A COMPARATIVE STUDY ON THE UTILIZATION OF SUMAC AND ROSEMARY AS ANTIMICROBIAL COMPONENT IN PRESERVATION OF KOFTA PRODUCT DURING FROZEN STORAGE

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Abstract

Spices (sumac and rosemary), are given more attention in natural antimicrobial researches. The present study was carried out to extend the shelf life of kofta (raw meat product with spices) under freezing conditions. The formulas contained individual concentration of sumac or rosemary (0 ,1, 1.5 and 2%) powders. The microbial load of the used commodities (raw minced meat and spices) were assessed before storage, while, kofta samples were evaluated for the zero time (after three hours) and after storing the samples for 3, 6,9 and 12 months. Kofta samples were fried and microbiologically estimated before and after frozen storage. Sensory charaterists before storage were also evaluated. The results showed that the highly acceptance treat meat was 2% sumac .The obtained results indicated that the total count of bacteria in sumac and rosemary was 2×10 and5x10 CFU/g sample , respectively, while the total count of molds and yeasts was 1×10 and 2x10 CFU/g sample, respectively. Coliform group, *Staphylococcus aureus* and *Salmonella* spp were not detected in both spices. Increasing the percentage of added sumac or rosemary decreased all the tested microorganisms. Results showed that both sumac and rosemary spices can be considered as potential sources of fiber which is helpful in alleviating gastrointestinal disorders. After 12 months of storage, the counts of all the studied microorganisms (total counts, molds and yeasts, *Salmonella spp* and *Staphylococcus aureus*) of treated samples were appreciably decreased compared to those before storage. It could be concluded that the sumac is a good source of phenolic compounds and could be utilized as strong antioxidants.

Keywords: Antimicrobial activity, antioxidant activity , Rosemary , Sumac, microbiological analysis.

INTRODUCTION

Meat products, including kofta, contain mainly meat and some spices as major ingredients. It then follows the main mechanism of spoilage, microbial spoilage and fat deterioration which affects both the keeping and organoleptic quality of meat. In meat processing, reservoirs of microorganisms include meat components, seasoning formulating ingredients, meat handlers with poor personal hygiene, animal skin ,byproducts, slaughter and the environment (air and water for processing), transport

and storage facilities (Mrema *et al.*,2006). Because of the high nutritive value of meat and meat products, fresh meat could only remain fresh for a short time before its spoilage, and to prevent this, meat should be processed into products. Meat seemed to be prone to both microbial and oxidative spoilage and, therefore, it would be desirable to use a preservative with both antioxidant and antimicrobial properties (Omojola, 2008).

Food antimicrobials are mostly synthetic chemicals and some are limited to use in foods, because they may cause adverse effects on public health and reluctance by consumers. Therefore, much attention in recent years has been focused on extracts from herbs and spices, which have been used for many centuries to improve the sensory characteristics and to extend the shelf life of foods. In the recent years, the attentions have been focused on using extracts from spices to improve sensory characteristics and extending the shelf life of food products. In addition, spices could be added to food, not only for flavors, but also for preservation. Rosemary is a powerful herb belonging to the Lamiaceae family that originates from the Mediterranean Region (Asia *et al.*, 2013). Kossah *et al.*, (2013) indicated that Syrian sumac fruit extracts might be used as a natural agent to prevent the growth of food spoilage bacteria, particularly, *Helicobacter pylori* leading to the reduction of gastroenteritis risk.

Sumac is documented to possess antibacterial, hepatoprotective, antifungal, antioxidant and anti-inflammatory (Özcan and Haciseferogullari 2004) activities. Antioxidant properties of rosemary spice in foods have also been investigated (Musa, 2003). As the implementation of natural compounds in meat products is limited, in the present study, the possibility to prolong the shelf life of kofta as ground meat product was addressed. The investigation based on the use of natural spices, sumac and rosemary into the minced meat under cold storage conditions.

