by **Mancini *et al*. (2016)**. Strong antioxidant activities were recorded by **Singh *et al*. (2014)** for clove powder added to raw chicken meat emulsion when compared with ginger and garlic paste. Antioxidant activities of grape seed extract oleoresin rosemary and water-soluble oregano extract in frozen raw products were reported by **Rojas and Brewer (2008).** Moreover, antioxidant activity of colorifico (a spice mix of annatto and corn flour) in frozen minced chicken meat at rate of 0.4 g/ 100 g was reported by **Castro *et al.* (2011).**

The power of natural herbs in inhibition of lipid oxidation has been reported to be more than that of natural or synthetic antioxidants. In this respect, inhibition of lipid oxidation in cooked beef and chicken meat as well as raw red meat, poultry and fish muscle by addition of exogenous tea catechins (300 mg /kg meat) were reported to be more effective when

compared with vitamin E **(Tang *et al*., 2001).** Reduction of lipid oxidation in precooked beef roasts by adding 2.5 % fresh plum juice concentrate or dried plum juice concentrate was reported by **Nunez de Gonzalez *et al*. (2008).**

The application of suitable natural ingredients for developing considerable antioxidant activities will be useful in maintaining the meat quality, extending shelf-life and preventing economic losses. In this respect, it has been observed that strong antioxidant activity of the mixture of water-soluble extract obtained from rosemary (WSR; 300) + green tea flavanol-rich concentrate (GTF; 200) in meat products was achieved by **Mohamed (2016).**

Antioxidant activities of garlic powder and /or α-tocopherol were added to emulsion sausages during storage at 4 °C for 0, 10, 20, and 30 days was investigated by **Kim and Choi (2012).**

The antioxidant properties of these plant extracts have been mainly attributed to their polyphenolic compounds. These compounds can prevent lipid peroxidation using the following mechanisms: decreasing localized oxygen concentrations; preventing chain initiation by scavenging initiating radicals; binding catalysts,such as metal ions to prevent initiating radical generation; decomposing peroxides, by this way-they cannot be reconverted to initiating radicals; chain-breaking to prevent continued hydrogen abstraction by active radicals **(Lal. 2012)**

Table (1): Thiobarbituric acid values (TBA) mg/ kg of meat balls treated with different natural herbs and their combinations during frozen storage at - 18 °C for 3 months.

Treatments	Storage (month)			
	0-Time	1st month	2nd month	3rd month
Control	0.44±0.01[a]	0.48±0.01[a]	0.54±0.03[a]	0.65±0.03
Celery 1%	0.43±0.02[a]	0.46±0.01[a]	0.57±0.01a	0.66±0.04
Coriander 2%	0.34±0.03[b]	0.36±0.04[b]	0.43±0.05[b]	0.61±0.03
Turmeric 0.5%	0.34±0.05[b]	0.36±0.01[b]	0.42±0.01 [b]	0.59±0.02
Celery 0.5% with Coriander 1%	0.34±0.08[b]	0.35±0.01[b]	0.43±0.06 [b]	0.58±0.02
Celery 0.5% with Turmeric 0.25%	0.33±0.03[b]	0.34±0.03[b]	0.44±0.04 [b]	0.62±0.03
Coriander 1% with Turmeric 0.25%	0.32±0.01[b]	0.37±0.01[b]	0.38±0.01 [b]	0.62±0.04

***Data are presented by the mean of three independent replicates ± SD**

[a-b] values with different superscripted significantly (P <0.05) different.

Control; base formula containing common salt, polyphosphate, fat and beef minced Sensory evaluation.

