THE EFFECT OF SOME HERBS SPICES AND PLANTS AS NATURAL ANTIOXIDANTS ON THE QUALITY OF MINCED HAMOOR (*Epinéphelus chlorostigma*) AND CHICKEN THIGH DURING DIFFERENT STORAGE CONDITIONS

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ABSTRACT

Some herbs, species and plants used as natural antioxidants were added to two different meat systems and stored under different storage conditions. The thiobarbeturic acid (TBA) values were determined in an attempt to evaluate the natural antioxidant potentials on retarding the onset of lipid oxidation. The pH, cooking yields (CY%) and organoleptic tests were also measured to assess quality. Barley powder (Bar), fenugreek powder (Fen), thyme + rosemary blend (TR), thyme + sage blend (TS) as natural antioxidants were added at different concentrations to minced hamoor (Epinephelus chlorostigma) beside a control sample (100% minced hamoor) and stored for 4 months at –18°C. Tea catechin extract (TC), TC + 5% citric acid (TC/A), soy protein isolate (SPI) and thyme powder (Thy) were added at different concentrations to minced chicken thigh (CT) and stored for 25 days at 4°C beside a control treatment. Results indicated that all added herbs, spices and plants to both minced hamoor and CT, significantly ($P<0.05$) suppressed lipid oxidation as compared to their controls. The highest antioxidant acitivity was found in TR and Fen in case of minced hamoor where the inhibition percent of TBA were 67.38% and 64.16%, respectively, at the end of the storage period. TC in case of minced chicken thighs showed the strongest inhibition of lipid oxidation being 94.33% at the end of the storage period. A significant incline in the pH values of minced hamoor treatments and control were observed as a function of time, whereas a significant rise in the pH values of minced chicken thighs treatments and control were observed in this respect. The CY% of minced hamoor with Fen and TS showed the highest values being 67.84 and 63.33%, respectively as compared to control, whereas, the CY% of minced chicken thighs with SPI and Thy exhibited the highest ($P<0.05$) values (85.82, 82.50%), respectively, in this respect. The organoleptic scores of hamoor burgers showed that Bar, TS and TR were the most acceptable ($P<0.05$) as compared to control. The panel scores for minced chicken thigh patties showed that all added treatments were significantly acceptable ($P<0.05$) in comparison to control especially (Thy) patties which were highly scored ($P<0.05$) in terms of flavour and overall acceptability. All products remained in good quality during storage. Results indicated that some of the used herbs spices and plants are powerful natural antioxidants when used in minced muscles food.

Keywords: *Minced hamoor, chicken thigh mince, herbs, spices, tea catechin extract, lipid oxidation, quality, frozen and chilled storage.*

INTRODUCTION

The control of lipid oxidation in fresh and further processed meat products is a goal of food scientists and food processors (Sheldon *et al.*, 1997). Apart from microbial spoilage, lipid oxidation is the primary process by which quality loss of muscle foods occurs (Buckley *et al.*, 1995).

Lipid oxidation is of great concern to the meat and fish industry because it leads to the development of undesirable rancidity and potentially toxic reaction products (Halliwell *et al.*, 1995 and Aubourg, 1999) as well as adverse changes in colour, flavour and nutritive value (Jensen *et al.*, 1998).

Chilled raw meat is usually oxidatively stable, but mincing, cooking and other processes prior to refrigerated storage disrupt muscle cell membranes facilitating the interaction of polyunsaturated fatty acids (PUFA) with prooxidant substances such as non-heme iron, and thereby accelerating lipid oxidation that leads to rapid quality deterioration and development of rancidity (Botsoglau *et al.*, 2002). Poultry meat and fish in particular, are very sensitive to oxidative deterioration because of their higher content of PUFA (Mejlholm and Dalgaard, 2002; Serdaroglu and Turp, 2004).

Several studies have indicated that lipid oxidation can be controlled or at least minimized through the use of antioxidant (Gray *et al.*, 1996 and Decker and Xu, 1998). Synthetic antioxidants were widely used in the meat industry, but consumers concern over their safety and toxicity pressed the food industry to find natural sources of antioxidants (Monahan and Troy, 1997). Therefore, the importance of screening naturally occurring alternatives which are safe and effective is increasing (Tang *et al.*, 2001a).

Much attention in recent years has been focused on extracts from herbs and spices which have been used traditionally for centuries to improve the sensory characteristics and extend the shelf-life of foods (Mejlholm and Dalgaard, 2002). They also play an important role in the prevention of diseases (Nakatani, 2000). Some herbs of the *labiata* family, particularly rosemary and sage have been extensively studied for their antioxidative activity (Brieskorn and Demling, 1969; Schwarz and Ternes, 1992; Cuvelier *et al.*, 1996 and Wang *et al.*, 1999). Potent aromatic plants, apart from rosemary and sage, had antioxidative activities equal or better than those of synthetic antioxidant have been identified in several parts of the world (Adegoke *et al.*, 1998). The use of spice extracts as antioxidants is relatively new but they are of interest for many producers since they are plant extracts of natural origin. Another advantage is that comprehensive toxicological testing is not required, as such extracts are not considered to be food additives (Loliger, 1991).

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In addition, spices, herbs, fruits and vegetables are also good sources of antioxidants as they are enriched in antioxidant vitamins such as tocopherols, ascorbic acid and β-carotenes (Adegoke *et al.*, 1998).