MATERIALS AND METHODS

Plant materials and chemicals

Spices including sumac (*Rhus coriaria*) and rosemary (*Rosmarinus Officinalis L.*) as well as onions, salt and sunflower oil were obtained from local market at Cairo and used for preparation of beef burger. Soy protein was purchased from the Food Technology Research Institute, Agricultural Research Center ,Giza, Egypt. Minced meat was purchased from butcher shop in local market at Giza. Soy protein was rehydrated (by mixing one part of powdered soy protein with two parts of tap water)

before addition to meat. The 2,2-diphenyl-1-picrylhydrazyl (DPPH) Sigma (Sigma-Aldrich), was purchased from local company.

Nutrient agar, Malt agar, MAC-CONKEY agar, Mannitol Salt agar and Salmonella agar media used for estimating the microbial growth were obtained from Biolife Italian Company dealer at Cairo.

Methods

Kofta samples preparation and storage

Seven types of kofta with similar ingredients in type and quantity except the level of rosemary spice and sumac were prepared in Experimental Kitchen, Food Technology Research   Institute , Agricultural Research Center . Tested samples were formulated to contain individual concentration of   0 ,1, 1.5 and 2%   sumac or rosemary   powders. The ingredient percentages of kofta formulations are shown in Table (1). Immediately after the addition of ingredients, meat samples and spices were thoroughly mixed using laboratory mixer. After preparation of each formula, the samples were packed in polyethylene bags and were stored in the refrigerator for 12 months at- 4℃ until required. Every3 month, the samples were subjected for microbiological analysis.

Table 1. Ingredient percentages of kofta formulations (g /100g).

Kofta sample	Meat	Sumac	Rosemary	Soy protein	Onion	Salt	Black pepper
Control	73.5	–	–	5	20	1.0	0.5
(1%) Sumac	72.5	1.0	–	5	20	1.0	0.5
(1.5%) Sumac	72.0	1.5	–	5	20	1.0	0.5
(2%) Sumac	71.5	2.0	–	5	20	1.0	0.5
(1%) Rosemary	72.5	–	1.0	5	20	1.0	0.5
(1.5%) Rosemary	72.0	–	1.5	5	20	1.0	0.5
(2.5%) Rosemary	71.5	–	2.0	5	20	1.0	0.5

Chemical composition:-

Moisture, ether extract, crude fiber, protein and ash of the samples(sumac and rosemary), were measured according to AOAC (2000).

DPPH radical-scavenging activity:

The DPPH free radical scavenging activity was determined by the method of Yang *et al.*, (2008) with some modifications. sample, at different concentrations in ethanol (2 ml), was mixed with 2 ml of ethanolic solution containing 1 mM DPPH. The mixture was shaken vigorously shaken, then left to stand for 30 min in the dark. The absorbance was measured at 517 nm. The absorbance of the control was obtained by

replacing the sample with ethanol. The DPPH scavenging activity was calculated as follows:

DPPH   radical   scavenging   activity   (%)   =   [1 - absorbance of sample/absorbance of control] X 100

Determination of total phenolic content:

The total   phenolic content was estimated by Folin-Ciocalteu colorimetric method, based on the procedure in Singleton and Rossi (1965). Procedure: Briefly, the crude extract (50 mg) was mixed with Folin-Ciocalteu reagent (0.5 mL) and deionized water (7.5 mL). The mixture was kept at room temperature for 5 min, and then, 10 mL of 7% sodium carbonate was added to the mixture, and then incubated for 90 min at room temperature. After incubation the absorbance against the reagent blank was determined at 760 nm. The total phenolic content of the plant was expressed as gram of tannic acid equivalent (TAE) per 100 g extract.

Cooking treatments

For frying, kofta samples were shallow fried in sunflower oil until it becomes golden .

Sensory evaluation:-

The Sensory characteristics of the cooked kofta were carried out by ten well trained ten panelists of Food Technology Research Institute (FTRI) who were asked to evaluate the tested samples for color, taste, odor, texture, appearance and tenderness attributes, according to the method described by A.M.S.A.(1995).

Microbiological evaluation of samples

The microbiological evaluation of kofta samples includes; the determination of total plate count and the detection of coliform group, *Staphylococcus aureu*, *Salmonella* spp and yeasts and molds.

