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EFFECT OF VARIOUS LEVELS OF GINGER AND SUMAC ON THE QUALITY OF FRESH BEEF SAUSAGE DURING REFRIGERATED STORAGE

Goneim, Gehan A.
Food Industries Dept., Fac. of Agriculture, Mansoura University, Egypt

ABSTRACT

This study was conducted to evaluate effect of ginger and sumac using at levels of 150 and 300ppm (phenolic compounds as gallic acid) on quality of fresh beef sausage stored at 5±2°C for 5 days. Phenolic compounds in sumac and ginger extracts were identified and determined by HPLC, antioxidant activity of sumac and ginger extracts were screened using DPPH radical scavenging methods. pH, total volatile nitrogen (TVN) and tiobarbituric acid (TBA) were determined in studied treatments after 0, 1, 3 and 5 days as an indicator of spoilage. From obtained results, it could be seen that inhibition percentage values ranged from 60.72 to 90.47% and 41.72 to 81.43% for ginger and sumac extracts, respectively. Addition of ginger or sumac to sausage formula reduced pH, TBA and TVN values compared with control sample. Organoleptic evaluation results indicated that there were no significant differences between all treated sausage samples with sumac compared with control. So, it could be recommended to use these spices, ginger and sumac, as antioxidative and flavoring agents to prolongate meat products shelf life.
Keywords: Spices, phenolic compounds, DPPH, fresh sausage, sumac, ginger.

INTRODUCTION

Since ancient times, spices and herbs have been used for preventing food spoilage and deterioration, and for extending shelf life of food. Many of the spices and herbs used today have been valued for their antimicrobial effects and their medicinal powers in addition to their flavor and fragrance qualities (Ceylan and Fung, 2004). Spices are herbal products which have been safely used by people around the world to impart desirable aromas to the local foods. It looks that there has been a natural selection for spices as these products are mainly originated from plants grown in the tropical regions with wide distribution of food-borne bacteria. Several of these spices and their essential oil extracts have been reported to posses antimicrobial activities including garlic, savory, basil, laurel, mint, cumin, onion, sumac and thyme (Özcan and Erkmen, 2001 ; Delgado*, et al.,* 2004 *;* Nasar-Abbas and Kadir Halkman, 2004).

Sumac (*Rhus coriaria L.*) is one example, which is widely used in Turkey and the Middle East. The fruits are red colored and contain one seed. Its dried and ground leaves have been used as a tanning agent due to their high tannin content. Previous phytochemicals studied of this plant reported that its leaves contained flavones, tannins, anthocyanins, and organic acids (Mavlyanov*, et al.,* 1995*;* Mavlyanov, *et al.,* 1997). However, it is the fruit of the plant that is typically consumed as spice after drying and grinding. Other reports indicated that sumac has antimicrobial activity with limited information on its antioxidant activity and potential as a new source of antioxidative substances, but these claims were not fully substantiated (Candan, 2003; Candan and Sokmen, 2004). Sumac extracts have been found to have

antimicrobial, antioxidant and hypoglycemic activities (Rayne and Mazza*,* 2007). In foods, the use of sumac extracts as a potential natural preservative for the control of natural microflora of broiler meat has been reported in raw broiler wings (Gulmez *et al.,* 2006). Some studies have also been conducted on the antioxidant effect of sumac in foods such as sucuk (Turkish dry-fermented sausage) (Bozkurt, 2006), peanut oil (Özcan, 2003*)* and sunflower oil (Özcan and Akgül, 1995).