Several studies were conducted using natural herbs and spices in controlling the onset of lipid oxidation in meat systems. Vareltzis *et al.* (1997) found that rosemary extract retarded the oxidation of filleted and minced fish during a period of frozen storage. Tea catechins were also reported to function as potential antioxidants in lipid model systems (Amarowicz and Shahidi, 1995 and Frankel *et al.* 1997), fish oil (Wanasundara and Shahidi, 1996), fish (He and Shahidi, 1997) and pork (Shahidi and Alexander, 1998).

The antioxidant activities of 22 selected culinary herbs and spices added to pork homogenate in the form of liquid extracts were evaluated. Results indicated that the addition of the aforementioned extracts significantly suppressed lipid oxidation of pork with special emphasis to the extracts of sansho, sage and ginger (Tanabe *et al.* 2002).

Escalante *et al.* (2003) used natural antioxidants such as cayenne hot pepper, red sweet pepper, lycopene – rich tomato pulb and extract of tomato rich in lycopene in beef patties stored at 2±1°C as a means of delaying and inhibiting the oxidation of lipids, as well as the growth of psychotrophic bacteria.

Racanicci *et al.* (2004) reported that dittany represented an interesting alternative to rosemary as a source of antioxidants for precooked meat.

Giménez *et al.* (2005) confirmed that the application of natural antioxidants such as, rosemary and ascorbic acid led to an improvement in sensory quality and retarded lipid oxidation of salmon fillets stored under conventional light.

Notewithstanding, the optimised use of natural antioxidants in food is still in its infancy and needs a lot of research and development (Medina *et al.*, 2003).

The objectives of the present research were to determine the antioxidant potential of some herbs, spices and plant extracts in retarding lipid oxidation, organoleptic deterioration and other quality parameters (pH and cooking yield) in two different meat systems (fish mince and chicken mince) under different cold storage conditions (–18°C and 4°C±1), respectively in an attempt to improve the shelf-life and quality of their final products.

MATERIALS AND METHODS

Materials

Screening ingredients

Natural food ingredients, spices and herbs as natural antioxidants used in fish mince were: (a) whole barley seeds [kindly provided from a special organic farm located in the southern area in Saudi Arabia (SA)]. (b) whole fenugreek seeds (*Trigonella foenumgraecum*) a product of Pakistan (National Foods Ltd. Karachi-Pakistan) was purchased from a local supermarket (Jeddah, SA). (c) Thyme (*Thymus vulgaris* L.) and rosemary (*Rosmarnus officinalis*) leaves a product of American Garden, Seaford, New York were purchased from a supermarket (Jeddah, SA). (d) Sage (*Saliva officinalis* L.) a product of Amman, Jordan was specially packed for Thimar El Zaytoun Corporation, SA.

Ingredients used as natural antioxidant in chicken mince were: (a) Green tea extract with polyphenol catechins (Kinglong Natural Plant Products Industry Ltd, Changsha, Hunan, China) was purchased from General Nutrition Corporation (GNC, Jeddah, SA). (b) Citric acid ($C_6H_3O_7$) anhydrous powder (Panreac Co., Spain). (c) Soy protein isolate (90%) a product of Good'N Natural Manufacturing Corp (Holbrook, NY, USA) was purchased from GNC (Jeddah, SA). The aforementioned product also contained egg albumin, brewer's yeast, lecithin, natural and artificial vanilla flavour, bromelain and papain.

Preparation of fish samples and storage conditions:

Ephinéphelus chlorostigma or hexagonal spotted grouper commonly known as hamoor were purchased fresh from the main fish market in Jeddah, SA. The fish were filleted on spot put in ice bags and directly transferred to the laboratory. The fillets (≅10kg±2) were put in plastic bags and frozen stored over night at -20°C. They were then cut into pieces while half frozen and minced through a 4mm plate (National UK-G 20NR, Japan). The minced fish muscle was then divided into 5 portions of two kilogram each for adding the following ingredients: (a) 5% (50g kg^{-1}) finely ground whole fenugreek (Fen). (b) 5% finely ground whole barley (Bar). (c) 2.5% powder thyme and 2.5% powdered sage (TS). (d) 2.5% powdered thyme and 2.5% powder rosemary (TR). (e) Control sample (100% minced fish). The added ingredients were ground using a Braun grinder (Model no. 1300k powder plus G, Germany). All treatments and control were further divided for the chemical and sensory evaluation packed in plastic polyethylene bags, frozen stored at –18°C for 4 months and periodically monitored for evaluation at one-month interval (Abdel-Aal, 2001).

Preparation of chicken samples and storage conditions

Twelve kilogram of minced chicken thighs were prepared from fresh chicken in the chilling department of a local meat processing plant (Radwa Food Corporation, Jeddah, SA). The chicken mince was further divided into five equal portions to be mixed with the following ingredients: (a) 300mg green tea catechin extract (TC) dissolved in 50 ml distilled water (300mg TC Kg^{-1}). (b) 150mg TC dissolved in 50ml distilled water + 5% citric acid (TC/A). (c) 5% (50g kg^{-1}) soy protein isolates (SPI). (d) 5% (50g kg^{-1}) Thyme (Thy). (e) A control sample (100% chicken thigh mince). The minced samples in case of (a) and (b) were sprayed by fine aerosol into the minced samples which were then thoroughly mixed by

hand. The same amount of distilled water was sprayed into the control minced samples (Tang *et al.*, 2001a). The treatments were further divided for chemical and sensory evaluation, packed in polyethylene bags and displayed in a refrigerator at 4°C±1 for 25 days (Botsoglau *et al.*, 2002) . Samples were periodically monitored for chemical and sensory evaluation at 5 days interval.