Sample preparation

Five g of each of the tested samples were weighted under aseptic conditions and transferred into a sterile flask. A known volume of sterile water (45 ml) was added and shacked for 2-3 min, then different dilutions were made (1/10, $1/10^2$,$1/10^3$, $1/10^4$,$1/10^5$ and $1/10^6$).

Microbiological analysis

 1. Total plate count

Total   plate   count was assessed on nutrient agar medium. Plates were incubated at 37°C for 48 hours (A.P.H.A., 2004).

2. *Staphylococcus aureus*

Staphylococcus aureus were determined on Mannitol Salt agar medium, plates were incubated at 37°C for 48 hours according to (Difco, 1994).

3. Coliform group

Coliform group was determined on MAC-CONKEY agar. Plates were incubated at 37°C for 48h. according to the method of A.P.H.A., (2004).

4. *Salmonella* spp

Salmonella spp were detected using Difco *Salmonella Shiguella* agar medium. The plates were incubated at 37°C for 48 hours (Difco,1994)   .

5. Molds and yeasts

Molds and yeasts counts were assessed on malt agar medium. Plates were inoculated at 30°C for 72 h. as mentioned by A.P.H.A. (2004).

Statistical analysis: Results were subjected to the analysis of variance (ANOVA) using the SAS (1987) for Windows, and Duncan's multiple-range test was used to compare means at a significance level of 5%.

RESULTS AND DISCUSSION

Chemical composition: The chemical compositions of sumac and rosemary were presented in Table (2). It was found that sumac possessed higher contents in ether extract and crude fiber than rosemary. But, higher values of protein and ash were realized by rosemary as compared with sumac. These results are agreed with Özcan and Haciseferogullari (2004). Results showed that sumac species can be considered as potential sources of dietary fiber which is helpful in alleviating gastrointestinal disorders. Results in the same Table showed that moisture ,ether extract, protein, crude fiber and ash content of rosemary were 8.53, 5.84 ,4.48, 13.2 and 8.03%, respectively. Farrell (1999) found that rosemary contained 9.3%moisture,15.2% ether extract,4.9% protein and 6.5% ash.

The same Table, showed that sumac contains a high amount of phenolic and scavenging activity of DPPH (136.6 sumac and 43.41, respectively) than that of rosemary. The relationships between total phenolic content and antioxidant properties of many plants have been investigated in previous studies. Some studies obtained good positive linear correlations; others obtained poor linear correlations or even could not explain the relationship between total antioxidant activity and phenolic content, as presented by Mata (2007).The addition of rosemary extract before cooking lowered oxidative changes during cooking and later during storage. This study is in agreement with Rhee (1988) who reported that the rosemary extracts containing

phenolic derivatives to have strong antioxidant effects on cooked meat, findings where it was found that lipid oxidation is greatly affected by storage time and elevated temperature . Recently, the fruits of *R. coriaria* growing in Syria were found to contain a high amount of phenolic compound (Kossah *et al.*, 2013).

Table 2. Chemical composition (%on dray weight basis). Total phenolic as (g TAE/ 100g) and DPPH radical-scavenging activity of sumac and rosemary %

Items	Sumac	Rosemary
Moisture	11.60	8.53
protein	2.60	4.48
Ash	1.80	8.03
Ether extract	7.40	5.84
Crude fiber	22.6	13.2
Phenolic content (g_{TAE}/100 g extract)	136.6	14.20
DPPH	43.41	41.76

Microbiological evaluation of sumac, rosmary and raw minced meat

Numbers of recovered microorganisms are illustrated in Table (3). The obtained results indicated that the total count of bacteria in sumac and rosemary was 2×10 and5x10 CFU/g respectively, while the total count of molds and yeasts was 1×10 and 2x10 CFU/g, respectively.