Ginger (*Zingiber officinale Roscoe*) has been used as a spice for over 2000 years (Bartley and Jacobs, 2000). It is cultivated in many tropical and subtropical countries including China, India, Nigeria, Australia, Jamaica and Haiti. Among which, China and India are the world's leading producers of ginger (Blumenthal*, et al.,* 2000). Several cultivars of ginger are grown in different ginger growing areas in India which were named after the localities from where they are cultivated or collected. The ginger has been increasingly used recently because of its low toxicity and its broad spectrum of biological and pharmacological applications such as antitumor, antioxidant, anti-inflammatory, antiapoptotic, cytotoxic, anti-proliferative and anti-platelet activities (Wei, *et al*., 2005 ; Young *et al*., 2005 ; Shukla and Singh, 2007). The pungency of fresh ginger is due primarily to the gingerols, which are a homologous series of phenols. The most abundant is 6-gingerol, although smaller quantities of other gingerols with different chain lengths are also present. The pungency of dry ginger mainly results from shogaols, which are dehydrated forms of gingerols. Shogaols are formed from the corresponding gingerol during thermal processing (Ali, *et al.,* 2008). These compounds are also known for their anti-oxidant activity (Stoilova*, et al.,* 2007 ; Chan *et al.,* 2008), in particular, it has been shown that 6-gingerol is endowed with strong anti-oxidant action both *in vivo* and *in vitro*, in addition to strong anti-inflammatory and anti-apoptotic actions (Kim*, et al.,* 2007).

Sausage is one of the oldest known forms of processed meat products and is very popular in many areas. Fresh sausages, e.g. fresh pork sausage, country-style pork sausage, fresh kielbasa (Polish), Korr (Swedish), Italian sausage, bratwurst, bockwusrt, chorizo (fresh) and thuringer (fresh), are some common examples (Romans*, et al.,* 1994). The cited authors indicated that fresh sausage is a sausage ‘‘made from selected cuts of fresh meat (not cooked or cured) and must be stored in a refrigerated (or frozen) state prior to being consumed." Therefore, adding ‘‘curing agents" (mainly nitrites and nitrates) to a formula, or not, is the major criterion used to judge whether the product belongs to ‘‘fresh sausage" or cured sausage. Also, raw materials of fresh sausage should not be cooked. No typical thermal treatments, such as drying, smoking or cooking, should be applied when making fresh sausages. Liu *et al*. (2009) studied the effect of various levels of rosemary or Chinese mahogany on the quality of fresh chicken sausage during refrigerated storage and they found that pH values of the sausage remained stable and were approximately 6.4–6.6 during the first 10 days of refrigerated storage, and significantly (P<0.05) decreased thereafter.. Samples that had more rosemary or Chinese mahogany added had significantly (P<0.05) lower VBN values. At day 14, the control samples had significantly higher VBN value of 30.7 mgN/100g sample. The more rosemary or Chinese mahogany that was

added to sausages, the lower were the VBN values of the samples observed. The same Authors reported that TBA values of the sausage samples increased with refrigerated storage time during the first 3 days, indicating that lipid oxidation had occurred during this stage. TBA values increased up to a maximum point at day 3, and then decreased gradually. TBA values of the samples with rosemary or Chinese mahogany added were lower than those of the controls. The results in this study demonstrate that the addition of rosemary or Chinese mahogany inhibited the lipid oxidation of fresh chicken sausages.

Therefore, the aim of this study was to compare the effects of various levels of ginger or sumac on the quality of fresh beef study sausage during refrigerated storage and try to prolongate shelf life of this fresh product using natural preservatives.

MATERIALS AND METHODS

Materials:

Ginger *(Zingiber officinale)*, sumac *(Rhus coriaria L.)*, minced beef meat, minced beef fat, natural casings and other spices were purchased from local market in Mansoura city, Egypt.

Chemicals used for following examinations were brought from El-Gomhoria Company, Mansoura branch, Egypt.

Methods:

Fresh beef sausage preparation:

Minced meat (66%) was mixed thoroughly with beef fat (15%), ice (17%) and salt (1.79%) with a mixer for 1.5 min, and then other spices and seasonings were added, including 0.008% sugar, 0.056% black paper, 0.033% nutmeg powder, 0.033% cardamom, 0.04% kababh, and 0.04% cloves, pre-assigned amounts of ground ginger (150 and 300 ppm) or sumac (150 and 300 ppm), according to its content of phenolic compounds as gallic acid, then mixed for another 1.5 min. *(*El-Dashlouty, 1978). The mixtures were cured at 5**±**2°C for 16 h, and then stuffed into natural casings. Raw sausages were manually linked, packed in polyethylene bags and stored at 5**±**2°C for 5 days. All chemical tests were done after 0, 1, 3 and 5 days of storage.