Methods

Proximate chemical composition

Percentages of moisture, crude protein and ash of the control minced fish and chicken were determined according to the methods 934.01, 978.02 and 938.08 respectively, of AOAC (1995) procedures. The fat was extracted and determined according to the method of Folch *et al.* (1957).

pH determination

Ten grams of minced meat samples (fish and chicken) blended with 90 ml distilled water were measured with a standard combined electrode attached to a digital pH meter (Metrohm 744, Metrohm Ltd. CH-9101 Herisau, Switzerland) as described by Vareltzis *et al.* (1997).

Cooking yield

The cooking yields (CYs %) for minced meats were measured by weight differences before and after cooking to an internal temperature of 71.7°C (Chin *et al.*, 1999).

Measurement of lipids oxidation

The 2-thiobarbituric acid (TBA) distillation method of Tarladgis *et al.* (1960) as modified by Rhee (1978) was used to determine lipid oxidation. The TBA reactive substances were calculated by multiplying the absorbance readings by a factor of 7.8 (Tarladgis *et al.* 1960) and expressed as mg malonaldehyde (MDA) kg^{-1} meat sample.

Lipid oxidation inhibition percentage

The sum of TBA values evaluated at 0, 5, 10, 15, 20 and 25 days for untreated (control) and treated samples for chicken mince and the values of TBA evaluated at 0, 1, 2, 3 and 4 months for hamoor mince were used to calculate the inhibition of lipid oxidation as follows:

$$\text{Inhibition (\%)} = \frac{\text{TBA values (Control} - \text{treatment)}}{\text{Control at the same storage period}} \times 100$$

All chemical determinations were carried out in triplicate.

Sensory evaluation

Chicken and fish mince were shaped for sensory evaluation into patties and burgers of approximately 57±2g, respectively. Patties and burgers were grilled using a barbeque grill (Korkhaz A304, Mangalet 1800W, Istanbul, Turkey) for 6 min at each side with medium heat. Samples were served along with water and unsalted crackers to 5 trained member and specialist panels from the Dept. of Food & Nutrition. Panelists were instructed to rinse with water and consume crackers after tasting each sample and relax for 20 to 30s before tasting the next samples. Empty cups were provided for expectoration of the samples (Kramer and Twigg, 1970). The panelists received 5 samples at each testing period (each 5 days for chicken patties and monthly for fish burgers). Sensory scores for colour, taste, odour, texture and overall acceptance were determined using a five-point hedonic scale, where 5 = non detectable off flavour and 1 = extreme off flavour; 5 = typical fresh colour and 1 = faint colouration and 5 = firm and juicy and 1 = soft and fibrous for texture (IFT/SED, 1981).

Statistical analysis

Data were analyzed by analysis of variance with the general linear models procedure (GLM) of the SAS package (SAS *Institute*, Inc., 1995). Comparison of treatment means, time and interaction (time × treatment) was based on Duncan's multiple range test.

RESULTS AND DISCUSSION

Proximate chemical composition of minced hamoor and chicken thigh mince

The proximate composition of the minced hamoor and chicken thigh is presented in Table (1). The moisture (78.98%), protein (18.85%) and fat (1.37%) of the hamoor were in the range of *Epinephelus* mixed species as reported in the Encyclopedia Britannica Inc. (2005). The moisture (71.27%), protein (16.61%), fat (10.07%) and ash (2.04%) of the chicken thigh were quite comparable to that of Shaltout (1994) for chicken thighs and legs mince where the moisture, protein, fat and ash percentage were 72.38, 14.00, 9.14 and 3.50, respectively.

Oxidative stability

The TBA values of minced hamoor samples as shown in (Fig. 1a) were affected by the treatment and storage periods. The treatment × storage effect for TBA values were significant ($P<0.05$). The overall mean TBA values of minced hamoor containing different antioxidants were lower than those of controls. Thyme-Rosemary (TR) as well as (Fen) treatments were the best in lowering ($P<0.05$) the onset of lipid oxidation as they were not different from each other at the end of the storage period but different from the control and the other treatments. As a matter of fact, the TBA levels for all treated and untreated samples at the end of the storage period were considerably below the TBA values reported as acceptable for frozen sea food (Abdel-Aal, 2001). Table (2) which shows the percent inhibition in TBA values for minced hamoor containing different herbs and spices, further confirmed that TR (67.38%) and Fen (64.16%)

treatments exhibited the highest inhibition values after 4 months of storage. The aforementioned results were in accordance with Vareltzis (1997), Feng (1997), and Gimenéz *et al.* (2005). They confirmed that spices belonging to the *Labiata* family (rosemary and sage) as well as thyme exhibited the highest antioxidant activity among all tested spices, with special reference to rosemary extract which inhibited the onset of oxidation in different fish species during frozen storage. They also reported that sage exhibited strong antioxidant activity at 4°C storage. On the other hand, Hettiarachchy *et al.* (1996) reported that raw and cooked meat samples containing fenugreek extracts had better oxidative stability compared to some synthetic antioxidant (BHA, BHT and TBHQ) and control which emphasized the fact that fenugreek may be a promising natural antioxidant.

The oxidative stability of the treated minced chicken thigh as measured by the TBA values is shown in Fig. (2a). Results revealed (treatment × storage) a significant ($P<0.05$) increase in the mean TBA values of all treatments and control. As a matter of fact, all treated samples showed a markedly slowed down ($P<0.05$) TBA values as compared to control. However, minced chicken samples with added TC extracts exhibited an obvious ($P<0.05$) lower TBA values among the other treated samples and control. The antioxidant potential of the added herbs and spices in retarding the onset of oxidation in the minced chicken samples may be arranged decreasing order as follows: TC> Thy> TC/A> SPI. Table (3) which shows the inhibition percentages in TBA for minced chicken thighs containing different herbs and spices, further confirmed the fact that TC samples (94.33%) were the most efficient in retarding the onset of oxidation during the whole storage period (25 days).