Table 3. Microbiological quality of raw material

Microorganisms	Microbial count (CFU/g)		
	Meat minced	sumac	Rosemary
Total counts			
	$6x10^6$	2x10	5x10
Molds and yeasts	$4x10^5$	1X10	2X10
E. Coli	ND	ND	ND
Staph. aureus	9x10	ND	ND
Salmonella spp	28	ND	ND

N.D.: not detected

Coliform group, *Staphylococcus aureus* and *Salmonella* spp. were not detected in both spices. It could be also observed that the total bacterial counts in raw meat reached 6×10^6 CFU/g sample while the molds and yeasts count were 4×10^5 CFU/g sample. Data in the same Table showed that *Salmonella* spp and *Staph. aureus* were detected in the tested raw meat sample. The obtained results are in the same line with those of Mrema *et al.*, (2006) who found some kinds of *Salmonella* in raw meat samples. Meat shelf-life would depend on many factors including the number and types of microorganisms initially present and their subsequent growth, in addition, among other issues; the storage temperatures could play an important role in the handling of the raw meat products (Nychas *et al.*, 2008).

Sensory evaluation

Sensory evaluations are the most significant methods for predicting consumer acceptability (Rajalakshmi and Narasimhan 1996).

Table 4. Sensory properties of kofta samples

Sample	Sensory characteristics of the fried kofta					
	Color (10)	Taste (10)	Odor (10)	Texture (10)	Appearance (10)	Tenderness (10)
Control	8.4[d]	6.6[d]	7.6[e]	8.0[d]	8.4[d]	8.2[d]
(1%) Sumac	9.1[c]	8.5[c]	8.5[b]	8.3[cd]	8.8[b]	8.6[b]
(1.5%) Sumac	9.2[b]	8.7[b]	8.7[ab]	8.5[b]	8.9[ab]	8.6[b]
(2%) Sumac	9.5[a]	8.9[a]	8.8[a]	8.7[ab]	9.0[a]	8.5[c]
(1%) Rosemary	8.2[e]	8.5[c]	8.0[d]	8.3[cd]	8.5[c]	8.8[ab]
(1.5%) Rosemary	8.2[e]	8.85[ab]	8.1[cd]	8.4[c]	8.7[bc]	8.9[a]
(2.5%) Rosemary	8.1[f]	8.87[ab]	8.2[c]	8.8[a]	8.9[ab]	8.9[a]

Results of the sensory evaluation are tabulated in Tables (4) and are represented the average score of the sensory properties and their statistically analyzed. Data indicated that regardless the slight variations among some sensory scores of the samples, significant differences were noticed for their sensory attributes (tenderness, texture and appearance) among cooked kofta samples. On the other hand, the control formula had the lowest score of odor and taste, but were significantly differed among the other tested samples. The results also showed that there were significant differences among kofta supplemented with sumac for color characteristics compared to other blends (control and kofta supplemented with rosemary). Sensory evaluations of cooked kofta with rosemary were significantly different in scores of color, odor, appearance and texture. The results were in agreement with those reported by Güntersperger *et al.*, (1998). Rosemary spice is organoleptically acceptable at levels of 0.1 - 0.4% as reported by Oiye and Muroki (2002).

It is worthy to mention that adding sumac and rosemary to kofta samples extended shelf life of the stored kofta at 4°C up to 12 months. The counts of total counts, molds and yeasts, *E. coli*, *Salmonella* spp and *Staphylococcus aureus* in kofta samples were periodically determined(every three months) throughout storage period to follow up changes in the number of the detected microorganisms (Tables 5, 6, 7, 8 and 9). Results in Table (5) showed that total bacterial count of uncooked samples at   zero time (after 3hr form samples preparing) ranged from $3x10^5$ in rosemary (1.5%) to $3x10^6$ in control sample. The same Table indicated that *Salmonella spp* count (cfu /g) in uncooked samples at zero time storage ranged from 28 cfu /g in control sample to 10 cfu /g in sumac (2%) sample .Table (5) illustrated that the molds and yeasts of uncooked at zero time storage ranged from $7x10^5$ cfu /g in control to $3x10^4$ cfu /g in sumac 2%. Data in Table (5) also illustrated the effect of cooking methods on microbiological quality of freshly prepared kofta at zero time. It could be noticed that the applied cooking methods (frying) greatly decreased the number of recovered microorganisms of TC and molds and yeasts in the cooked kofta. However, it totally destroyed *Salmonella serotypes*. These findings are in accordance with those of other studies, which noted the absence of *Salmonella* growth at refrigeration temperatures (7to8°C) in beef (Mattick *et al*., 2003).