Chemical analysis:

Moisture content, ether extracts (fat), protein, crude fiber and ash content in frozen meat determined using the methods outlined in AOAC (1990).Carbohydrates content was calculated by difference. {100-(moisture% + protein% + fat% + ash %)}

Phenolic compounds for both ginger and sumac were analyzed at Bio-technology Lab., Plant Pathology Institute, Agricultural Research Center, Giza, Egypt. Analysis was performed with a high pressure liquid chromatography HPLC "HP1050" equipped with a 4.6 mm x 150 mm ODS C_{18} column with UV detector and the injection volume was 5µl. Isocratic mobile phase was 40 methanol: 60 distilled water. The wave length in the UV detector was 230 nm, total run time for the separation was approximately 15 min. at a flow rate of 0.60 ml/min. according to the proposed method of Waskmundzka *et al*. (2007).

The antioxidant activity of ginger and sumac extracts were assessed by their ability to scavenging 2,2-diphenyl-1-picrylhydrazyl stable radicals (DPPH). The DPPH assay was performed as described by Miler and Rice-Evans (1997).

pH value was measured, as described by Lima dos Santos *et al.* (1981), using a digital pH meter (HANNA instruments pH 211 Microprocessor pH meter).

Total volatile nitrogen (TVN) was determined according to the method mentioned by Pearson (1968). Results were expressed as mg nitrogen per 100g sample.

Thiobarbituric acid value (TBA) was determined as described by *Tarladgis et al. (1960). TBA value was expressed as mg malonaldehyde/kg* fat using the following equation:

$$TBA=7.8 \times O.D.$$

Where: O.D. = optical density at 538 nm.

Sensory evaluation:

Sensory evaluation of texture, taste, aroma and color were conducted by 15 panelists at the Food Industries Department, Faculty of Agriculture, Mansoura University, Egypt. Hedonic scale (0-1 very poor, 2-3 poor, 4-5 fair, 6-7 good and 8-9 very good) according to Molander (1960).

Statistical analysis

Data of chemical analysis and sensory evaluation of fresh beef sausage were subjected to analysis of variance (ANOVA) using SPSS (2008) version 17 program for windows.

RESULTS AND DISCUSSION

Phenolic compounds content in Sumac and Ginger:

Results in Table (1) show phenolic compounds content in Sumac (*Rhus Coriaria*) and Ginger (*Zingiber efficinale*) (mg/100g). As shown in Table (1), the content of phenolic compounds ranged from 8.26 to 293.85 mg/100g in sumac, while it ranged from 0.021 to 119.26 mg/100g in ginger. In general sumac has higher amount of phenolic compounds than ginger such as gallic acid, Catechol, Chlorogenic, Catechien, P.OH. Benzoic, Coumaric, Sallicylic and Caffeine.

Antioxidant activity as inhibition % DPPH of Sumac and Ginger extracts:

Sumac and ginger extracts were tested for antioxidant activity using the DPPH assay. The results were expressed as percentage of inhibition (Fig. 1). As shown in (Fig. 1), there is a wide range of free radical scavenging activity of sumac and ginger extracts. Inhibition percentage values ranged from 60.72 to 90.47% and 41.72 to 81.43% for ginger and sumac extracts, respectively. It could be stated that scavenging effects is not limited to phenolic and flavonoid compounds only. The activity also comes from the presence of other antioxidant secondary metabolites in the extracts which

directly or indirectly contribute to the activity. These data are in accordance with others (Moussa *et al.,* 2011*;* Rohman *et al.,* 2010*)* who have reported that there is no correlation between the content of these main antioxidant compounds and the radical scavenging activity.