Table 1: Proximate composition (wet weight basis) of minced hamoor and chicken thighs

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
Hamoor	78.98±0.73	18.85±0.62	1.37±0.36	1.09±0.62
Chicken thighs	71.27±0.70	16.61±0.38	10.07±0.4	2.04±0.07

Table 2: Percentage inhibition[1] in TBA values for minced hamoor containing different herbs and spices[2] during frozen storage at (–18°C) for 4 months

Antioxidant treatment	Storage period (Months)				
	0	1	2	3	4
Fen	20.0	78.68	74.16	70.79	64.16
Bar	4.28	74.87	53.33	52.20	45.94
TS	6.42	74.87	65.83	64.43	52.37
TR	15.71	73.13	73.16	70.79	67.38

[1]Percentages were computed from the statistical data in Fig. (1a) following the formula :

$$\text{Inhibition } \% = \frac{\text{TBA values (Control} - \text{Treatment)}}{\text{Control}} \text{ at the same storage period} \times 100$$

[2]Fen : 5% Fenugreek powder
Bar : 5% whole barley powder
TS : 2.5% Thyme + 2.5% Sage powder
TR : 2.5% Thyme + 2.5% Rosemary powder

Table 3: Percentage inhibition[1] in TBA values for minced chicken thighs containing different herbs and spices[2] during refrigerated storage at (4°C) for 25 days

Antioxidant treatment	Storage period (Days)					
	0	5	10	15	20	25
TC	15.32	87.87	92.31	92.67	94.46	94.33
TC / A	8.75	91.29	89.68	90.44	88.68	72.97
SPI	—*	73.79	80.78	83.66	82.79	74.22
Thy	13.13	93.72	95.67	94.50	87.46	84.53

[1]Percentages were computed from the statistical data in Fig. (1a) following the formula :

$$\text{Inhibition } \% = \frac{\text{TBA values (Control} - \text{Treatment)}}{\text{Control}} \text{ at the same storage period} \times 100$$

[2]TC : Tea catechin extract
TC/A : TC + 5% citric acid
SPI : 5% Soy protein isolate
Thy : 5% Thyme powder
* TBA at zero time higher than control

These results were in accordance to Tang *et al.* (2001a, b) who confirmed that TC significantly reduced lipid oxidation in different minced meat species compared with their controls. Abdel-Alim *et al.* (1999) reported that the lipid oxidation was effectively inhibited in the minced chicken treated with several dry spices diminishing the TBA to a range of 32% and 83% of those found in the control samples. Botsoglau *et al.* (2002) also showed that thyme extracts exerted antioxidative effects being most effective in retarding lipid oxidation in stored raw and cooked chicken during refrigerated storage. It was also observed by Sommers *et al.* (2003) that citric acid although an antioxidant synergist did not increase antioxidant activity on frankfurter surfaces.

pH values

The mean pH of minced hamoor control and treated samples with different herbs and spices (Fig 1b) were in the range of 6.64–6.86 at the beginning of the storage period. The addition of the different herbs and spices markedly changed the pH values of the minced hamoor at zero time. A gradual drop in the pH of all treated samples and control ($P<0.05$) were observed during the storage period where the control recorded the highest drop ($P<0.05$) in this respect. As a matter of fact, the drop in the pH value of minced hamoor during the frozen storage may be due to the production of lactic acid by lactic acid bacteria as a result of some microbial activity (Otremba *et al.*, 1999). Also Frazier (1967) reported that the decrease in pH with the production of small amounts of acid by lactic acid bacteria may enable the lactics to suppress the undesirable proteolytic organisms. Meanwhile, unlike aerobic spoilage microorganisms, the growth of lactic acid bacteria might not be accompanied by overt evidence of spoilage in many foods (Sharpe and Pettipher, 1983).

The mean pH values of treated minced chicken thighs and control (Fig. 2b) showed a gradual unsteady increase ($P<0.05$) during the storage period. As a matter of fact, both TC/A and TE samples exhibited the least increase in pH ($P<0.05$) being 6.31 and 6.59, respectively at the end of the storage period as compared to control (6.94) and the other treated samples. On the other hand, the pH value of SPI exceeded that of control at the end of the storage period. The increase in the pH of the minced chicken thigh may be due to some bacterial activity as affected by the temperature and time of storage (Frazier, 1967). It was also reported by Chin *et al.* (1999) that the pH values increased with increasing levels of hydrated SPI.

It was reported by Sommers (2003) that citric acid at different concentration ranges (5–10%) had a significant effect in lowering the pH of frankfurters and in inhibiting *Listeria monocytogenes* which is a food borne pathogen capable of growth at refrigerated temperature and is a pH dependent. It was also reported by Ismail *et al.* (2001) that the application of lactic acid with different synergists reduced *Yarrowia lipolytica* which is one of the predominant yeasts in raw poultry and believed to play a role in spoilage and is a pH dependent. Schmitz *et al.* (1994) and Ozean (1998) confirmed the inhibitory effectiveness of a wide range of herbs, spice and their extracts against a wide range of bacteria and mould with special emphasis directed towards thyme, sage oregano and rosemary extract. As a matter of fact, Ismail *et al.* (2001) reported that chicken wings with sage or thyme decoctions significantly reduced the population of *Y. lipolytica* but did not control its growth during storage at 5°C for to 9 days.