Table 5. Microbiological count of raw and cooked kofta after storage and at zero time

Sample	Count in uncooked samples				
	Total bacterial counts (cells/g sample)	Yeasts and moulds (colons/g sample)	Coliform group	*Staph. aureus*	*Salmonella* spp
Control	$3X10^6$	$7x10^5$	ND	$9.0x10$	28
(1%) Sumac	$4x10^5$	$8x10^4$	ND	$7.5x10$	14
(1.5%) Sumac	$6x10^4$	$6x10^4$	ND	$6.5x10$	12
(2%) Sumac	$5x10^4$	$3x10^4$	ND	$6.0x10$	10
(1%) Rosemary	$4x10^5$	$2.1x10^4$	ND	$8.0x10$	18
(1.5%) Rosemary	$3X10^5$	$1.8X10^4$	ND	$7.5x10$	15
(2.5%) Rosemary	$1.8X10^5$	$9X10^3$	ND	$7.0x10$	12
Count in fried samples					
Control	$4X10^4$	$8X10^3$	ND	ND	ND
(1%) Sumac	$7X10^3$	$6X10^3$	ND	ND	ND
(1.5%) Sumac	$9X10^3$	$5X10^3$	ND	ND	ND
(2%) Sumac	$6X10^3$	$2X10^3$	ND	ND	ND
(1%) Rosemary	$9X10^4$	$9X10^3$	ND	ND	ND
(1.5%) Rosemary	$7X10^4$	$6X10^3$	ND	ND	ND
(2.5%) Rosemary	$4X10^4$	$4X10^3$	ND	ND	ND

Kossah et al., (2013) indicated that Syrian sumac fruit extract might be used as a natural agent to prevent the growth of food spoilage bacteria, particularly. pylori leading to the reduction of gastroenteritis risk. The highest concentration of sumac 2% showed the greatest decreasing effect of such counts among those treated concentrations. Following it, 2% rosemary came. The presence of microbial load to frying kofta might be due to increasing water and fat binding properties of meat products (Cofrades et al., 2000).

Data in Table (6) showed a similar effect on decreasing microbial counts in samples stored for three months. Data also showed that all the detected microorganisms counts in the stored samples for zero time were greatly lower than those of corresponding samples either before or after storage for three months.

Table 6. Microbiological counts of raw and cooked kofta after storage for three months

Sample	Count in uncooked samples				
	Total bacterial counts (cells/g sample)	Yeasts and moulds (colons/g sample)	Coliform group	*Staph. aureus*	*Salmonella* spp
Control	3×10^6	7×10^4	ND	8.0×10	ND
(1%) Sumac	4×10^4	8×10^3	ND	6.5×10	ND
(1.5%) Sumac	6×10^3	6×10^3	ND	5.5×10	ND
(2%) Sumac	4×10^3	3×10^3	ND	5.0×10	ND
(1%) Rosemary	9×10^3	1.1×10^4	ND	7.0×10	ND
(1.5%) Rosemary	6×10^3	9×10^3	ND	6.5×10	ND
(2.5%) Rosemary	2×10^3	6×10^3	ND	6.0×10	ND
Count in fried samples					
Control	4×10^3	6×10^3	ND	ND	ND
(1%) Sumac	9×10^2	9×10^2	ND	ND	ND
(1.5%) Sumac	8×10^2	5×10^2	ND	ND	ND
(2%) Sumac	6×10^2	2×10^2	ND	ND	ND
(1%) Rosemary	8×10^2	8×10^2	ND	ND	ND
(1.5%) Rosemary	6×10^2	6×10^2	ND	ND	ND
(2.5%) Rosemary	4×10^2	3×10^2	ND	ND	ND

As shelf life of meat has always been a concern, refrigeration considered to be the most common method of extending the shelf life of meat. It could be noticed that the applied cooking methods (frying) greatly decreased the number of recovered microorganisms of TC and molds and yeasts in the cooked kofta.