The sensory attributes (Appearance, Flavor, Juiciness, Tenderness and overall acceptability) scores of meat balls treated with celery1% coriander 2 % turmeric 0.5 %, celery 0.5% with coriander 1%, celery 0.5% with turmeric 0.25% and coriander 1% with turmeric 0.25% were significantly ($P < 0.05$) higher than those of non-treated meat balls at 0-time and during frozen storage for 3 months (Tables 2, 3). It has been reported that treatment of meat balls with lime and thyme extracts results in non-significance change in the sensory parameter **(Ozen and Coskim, 2014).** The flavor and overall acceptability of sausages processed with thyme and rosemary were lower than those of control; however, at the end of storage (6 weeks) the aroma, flavor and overall acceptability were not significantly different in all sausage samples **(Jin *et al.,* 2016)**. The sensory analysis of raw chicken sausage treated with fresh garlic revealed significant stronger flavor than that of control and sausages treated with garlic powder or garlic oil **(Sallam *et al*. 2004).**

Table (2): Appearance, flavor and juiciness scores of beef meat balls treated with different natural herbs and their combinations during frozen storage at - 18 °C for 3 months.

Treatments	Storage(month)			
	0-Time	1st month	2nd month	3rd month
Appearance*				
Control	5.07±0.12^{a}	4.67±0.58^{a}	5.17±0.29^{a}	5.00±0.00^{a}
Celery 1%	5.13±0.23^{a}	5.17±0.29^{a}	5.50±0.50^{a}	4.67±0.53^{a}
Coriander 2%	6.03±0.06^{b}	5.33±0.58^{a}	6.17±0.36^{b}	5.67±0.58^{b}
Turmeric 0.5%	5.67±0.58^{ab}	5.67±0.58^{a}	6.00±1.00^{ab}	5.67±0.58^{ab}
Celery 0.5% with Coriander 1%	5.67±0.58^{ab}	5.33±0.58^{a}	6.33±0.58^{ab}	5.33±0.58^{a}
Celery 0.5% with Turmeric 0.25%	5.33±0.58^{a}	5.33±0.58^{a}	6.17±0.29^{b}	5.67±0.58^{b}
Coriander 1% with Turmeric 0.25%	6.17±0.29^{a}	5.50±0.50^{a}	6.07±0.12^{a}	5.67±0.58^{b}
Flavor*				
Control	5.17±0.12^{a}	4.57±0.58^{a}	5.50±0.50^{a}	4.53±1.53^{a}
Celery 1%	5.43±0.58^{a}	5.43±0.58^{a}	5.43±0.58^{a}	5.00±1.00^{a}
Coriander 2%	6.43±0.58^{a}	5.87±0.06^{a}	5.67±0.58^{a}	5.67±1.15^{a}
Turmeric 0.5%	6.67±0.58^{b}	6.33±1.00^{b}	5.50±0.50^{a}	5.63±0.58^{a}
Celery 0.5% with Coriander 1%	5.67±0.58^{a}	5.97±0.06^{a}	5.83±0.29^{a}	6.00±1.00^{a}
Celery 0.5% with Turmeric 0.25%	5.67±0.58^{a}	6.43±0.58^{b}	6.67±0.58^{b}	5.67±1.53^{a}
Coriander 1% with Turmeric 0.25%	6.73±0.29^{b}	6.87±0.58^{b}	6.67±0.58^{b}	5.33±1.00^{a}
Juiciness*				
Control	5.33±0.58^{a}	4.33±0.58^{a}	5.33±0.58^{a}	4.67±0.53^{a}
Celery 1%	5.67±0.58^{ac}	5.07±0.12^{b}	5.67±0.58^{ac}	5.33±0.15^{a}
Coriander 2%	6.00±0.30^{bc}	6.00±0.10^{c}	6.00±0.10^{bc}	5.67±0.58^{b}
Turmeric 0.5%	6.00±0.10^{b}	6.67±0.58^{c}	6.50±0.50^{b}	6.33±0.58^{b}
Celery 0.5% with Coriander 1%	6.00±0.28^{b}	6.33±21.66^{c}	5.83±0.29^{c}	5.67±0.58^{b}
Celery 0.5% with Turmeric 0.25%	6.07±0.12^{b}	5.67±0.28^{d}	6.40±0.53^{b}	5.67±1.15^{b}
Coriander 1% with Turmeric 0.25%	6.67±0.58^{b}	5.67±0.18^{d}	6.33±0.58^{b}	5.67±0.58^{b}

***Data are presented by the mean of three independent replicates ± SD**

a- b values with different superscripted significantly (P <0.05) different.