Cooking yields

The addition of the herbs and spices greatly enhanced the mean cooking yields (CY%) of the minced hamoor which showed a significant increase during the course of frozen storage (Fig. 1c). Both Fen and Bar samples (67.84 and 63.33%, respectively) exhibited the highest increase in this respect and were significantly different ($P<0.05$) than the control (55.53%) and the other antioxidant treatments. Minerich *et al.* (1991) explained that the higher CY due to the addition of some ingredients to minced meat would be accounted for by the increased moisture retention of meat extended by those ingredients.

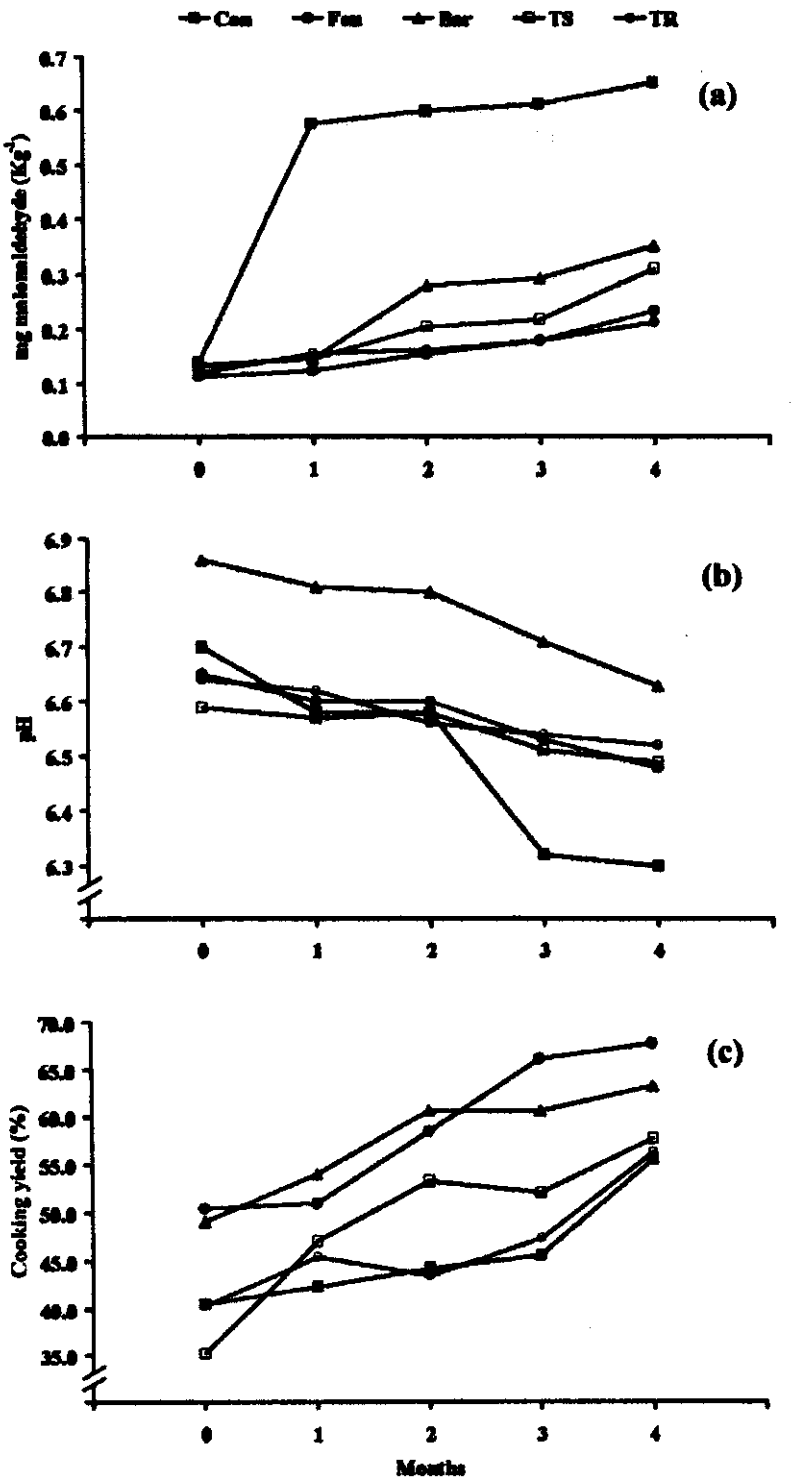

Fig. 1: Effect of some herbs and spices on minced hamoor stored under frozen conditions (–18°C) for 4 months, (a) oxidative stability, (b) pH and (c) cooking yield percentage