Table (1): Phenolic compounds content (mg/100g) in Sumac (*Rhus Coriaria*) and Ginger (*Zingiber Efficinale*)

Phenolic compounds	Concentration (mg/100g)	
	Sumac *(Rhus Coriaria)*	Ginger (*Zingiber Efficinale*)
gallic acid	293.85	119.26
Catechol	130.81	8.17
Chlorogenic	135.69	6.11
Catechien	448.44	36.66
Vanillic	8.26	-
Syringic	38.51	-
P.OH. Benzoic	43.07	1.99
Coumaric	38.90	1.78
Sallicylic	81.52	11.11
Caffeine	52.53	10.39
Cinnamic	-	0.95
Caffiec	-	-
Chrisin	-	0.021
Total as gallic acid	2086.964	1139.26

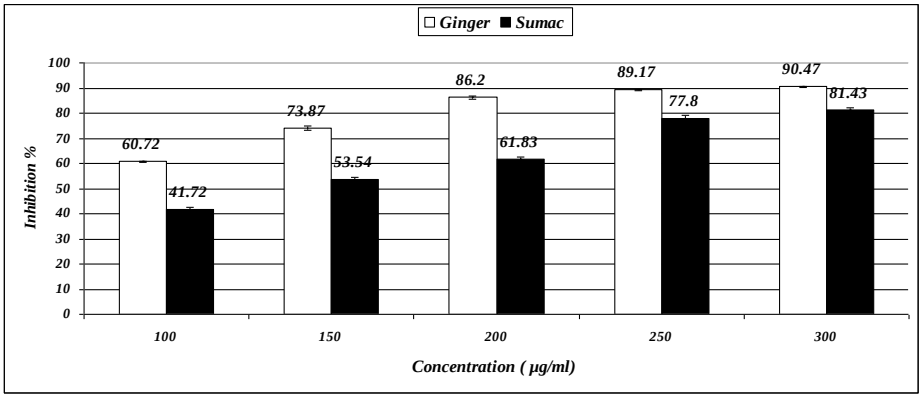

Fig. (1): Antioxidant activity as inhibition % of Sumac (*Rhus coriaria*) and Ginger (*Zingiber officinale*) methanol extracts as determined by the DPPH assay.

Chemical composition of frozen minced meat:

The chemical composition of frozen meat was shown in Table (2). Chemical analysis cleared that moisture content 72 % this sample was not in compatible with EOS, (2005). While crude protein 21.60%, crude fat 3.28 %, ash 0.97 and carbohydrates 1.49 %(WB) this findings in accordance with EOS, (2005) which stated that the crude protein not less than 18% and crude fat 20% or less. But, El-Damasy(2006) reported that frozen meat contain 75.45, 20.44, 2.63 and 0.98% for moisture, protein, crude fat and ash, respectively. Total volatile nitrogen (TVN) and pH value on frozen meat are

12.84 mg/100g sample and 5.27, respectively these results was in accordance with EOS, (2005) which stated that the TVN not exceed 20 mg/100g sample and pH value ranged between 5.6 -6.2 . In addition Malonaldehyde contents measured by the TBA procedure were 0.174 and 0.155 mg malonaldehyde / kg sample for minced meat and added fat, respectively. Thiobarbituric acid value (TBA) of frozen meat samples was in agreement with registered limits by EOS,(2005) which mentioned that TBA value of minced meat samples do not be more than 0.9 mg malonaldehyde / kg sample.

Table (2): Chemical composition of frozen minced meat:

Components	Crude minced meat (Wet basis)	*EOS (2005)*
Moisture(g/100g)	**72.66**	70% or less
Crude Protein (g/100g)	**21.60**	Not less than 18%
Crude fat (g/100g)	**3.28**	20% or less
Ash (g/100g)	**0.97**	**-**
Carbohydrates%	**1.49**	
pH	**5.27**	**5.6 -6.2**
TVN(g/100g)	**12.84**	Not exceed **20**
TBA of minced meat (mg malonaldehyde/kg sample)	**0.174**	Not exceed 0.9
TBA of added fat (mg malonaldehyde/kg sample)	**0.155**	

TVN=Total volatile nitrogen value. EOS: Egyptian Organization for Standardization

pH values of fresh sausage:

pH values of sausage recipe were studied during cold storage and obtained results are given in Table (3). During the first day of cold storage, pH values increased from 5.27 to 5.33 in control treatment, from 5.24 to 5.28 in S1, from 5.24 to 5.26 in S2, from 5.26 to5.31 in G1 and from 5.26 to5.29 in G2. Thereafter, the pH values significantly increased (P>0.05) at the fifth day to 6.44, 6.21, 6.19, 6.32, and 6.26 in control, S1, S2, G1 and G2, respectively. There were no significant differences (P>0.05) between all recipes made with and without natural preservatives during the first three days of cold storage period. While, there were significant differences between suggested treatments comparing with control at day 5.