Control; base formula containing common salt, polyphosphate, fat and beef minced meat.

Table (3): Tenderness and overall acceptability scores of beef meat-balls treated with different natural herbs and their combinations during frozen storage at - 18 °C for 3 months.

Treatments	Storage (month)			
	0-Time	1st month	2nd month	3rd month
Tenderness*				
Control	5.07±0.12^{a}	4.67±0.58^{a}	5.50±0.50^{a}	4.33±0.53^{a}
Celery 1%	5.33±0.58^{ab}	5.33±0.58^{a}	5.33±0.58^{a}	5.00±1.00^{a}
Coriander 2%	6.33±0.58^{b}	5.97±0.46^{b}	5.67±0.58^{ac}	5.67±0.45^{b}
Turmeric 0.5%	6.67±0.58^{b}	6.00±1.00^{b}	5.50±0.50^{a}	5.33±0.58^{b}
Celery 0.5% with Coriander 1%	5.67±0.58^{ab}	5.97±0.36^{b}	5.83±0.29^{ac}	6.00±0.52^{b}
Celery 0.5% with Turmeric 0.25%	5.67±0.58^{ab}	6.33±0.58^{b}	6.33±0.58^{bc}	5.67±0.53^{b}
Coriander 1% with Turmeric 0.25%	6.83±0.29^{c}	6.67±0.58^{b}	6.33±0.58^{bc}	5.00±0.37^{a}
Overall acceptability*				
Control	5.67±0.58^{a}	4.83±0.76^{a}	5.33±0.58^{a}	4.33±1.15^{a}
Celery 1%	5.67±0.58^{a}	5.13±0.15^{a}	5.67±0.58^{a}	5.00±1.00^{a}
Coriander 2%	6.17±0.29^{a}	6.07±0.12^{b}	5.83±0.29^{ac}	5.67±0.58^{b}
Turmeric 0.5%	6.33±0.58^{ac}	6.00±0.10^{b}	6.33±0.58^{bc}	6.33±0.58^{b}
Celery 0.5% with Coriander 1%	6.00±1.00^{ac}	5.33±1.15^{a}	6.17±0.29^{ac}	6.00±0.10^{b}
Celery 0.5% with Turmeric 0.25%	6.00±0.20^{ac}	5.50±0.50^{a}	6.33±0.29^{bc}	5.67±1.15^{b}
Coriander 1% with Turmeric 0.25%	6.67±0.58^{bc}	5.67±0.58^{b}	6.13±0.12^{bc}	5.67±0.58^{b}

***Data are presented by the mean of three independent replicates ± SD.**

a-b values with different superscripted significantly (P <0.05) different.

Control; base formula containing common salt, polyphosphate, fat and beef minced meat.

REFRENCES

AMSA (1995): Research Guidelines for Cookery, Sensory Evaluation, and Instrumental Tenderness Measurements of Fresh Meat. American Meat Science Association, Chicago, IL.

Buckley, D.J.; Morrissey, P.A. and Gray, J.I. (1995): Influence of dietary vitamin E on the oxidative stability and quality of pig meat. J. Anim. Sci., 73: 3122-3130.

Castro, W.F.; Mariutti, L.R.B. and Bragagnolo, N. (2011): The effects of colorifico on lipid oxidation, color and vitamin E in raw and grilled chicken patties during frozen storage. Food Chemistry,124 : 126-131.

Du, M.I. and Ahn, D.U. (2002): Effect of antioxidants on the quality of irradiated sausages prepared with turkey thigh meat. Poultry Science, 81:1251-1256.