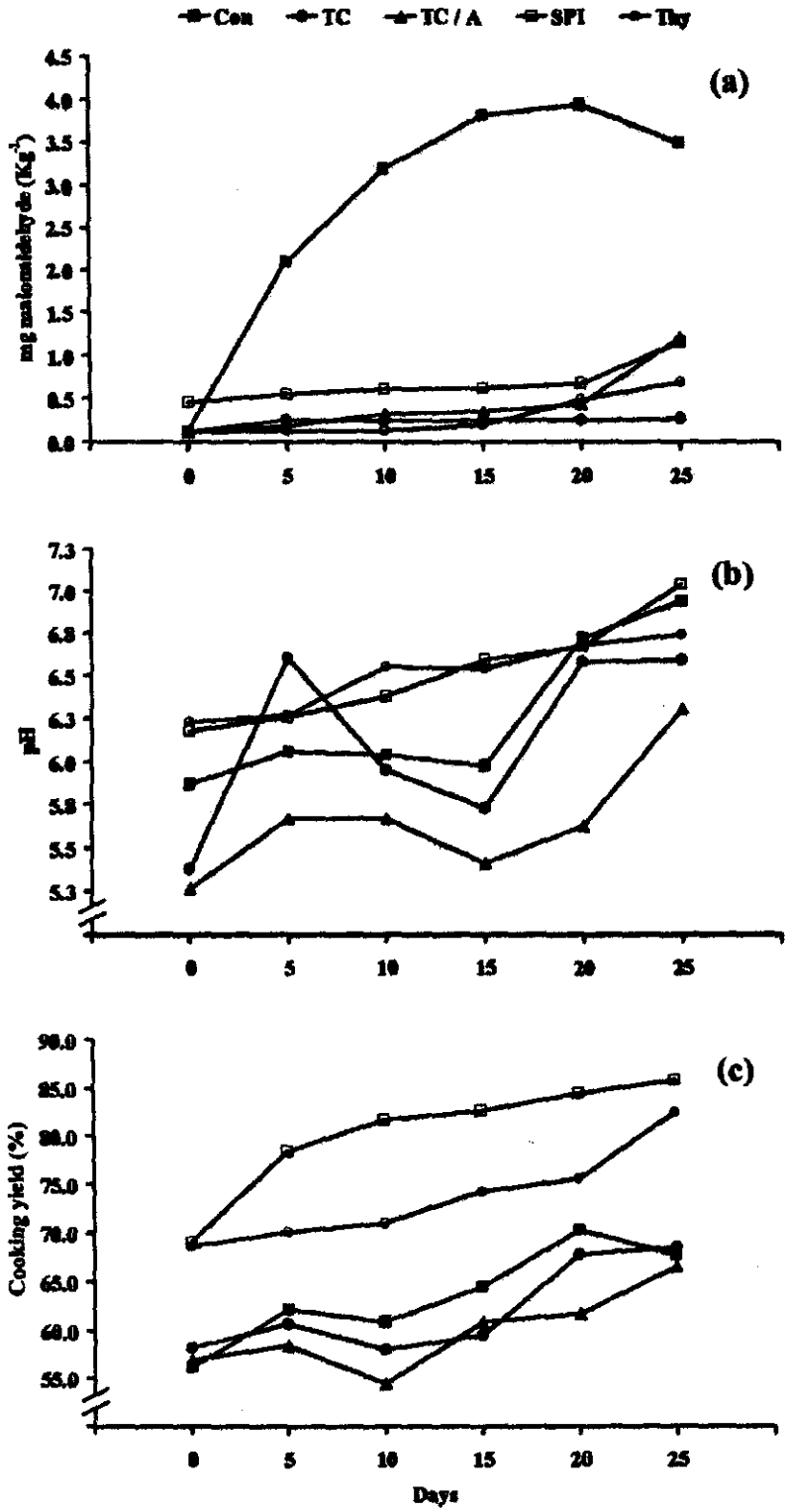

Fig. 2: Effect of some herbs and spices on minced chicken thighs stored under refrigerated conditions (4°C) for 25 days, (a) oxidative stability, (b) pH and (c) cooking yield percentage

The CY % minced chicken thigh samples and control (Fig. 2c) showed a rather steady rise as a function of time. The highest CY% reached at the end of the storage period was accounted for both SPI (85.82%) and Thy (82.50) samples, which were significantly different ($P<0.05$) than control (67.70%) and the TC/A and TC (66.44 and 68.5), respectively. The aforementioned results were in accordance to those of Huang *et al.* (2001), they observed that the destructed pressed smoked duck steaks with different added levels of SPI and carrageenan exerted minimum cooking losses and maximum water holding capacity. It was reported by Abdel-Aal (2001) that minced fish with added citric acid exhibited the highest cooking loss (least CY%) which may be related to the lowered pH values during storage.

Sensory evaluation

Table (4) shows that the addition of the different herbs and spices did not affect the colour scores of the fish burgers as a function of time. However, it exerted significant changes ($P<0.05$) on the final products as a function of treatments where Bar and Fen treatments got the best scores as compared to control and the other treatments. The panelists could detect a significant ($P<0.05$) change in the taste and odour during the period of frozen storage which was sensed after one month and was maintained up to the end of the storage period. In this respect, all treated samples were significantly ($P<0.05$) highly scored than the control. As a matter of fact, the TS treatment exhibited the best flavour scores during the storage period. Results also clarified that Fen

Table 4: Effect of some herbs and spices[1] on the sensory attributes of hamoor fish burgers during frozen storage at (–18°C) for 4 months