However, it totally destroyed *Salmonella serotypes* and *Staphylococcus aureus*. The obtained results are in the line with those Mattick *et al.*, (2003) who detected that *Salmonella* was found in 7.5% of frozen and 9.1 % of the chilled sausages. It was also added that after cooking (frying), *Salmonella* cells was allowed

to survive and the temperature profiles during cooking indicated that the lethal range was sometimes not reached. Whyte *et al*., (2003) noticed that the presence of pathogens , mostly gram negative enteric pathogens, such as *Escherichia coli* 0157:H7 and *Salmonella serotypes*. might be reduced by the application of steam to meat surfaces.

Table 7. Microbiological counts of raw and cooked kofta after storage for six months

Sample	Count in uncooked samples				
	Total bacterial counts (cells/g sample)	Yeasts and moulds (colons/g sample)	Coliform group	*Staph. aureus*	*Salmonella* spp
Control	$3X10^6$	$7x10^4$	ND	$7.0x10$	ND
(1%) Sumac	$9x10^3$	$10x10^2$	ND	$5.0x10$	ND
(1.5%) Sumac	$6x10^3$	$8x10^2$	ND	$4.5x10$	ND
(2%) Sumac	$1x10^3$	$5x10^2$	ND	$4.0x10$	ND
(1%) Rosemary	$6x10^3$	$9x10^2$	ND	$6.0x10$	ND
(1.5%) Rosemary	$3X10^3$	$6X10^2$	ND	$5.5x10$	ND
(2.5%) Rosemary	$1X10^3$	$4X10^2$	ND	$5.0x10$	ND
Count in fried samples					
Control	$4X10^3$	$6X10^2$	ND	ND	ND
(1%) Sumac	$9X10^2$	$5X10^2$	ND	ND	ND
(1.5%) Sumac	$8X10^2$	$3X10^2$	ND	ND	ND
(2%) Sumac	$6X10^2$	$2X10^2$	ND	ND	ND
(1%) Rosemary	$8X10^2$	$5X10^2$	ND	ND	ND
(1.5%) Rosemary	$6X10^2$	$3X10^2$	ND	ND	ND
(2.5%) Rosemary	$4X10^2$	$1X10^2$	ND	ND	ND

Data in Table (7) showed a similar effect in decreasing microbial counts of samples stored for six months . It also showed that all the detected microorganisms counts in the stored samples for six month were greatly lower than those of corresponding samples either before or after frying method storage for three month only.

The highest concentration (2%) of either sumac or rosemary resulted in a greatest decreasing effect on such counts in samples stored for six month among those noticed for other concentrations. The effect of sumac and rosemary were gradually increased with increasing its added percentages. After six month of storage,

values of the total counts, molds and yeasts and *Staphylococcus aureus* in samples with sumac or rosemary were appreciable lower than the control sample.

The tested samples before and after cooking at nine month storage were subjected to the total bacterial (TBC),yeast and mold, *Salmonella*, *Staph. aureu* and coliform group counts and the obtained results are shown in Table (8). The data revealed that the total bacterial count (TBC in kofta supplemented by sumac and rosemary) after frying can be arranged in the following descending order kofta prepared with 2% sumac powder (1×10^2), 2%, rosemary (2×10^2), 1.5% rosemary(3×10^2) , 1.5% sumac (3×10^2), 1% rosemary (5×10^2) , control (5×10^5). Extending storage time to nine months at $-4^{\cdot}$ C was accompanied by a decrease in yeast and mold . Results in the same Table showed that frying method of prepared samples eliminated *Staph.aureus* in all formulae.

Table 8. Microbiological counts of raw and cooked kofta after storage for nine months

Sample	Total bacterial counts (cells/g sample)	Yeasts and moulds (colons/g sample)	Coliform group	*Staph. aureus*	*Salmonella* spp
	Count in uncooked samples				
Control	3×10^6	7×10^4	ND	6.0×10	ND
(1%) Sumac	9×10^2	7×10^2	ND	4.0×10	ND
(1.5%) Sumac	7×10^2	5×10^2	ND	3.5×10	ND
(2%) Sumac	5×10^2	3×10^2	ND	3.0×10	ND
(1%) Rosemary	6×10^2	4×10^2	ND	5.0×10	ND
(1.5%) Rosemary	3×10^2	3×10^2	ND	4.5×10	ND
(2.5%) Rosemary	2×10^2	2.7×10^2	ND	4.0×10	ND
	Count in fried samples				
Control	5×10^5	5×10^2	ND	ND	ND
(1%) Sumac	7×10^2	1.2×10^2	ND	ND	ND
(1.5%) Sumac	3×10^2	9×10	ND	ND	ND
(2%) Sumac	1×10^2	8×10	ND	ND	ND
(1%) Rosemary	5×10^2	9×10	ND	ND	ND
(1.5%) Rosemary	3×10^2	7×10	ND	ND	ND
(2.5%) Rosemary	1×10^2	4×10	ND	ND	ND