Fernández-López, J.; Zhi, N.; Aleson-Carbonell, L.; Prez-Alverez, J.A. and Kuri, V. (2005): Anti-oxidant and antibacterial of natural extracts: application in beef meatballs. Meat Sci., 69: 371-380.

Jin, S.K.; Choi, J.S.; Lee, S.J.; Lee, S.Y. and Hur, S.J.(2016): Effect of Thyme and Rosemary on The Quality Characteristics, Shelf-life, and Residual Nitrite Content of Sausages During Cold Storage. Korean J Food Sci. Anim. Resour., 36:656-664.

Jung, W.S.; Chung, I.M.; Kim, S.H. Kim, M.Y.Ahmad, A. and Praveen, N. (2011): In vitro antioxidant activity, total phenolics and flavonoids from celery (Apiumgraveolens) leaves. Journal of Medicinal Plants Research, 5:7022-7030.

Karpińska, M.; and Tymoszczyk (2013): The effect of oil-soluble rosemary extract, sodium erythorbate, their mixture, and packaging method on the quality of Turkey meatballs. J Food Sci. Technology, 50:443 - 454.

Kim, Y. and Choi, I. (2012): Utilization of dried garlic powder and α-Tocopherol to improve the shelf life of emulsion type sausage during refrigeration storage, Korean J.Food Sci. An., 32: 725 -731.

Kolakowska, A. (2003): Lipid Oxidation in Food Systems. In: "Chemical and Functional Properties of Food Lipids". CRC Press LLC, London.

Lal,J.(2012): Turmeric,Curcumin and Our Life:A Review. Bull. Environ. Pharmacol. Life Sci.,111-17.

Mancini, S.; Preziuso, G. and Paci, G.(2016): Effect of turmeric powder (Curcuma Longa L.) and ascorbic acid on antioxidant capacity and oxidative status in rabbit burgers after cooking .World Rabbit Sci. , 24 : 121-127.

Mildner-Szkudlarz, S.; Zawirska-Wojtasiak, R.; Obuchowski, W. and Gośliński, M. (2009): Evaluation of antioxidant activity of green tea extract and its effect on the biscuits lipid fraction oxidative stability. Journal of Food Science, 74: 362-370.

Modaresi, M.; Ghalamkari, G. and jalalizand, A. (2012): The Effect of Celery (Apiumgraveolens) Extract on the Reproductive Hormones in Male Mice. APCBEE Procedia, 4: 99-104.

Mohamed, H. M. A. (2016): Antioxidant synergy effect of rosemary aqueous extract and green tea flavanol-rich concentrate for superior protection of buffalo meatloaves. Lucrări Ştiinţifice, 56, Seria Zootehnie.

Momin, R. and Nair, M.G. (2001): Mosquitocidal, nematicidal and antifungal compounds from Apiumgraveolens L. seeds. J. Agric. Food Chem., 49:142-145.

Naglaa, H.M.; Hassanen, A. and Eissa, M.F. (2015): Antioxidant and antimicrobial activity of celery (*Apiumgraveolens*) and coriander (*Coriandrumsativum*) herb and seed essential oils. Int. J. Curr Microbiol. App. Sci., 4: 284 -296.

Nanditha, B.R.; Jena, B.S. and Parabhasankar,P. (2008): Influence of natural antioxidants and their carry through property in biscuit processing. Journal of the Science of Food and Agriculture, 89: 288-298.

Nugboon, K. and Intarapichet, K. (2015): Antioxidant and antibacterial activities of Thai culinary herb and spice extracts, and application in pork meatballs. International Food Research Journal, 22: 1788-1800.

Nuñez de Gonzalez, M.T.; Hafley, B.S.; Boleman, R.M.; Miller, R.K.; Rhee ,K.S. and Keeton, J.T.(2008): Antioxidant properties of plum concentrates and powder in precooked roast beef to reduce lipid oxidation .Meat Science, 80: 997-1004.