Antioxidant treatment	Storage period (Months)					Treatment mean
	0	1	2	3	4	
Colour						
Control	2.4	3.4	4.2	4.1	4.2	3.66^{b}
Fen	5.0	4.0	3.1	3.8	3.4	3.92^{a}
Bar	3.9	3.6	3.9	4.2	4.2	3.96^{a}
TS	3.7	3.2	3.7	3.4	3.4	3.48^{b}
TR	4.0	3.4	3.5	3.4	3.8	3.62^{b}
Months mean	3.80^{a}	3.52^{b}	3.68^{ab}	3.78^{ab}	3.86^{a}	
Taste						
Control	4.8	3.3	3.1	2.9	2.7	3.36^{c}
Fen	4.0	4.1	3.8	4.1	4.1	4.02^{b}
Bar	4.5	3.9	4.0	4.0	4.6	4.20^{ab}
TS	4.2	4.0	4.4	4.4	4.6	4.32^{a}
TR	4.5	4.1	4.1	4.4	4.1	4.24^{ab}
Months mean	4.40^{a}	3.88^{b}	3.88^{b}	3.96^{b}	4.02^{b}	
Odour						
Control	4.6	3.5	3.2	3.1	2.9	3.46^{c}
Fen	4.3	4.0	4.3	4.2	3.8	4.12^{b}
Bar	4.5	4.0	3.9	4.2	4.2	4.16^{b}
TS	4.5	4.0	4.7	4.2	4.7	4.42^{a}
TR	4.7	4.2	4.4	4.1	4.0	4.28^{ab}
Months mean	4.52^{a}	3.94^{b}	4.10^{b}	3.96^{b}	3.92^{b}	
Texture						
Control	3.9	3.6	3.6	3.6	3.0	3.54^{c}
Fen	4.5	4.5	3.7	4.7	3.2	4.12^{a}
Bar	3.5	3.2	3.9	4.2	4.3	3.82^{b}
TS	4.1	3.6	3.9	3.8	3.6	3.80^{bc}
TR	4.2	3.3	3.5	3.7	3.2	3.58^{bc}
Months mean	4.04^{a}	3.64^{b}	3.72^{b}	4.00^{a}	3.46^{b}	
Acceptance						
Control	4.2	3.1	3.4	3.1	3.1	3.38^{c}
Fen	3.3	3.4	3.3	3.8	3.3	3.42^{c}
Bar	4.0	3.7	3.9	4.4	4.9	4.18^{a}
TS	2.9	3.4	4.0	3.9	4.0	3.64^{bc}
TR	4.2	3.9	3.7	4.1	3.6	3.90^{bc}
Months mean	3.72^{ab}	3.50^{b}	3.66^{ab}	3.86^{a}	3.78^{ab}	

$^{a-c}$Means with different superscripts in a raw or column are significantly different at ($P<0.05$)

[1]Fen : 5% Fenugreek powder
Bar : 5% whole barley powder
TS : 2.5% Thyme + 2.5% Sage powder
TR : 2.5% Thyme + 2.5% Rosemary powder

burgers exhibited the highest scores for texture and was different than the control and the other treatments. Concerning the overall acceptability, the Bar, TR and TS burgers were significantly (P<0.05) more acceptable than Fen and the control. The ability of rosemary and thyme to improve the sensory quality of meat products had been frequently reported. Thus, they were found to keep the typical fresh meat odour for a longer time when added to the different meats (Giménez *et al.*, 2005).

The changes in the colour scores of the chicken patties (Table 5) was significantly observed after 20 days of refrigerated storage. The least colour score were observed in the Thy treatment as compared to the control and the other treatments. A significant change (P<0.05) in the taste of the chicken patties was observed after 15 days of storage. All treatments were highly scored by the panelists with no significant difference between them as compared to the control which

Table 5: Effect of some herbs and spices[1] on the sensory attributes of chicken patties during refrigerated storage at (4°C) for 25 days

Antioxidant treatment	Storage period (days)						Treatment mean
	0	5	10	15	20	25	
Colour							
Control	4.9	4.8	4.7	3.8	3.4	3.5	4.18[a]
TC	4.4	4.7	4.8	3.9	4.2	3.9	4.31[a]
TC / A	4.1	4.9	4.5	4.1	4.2	3.9	4.28[a]
SPI	4.8	4.5	4.6	4.0	3.3	3.4	4.10[a]
Thy	3.5	3.7	3.7	2.9	2.5	2.3	3.10[b]
Months mean	4.34[ab]	4.52[a]	4.46[a]	3.74[b]	3.54[c]	3.40[cd]	
Taste							
Control	4.7	4.3	4.1	2.8	1.7	1.4	3.16[b]
TC	4.7	4.7	4.4	4.0	3.1	2.7	3.93[a]
TC / A	4.5	4.6	4.6	4.3	3.7	2.4	4.01[a]
SPI	4.2	4.2	4.2	3.6	3.6	2.9	3.78[a]
Thy	4.1	4.2	4.5	4.2	4.2	3.4	4.10[a]
Months mean	4.44[a]	4.40[a]	4.36[a]	3.78[b]	3.26[c]	2.56[d]	
Odour							
Control	4.8	4.1	3.9	2.8	1.6	1.3	3.08[c]
TC	5.0	4.8	4.4	3.6	3.1	2.5	3.90[b]
TC / A	4.9	4.4	4.4	4.2	2.4	2.3	3.76[b]
SPI	4.7	4.0	4.1	3.8	3.7	1.8	3.68[b]
Thy	5.0	4.7	4.5	4.5	3.9	3.2	4.30[a]
Months mean	4.88[a]	4.40[b]	4.26[b]	3.78[c]	2.94[d]	2.22[e]	
Texture							
Control	4.2	4.4	4.3	4.0	4.2	3.2	4.05[a]
TC	4.4	4.4	4.3	4.0	3.9	3.8	4.13[a]
TC / A	3.4	4.5	4.1	4.3	3.3	3.5	3.85[ab]
SPI	4.0	4.5	3.7	3.3	2.7	2.3	3.14[bc]
Thy	4.1	3.6	4.0	3.6	3.0	3.3	3.60[bc]
Months mean	4.02[a]	4.28[a]	4.08[a]	3.84[a]	3.42[b]	3.22[b]	
Acceptance							
Control	4.8	4.3	4.2	2.6	2.1	1.4	3.23[d]
TC	4.6	4.7	4.4	3.8	3.5	3.1	4.02[ab]
TC / A	4.3	4.6	4.4	4.3	3.2	2.6	3.93[ab]
SPI	4.4	4.1	4.2	3.5	3.2	2.5	3.66[bc]
Thy	4.4	4.1	4.3	3.7	3.6	3.7	4.06[a]
Months mean	4.50[a]	4.36[a]	4.30[a]	3.58[b]	3.16[c]	2.66[d]	