Table (3): pH values of fresh sausage as affected by cold storage and natural additives.

Sausage treatments		Cold storage (Time/day)			
Herbs & Spices	**Control + ppm***	**Zero**	**1**	**3**	**5**
Control		5.27^{a}±0.65	5.33±0.03	5.67±0.03	6.44^{a}±0.02
Sumac	**150(S1)**	5.24^{a}±0.64	5.28±0.10	5.68±0.01	6.21^{c}±0.06
	300(S2)		5.26±0.35	5.69±0.04	6.19^{c}±0.04
Ginger	**150(G1)**	5.26^{a}±0.02	5.31±0.02	5.63±0.03	6.32^{b}±0.03
	300(G2)		5.29±0.04	5.60±0.06	6.26^{b}±0.01

(S1)=(Sumac150 ppm) (S2)=(Sumac300 ppm) (G1)=(Ginger 150 ppm) (G2)=(Ginger 300 ppm)

ppm* means that Sumac or Ginger were added to the control according to its content of phenolic compounds as gallic acid.

Means of treatments having the same letter(s) within a column are not significantly different (P> 0.05).

These increments could be due to the buffering effect of salt and proteins or production of ammonia (Demeyer *et al.,* 2000; Bozkurt and Erkmen, 2002; Kayaardı and Gök, 2003).

Total volatile nitrogen values (mg/100g) of fresh sausage:

Increase amounts of total volatile nitrogen (TVN), which is the result of decomposition of protein during cold storage can be an index of meat product freshness. Table (4) illustrates that TVN values of sausage samples increased as expected when storage time increased. In this study, TVN values significantly increased during cold storage. In addition, sample that had more ginger level (300ppm, G2) had significantly (*P*>0.05) lower TVN values. At the last day of storage, control sample had significantly higher TVN value of 66.12 mg/100g, compared with those samples with ginger (30.59 and 32.64mg/100g for the G2 and G1, respectively). Similarly, sausage samples with sumac had significantly lower TVN values (34.19 and 49.60 mg/100g for the S2 and S1 treatments, respectively). The more ginger or sumac that was added to sausages, the lower were the TVN values of the samples observed. These decreases of sample TVN values were probably because ginger or sumac contained some antimicrobial compounds. These results were in agreement with the suggest that the possibility of using the fruit of sumac as a novel source of natural antimicrobial and antioxidant agents in food borne bacteria to expand its use other than as a flavor imparting substance in foods. (Nasar-Abbas and Kadir Halkman, 2004 and Rima *et al*., 2011). Less microbial growth in sausages, due to the addition of ginger or sumac to the formula, thus led to less protein decomposition and lower TVN values. The antimicrobial activity of ginger has been described and studied by (Onyeagba *et al.,* 2004 and Roopal *et al.,* 2011).

Table (4): Total volatile nitrogen values (mg/100g) of fresh sausage as affected by cold storage and natural additives.

Sausage treatments		Cold storage (Time/day)			
Herbs & Spices	Control + ppm*	Zero	1	3	5
Control		$15.50^{a}\pm0.03$	$36.12^{a}\pm0.92$	$55.94^{a}\pm1.08$	$66.12^{a}\pm0.92$
Sumac	150(S1)	$13.05^{b}\pm0.05$	$33.20^{b}\pm0.28$	$47.12^{b}\pm2.98$	$49.60^{b}\pm2.05$
	300(S2)		$29.73^{c}\pm0.22$	$31.67^{c}\pm1.95$	$34.19^{c}\pm2.37$
Ginger	150(G1)	$13.62^{b}\pm0.53$	$28.25^{c}\pm0.49$	$30.57^{c}\pm0.92$	$32.64^{d}\pm1.24$
	300(G2)		$19.49^{d}\pm0.31$	$26.13^{d}\pm2.25$	$30.59^{e}\pm1.61$

(S1)=(Sumac150 ppm) (S2)=(Sumac300 ppm) (G1)=(Ginger 150 ppm) (G2)=(Ginger 300 ppm)

ppm* means that Sumac Ginger were added to the control according to its content of phenolic compounds as gallic acid.