Özen, F. and Çoşkun, F. (2014): Effect of herbal extracts addition on microbial composition and sensory properties of Tekirdag meatballs. Journal of Tekirdag Agricultural Faculty, 11: 100-109.

Peiretti, P.G.; Gai, F.; Ortoffi, M.; Aigotti, R. and Medana, C. (2012): Effects of Rosemary Oil (*Rosmarinusofficinalis*) on the Shelf-Life of Minced Rainbow Trout (*Oncorhynchusmykiss*) during Refrigerated Storage. Foods , 1: 28-39.

Pezeshk, S.; Ojagh, S.M. and Alishahi, A. (2015): Effect of Plant Antioxidant and Antimicrobial Compounds on the Shelf-life of Seafood. Czech J. Food Sci., 33: 195 -203.

Reddy, V.; Urooj, A. and Kumar, A. (2005): Evaluation of antioxidant activity of some plant extracts and their application in biscuits. Food Chemistry, 90: 317-321.

Rojas, M.C. and Brewer,S.M. (2008): Effect of natural antioxidants on oxidative stability of frozen, vaccum-packaged beef and. Journal of Food Quality , 31: 173 - 188.

Ryu, Y.C.; Rhee, M.S.; Lee, M.H. and Kim, B.C. (2005): Effects of different levels of dietary supplemental selenium on performance, lipid oxidation, and color stability of broiler chicks. Poultry Sci., 84: 809-815.

Ryu, Y.C.; Rhee, M.S.; Lee, M.H.; Lee, S.K. and Kim, B.C. (2006): Effects of packaging methods on the meat quality of α-tocopherol supplemented broiler chicks during refrigerated storage. Food Sci. Biotechnol., 15: 248-253.

Salem, A.M.; Amin, R.A. and Afifi, G.S.A. (2010): Studies on Antimicrobial and Antioxidant efficiency of some essential oils in minced beef. J. of American Sci., 6: 691-700.

Sallam, K.; Ishioroshi, M. and Samejima, K. (2004): Antioxidant and antimicrobial effects of garlic in chicken sausage .Lebenson Wiss Technol., 37: 849 - 855.

Sebranek, J.G.; Sewalt, V.J.; Robbins, K.L. and Houser, T.A.(2005): Comparison of a natural rosemary extract and BHA/BHT for relative antioxidant effectiveness in pork sausage. Meat Sci. , 69: 289-96.

Singh, P.; Sahoo, J.; Chatli, M.K. and Biswas, A.K.(2014): Shelf life evaluation of raw chicken meat emulsion incorporated with clove powder, ginger and garlic paste as natural preservatives at refrigerated storage (4±1°C) . International Food Research Journal, 21: 1363-1373.

Sreelatha,S.;Padma,P.P.and Umadevi, M. (2009): Protective effects of Coriandrumsativum extracts on carbon tetrachloride-induced hepatotoxicity in rats. Food and Chemical Toxicology, 47: 702-708.

Suja, K.P.; Jayalekshmy, A.; and Arumughan, C. (2005): Antioxidant activity of sesame cake extract. Food Chemistry, 91: 213-219.

Tang, S.Z.; Kerry, J.P.; Sheehan,D.; Buckley, D.J. and Morrissey, P.A. (2001): Anti oxidative effect of dietary tea catechins on lipid oxidation of long-term frozen stored chicken meat. Meat, 57: 331-336.

Yu, L.; Scanlin, L.; Wilson, L. and Schmidt, G. (2002): Rosemary extracts as inhibitors of lipid oxidation and color change in cooked turkey products during refrigerated storage. Journal of Food Science, 67: 582-585.

Zia-ur-Rehman, Z.U. (2006): Citrus Peel Extract A Natural Source of Antioxidant. Food Chem., 99:450 - 454.

Zoubiri, S. and Baaliouamer, A. (2010): Essential oil composition of Coriandrumsativum seed cultivated in Algeria as food grains protectant. Food Chemistry, 122: 1226 -1228.