[a-e]Means with different superscripts in a raw or column are significantly different at (P<0.05)

[1]TC : Tea catechin extract
TC/A : Tea catechin + 5% citric acid
SPI : 5% Soy protein isolate
Thy : 5% Thyme powder

recorded the least scores in this respect. On the other hand, a significant change in odour was detected after 5 days of storage but still far from rejection. A significant (P<0.05) decrease in odour was sensed by the panelist as a function of time. However, the Thy treatment scored the best odour in comparison to the control and the other treated samples. A significant change in texture was observed after 20 days of storage where all added herbs and spices were highly scored in this respect including the control. Concerning the overall acceptance, all samples were highly accepted up to 20 days of storage. However, all products remained good quality during storage compared to the control which was significantly (P<0.05) less acceptable than all treated products.

In the present study, some herbs spices and plants such as fenugreek, thyme, rosemary and sage mixtures as well as tea catechin extract were proved to be powerful antioxidants when introduced to minced hamoor and chicken thighs intended for either refrigerated or frozen storage. They were proved to be advantageous in regard of shelf-life of their products as well as human health because of the beneficial effect of the inhibition of lipid oxidation during frozen and chilled storage.

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الملخص العربى

تأثير بعض الأعشاب والتوابل والنباتات كمضادات طبيعية للأكسدة على جودة مفروم سمك الهامور وأفخاذ الدجاج تحت ظروف تخزينية مختلفة

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تم دراسة إضافة بعض أنواع من الأعشاب والتوابل والنباتات كمضادات طبيعية للأكسدة في نظامين مختلفين من اللحوم والتي تم حفظهما تحت ظروف تخزينية مختلفة بهدف تقييم قدرة هذه الإضافات على تأخير ظاهرة تأكسد الليبيدات والتي تم قياسها عن طريق اختبار حامض الثيوباربتيورك (TBA). كما تم قياس رقم الأس الهيدروجيني وعائد الطهي والاختبارات الحسية بهدف تقييم الجودة.

في هذه التجربة تم إضافة مطحون الشعير ومطحون الحلبة ومخلوط الزعتر + إكليل الجبل ومخلوط الزعتر + المرمية بتركيزات مختلفة إلى لحم سمك الهامور المفروم في وجود عينة ضابطة، حيث تم تخزينهم لمدة ٤ أشهر على –١٨°م. كما تم إضافة مستخلص كاتكين الشاي ومستخلص كاتيكين الشاي +٥% حامض ستريك ومعزول فول الصويا ومطحون الزعتر بتركيزات مختلفة إلى مفروم أفخاذ الدجاج في وجود عينة ضابطة، حيث تم تخزينهم لمدة ٢٥ يوم على ٤°م.

وقد أوضحت النتائج أن جميع هذه الإضافات قد أبطأت بطريقة معنوية ($P<0.05$) تأكسد الليبيدات في كل من الهامور وأفخاذ الدجاج المفروم بالمقارنة بالعينة الضابطة. وقد كان لتأثير مخلوط الزعتر + الروزماري، والحلبة أعلى قيم تثبيط للـ TBA (٦٧,٣٨%، ٦٤,١٦%) في حالة سمك الهامور المفروم أثناء التخزين المجمد. كما كان لمستخلص كاتكين الشاي أعلى تأثير معنوي في تثبيط الـ TBA (٩٤,٣٣%) أثناء فترة التخزين المبرد. كما لوحظ وجود انحداراً معنوياً في قيم الأس الهيدروجيني خلال فترة التخزين المجمد في عينات الهامور المفروم المعاملة بالإضافات والعينة الضابطة، في حين أظهرت عينات أفخاذ الدجاج المفروم المعاملة والعينة الضابطة ارتفاعاً معنوياً ملحوظاً في هذا الصدد. وقد أظهرت نتائج عائد الطهي أن لعينات سمك الهامور المحتوية على الحلبة ومخلوط الزعتر + المرمية أعلى قيم (٦٧,٨٤%، ٦٣,٣٣%) بالمقارنة بالعينة الضابطة. في حين أظهرت عينات مفروم أفخاذ الدجاج المحتوية على معزولات فول الصويا ومطحون الزعتر أعلى قيم في هذا الصدد (٨٥,٨٢%، ٨٢,٥%).

وقد بينت نتائج الاختبارات الحسية لبرجر سمك الهامور المحتوية على مطحون الشعير ومخلوط الزعتر + المرمية ومخلوط الزعتر + إكليل الجبل، أعلى تقبل إذا ما قورنت بالعينة الضابطة. في حين بينت نتائج التحكيم في هذا الصدد أن اقراص أفخاذ الدجاج المحتوية على جميع الإضافات كان لها تقبلا معنوياً عالياً مقارنةً بالعينة الضابطة. كما مُنحَت أقراص الدجاج المحتوية على مطحون الزعتر على وجه الخصوص، أعلى الدرجات من قِبَل المحكمين من حيث النكهة والتقبل العام.

وقد بينت النتائج المتحصل عليها أن بعض هذه الأعشاب والتوابل والنباتات التي تم دراستها تعتبر بمثابة مضادات أكسدة طبيعية قوية وفعالة عند إضافتها لمفروم اللحوم.