Means of treatments having the same letter(s) within a column are not significantly different (P> 0.05).

Thiobarbituric acid value (TBA, mg malonaldehyde/kg sample) of fresh sausage:

TBA values, which are indicators of lipid oxidation, are shown in Table (5). TBA values of sausage samples increased with refrigerated storage time during the first 3 days, indicating that lipid oxidation had occurred during this stage. This increase of TBA values in fresh sausage samples during storage has also been reported by other researchers. In this study, TBA values

increased up to a maximum point at day 3, and then gradually decreased, and this tendency agreed with a study reported by Kuo, *et al.,* 1987 and Liu *et al.,* (2009) explained that, during storage, malonaldehyde, which is an intermediate by-product during lipid oxidation, is further oxidized to other organic acids and alcohols that can not react with TBA agent. This might be the reason why the TBA values increased then decreased. TBA values of samples with ginger or sumac were lower than those of control. At day 3, TBA value of the control increased from0.207 to 0.361 mg malonaldehyde/kg, while TBA value of sumac treated samples increased from 0.191 to 0.236 and from 0.191 to 0.342 mg malonaldehyde/ kg in S2 and S1 samples, respectively. These values were significantly lower than control. Similarly, samples with ginger had significantly lower TBA values of 0.195 to 0.290 and 0.195 to 0.345 mg malonaldehyde/kg for G2 and G1 samples, respectively. Then, TBA values decreased for all treatments. TBA value of the control decreased to 0.353 mg malonaldehyde/ kg at the fifth day, while TBA values of samples with sumac were 0.109 and 0.103 mg malonaldehyde/kg for S2 and S1, respectively. TBA values of samples with ginger were 0.148 and 0.191 mg malonaldehyde/kg for G2 and G1 samples, respectively. These decreases of TBA values were probably due to both sumac and ginger, which are reported to have some antioxidative ability, and to retard fat oxidation**.**

Table (5): Thiobarbituric acid value (TBA, mg malonaldehyde/kg sample) of fresh sausage as affected by cold storage and natural additives.

Sausage treatments		Cold storage (Time/day)			
Herbs & Spices	Control + ppm*	Zero	1	3	5
Control		0.207 ^{a}±0.087	0.265^{b}±0.07	0.361^{a}±0.01	0.353^{a}±0.01
Sumac	150(S1)	0.191^{b}±0.070	0.196^{c}±0.03	0.342^{a}±0.02	0.103 ^{d}±0.01
	300(S2)		0.179^{c}±0.04	0.236^{c}±0.02	0.109 ^{d}±0.01
Ginger	150(G1)	0.195^{b}±0.11	0.296^{a}±0.05	0.345^{a}±0.11	0.191 ^{b}±0.03
	300(G2)		0.181^{c}±0.01	0.290^{b}±0.04	0.148 ^{c}±0.05

(S1)=(Sumac150 ppm) (S2)=(Sumac300 ppm) (G1)=(Ginger 150 ppm) (G2)=(Ginger 300 ppm)

ppm* means that Sumac Ginger were added to the control according to its content of phenolic compounds as gallic acid.

Means of treatments having the same letter(s) within a column are not significantly different (P> 0.05).

Organoleptic evaluation of cooked beef sausage:

Organoleptic evaluation of cooked beef sausage samples are given in Table (6). Statistical analysis was performed to determine the effect of adding both of sumac and ginger on sensory attributes. It was found that there were no significant differences between all level of sumac treatments and control sample (*P*>0.05). It could be easily seen that color, taste, aroma, texture and overall acceptability scores were higher than ginger treated sausage, so it could be recommended to use sumac as antioxidant, antimicrobial, flavoring and coloring agent. The sensory characteristics score decreased after adding of ginger compared with control. These results matched with these results obtained by Bozkurt (2006) who reported that addition of sumac extract have

no significant in acceptability of fermented beef sausage compared with control sample.

Table (6): Organoleptic evaluation of coked beef sausage treatments as affected by Sumac (*Rhus coriaria*) and Ginger (*Zingiber officinale*):

Sausage treatments		Sensory Characteristics				
Herbs & Spices	Control + ppm*	Colour (9)	Taste (9)	Aroma (9)	Texture (9)	Overall acceptability (9)
Control		$8.143^{a}\pm0.261$	$8.439^{a}\pm0.571$	$7.429^{a}\pm0.481$	$8.429^{a}\pm0.297$	$8.571^{a}\pm0.297$
Sumac (*Rhus Coriaria*)	150	$7.714^{abc}\pm0.286$	$6.857^{abc}\pm0.508$	$7.00^{ab}\pm0.655$	$6.714^{ab}\pm0.606$	$7.00^{ab}\pm0.436$
	300	$7.857^{ab}\pm0.143$	$7.286^{ab}\pm0.268$	$7.286^{ab}\pm0.474$	$7.571^{a}\pm0.369$	$7.857^{a}\pm0.340$
Ginger (*Zingiber Efficinale*)	150	$5.857^{bc}\pm0.705$	$5.143^{bc}\pm1.164$	$5.286^{bc}\pm0.918$	$5.00^{bc}\pm1.113$	$5.286^{bc}\pm0.918$
	300	$5.857^{bc}\pm0.769$	$5.00^{bc}\pm0.655$	$5.143^{bc}\pm0.553$	$5.00^{bc}\pm0.655$	$5.426^{bc}\pm0.812$

ppm* means that Sumac Ginger were added to the control according to its content of phenolic compounds as gallic acid.

Means of treatments having the same letter(s) within a column are not significantly different (P> 0.05).

Conclusion

From all previous results, it could be recommended to use these spices, ginger and sumac, as antioxidative, antimicrobial and flavoring agents to prolongate meat products shelf life using natural preservatives.

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تأثير مستويات مختلفة من الزنجبيل و السماق على جودة السجق البقري الطازج أثناء التخزين المبرد

جيهان علي غنيم
قسم الصناعات الغذائية – كلية الزراعة – جامعة المنصورة – مصر

تم تنفيذ هذه الدراسة لتقييم تأثير استخدام الزنجبيل و السماق بتركيزات ١٥٠ و ٣٠٠ جزء في المليون (مركبات فينولية كحمض جاليك) على جودة السجق البقري الطازج المخزن على ٥°م لمدة ٥ أيام. تم التعرف على المركبات الفينولية بالزنجبيل و السماق باستخدام جهاز الفصل الكروماتوجرافي عالي الكفاءة و تم قياس الفاعلية المضادة للأكسدة لكلاً منهما باستخدام طريقة كبح الشوارد الحرة DPPH. و كذلك تم تقدير كلاً من درجة الأس الأيدروجيني و النيتروجين المتطاير الكلي وقيمة حمض الثيوباربيتيوريك في المعاملات المختلفة بعد صفر ، ١ ، ٣ و ٥ أيام كمؤشر للفساد. و من النتائج المتحصل عليها نجد أن نسب التثبيط لمستخلصات الزنجبيل و السماق تراوحت بين ٦٠,٧٢ إلى ٩٠,٤٧% و ٤١,٧٢ إلى ٨١,٤٣% على التوالي. و أن إضافة الزنجبيل و السماق لخلطات السجق قد خفضت قيم الـ pH, TVN, TBA بالمقارنة بالعينة الضابطة. و لقد أشارت نتائج التقييم الحسي إلى عدم وجود فروق معنوية بين جميع عينات السجق المعامل بالسماق مقارنه بالكنترول. لذا فإنه ينصح باستخدام هذه التوابل (الزنجبيل و السماق) كعوامل مضادة للأكسدة و مكسبه للطعم و الرائحة كي تطيل فترة صلاحية منتجات اللحوم.

الكلمات الدالة: التوابل – المركبات الفينولية – DPPH – السجق الطازج- السماق – الزنجبيل.

قام بتحكيم البحث

أ.د / محمد طه شلبي	**كلية الزراعة – جامعة المنصورة**
أ.د / عبد الجواد محمد الشواف	**معهد الكفاية الإنتاجية – جامعة الزقازيق**