Results presented in Table (9) showed that addition of sumac or rosemary partially decreased the initial microbial count and slowed down the growth during the storage period in parallel to increasing the concentration. In general, the microbiological quality of meat products as purchased by the consumer relies on a number of factors, such as the quality of the raw materials, other ingredients or processing operations to the products as extraneous contaminants, sanitation during processing and packaging. At concentration of 1, 1.5 and 2%, sumac or rosemary the mean aerobic counts in the samples were reduced.

Control sample showed slightly higher counts of all the tested microorganisms after extending storage time up to 12 months than those of other samples treated with sumac and rosemary. These findings are concurrent and confirmed with that found by Kossah *et al.*, (2013) who reported that the extract of Syrian sumac fruit can be used as a natural source of antimicrobial and antioxidant agents to preserve foodstuffs against a range of food related microorganisms. Sumac is rich in water-soluble tannins, and the antimicrobial activity of tannins is well documented (Chung *et al.*,1998). Addition of rosemary extract prior to cooking (on heat sterilized ground pork) lowered oxidative changes during precooking and storage (Güntersperger *et al.*, 1998). The aforementioned results were agreed with Egyptian Organization for Standardization and Quality.

Table 9. Microbiological counts of raw and cooked kofta after storage for 12 months

Sample	Count in uncooked samples				
	Total bacterial counts (cells/g sample)	Yeasts and moulds (colons/g sample)	Coliform group	*Staph. aureus*	*Salmonella* spp
Control	$3X10^4$	$7x10^4$	ND	$5.0x10$	ND
(1%) Sumac	$7x10^2$	$7x10$	ND	$3.0x10$	ND
(1.5%) Sumac	$5x10^2$	$5x10$	ND	$2.5x10$	ND
(2%) Sumac	$2x10^2$	$3x10$	ND	$1.0x10$	ND
(1%) Rosemary	$4x10^2$	$4x10$	ND	$3.0x10$	ND
(1.5%) Rosemary	$3X10^2$	$3X10$	ND	$3.5x10$	ND
(2.5%) Rosemary	$1X10^2$	$1.5X10^2$	ND	$2.0x10$	ND
	Count in fried samples				
Control	$5X10^2$	$5X10^2$	ND	ND	ND
(1%) Sumac	$6X10$	$1.2X10^2$	ND	ND	ND
(1.5%) Sumac	$5X10$	$9X10$	ND	ND	ND
(2%) Sumac	$1X10$	ND	ND	ND	ND
(1%) Rosemary	$6X10$	$9X10$	ND	ND	ND
(1.5%) Rosemary	$3X10$	$7X10$	ND	ND	ND
(2.5%) Rosemary	$1X10$	ND	ND	ND	ND

CONCLUSION

The sumac and rosemary showed a remarkable inhibitory activity against the growth of food spoilage and/or poisoning bacteria, especially *Salmonella* and *Staph. aureu*s .On the other hand, sumac fruit powder exhibited a good antioxidative capacity. Therefore, the sumac fruit and rosemary leaves can be used as a natural source of antimicrobial and antioxidant agents to preserve foodstuffs against a range of food related microorganisms. The sumac and rosemary species can be considered as good sources of additives and/or ingredients for the food industry. These findings would be useful for food scientists and nutritionists interested in the nutritive value of nonconventional plants such as sumac and rosemary . Results of this study showed that the fruit of the sumac are, also, a good source of phenolic compounds, which are strong antioxidants.

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دراسة مقارنة لاستخدام السماق و الروز ماري في حفظ الكفتة اثناء التخزين

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لوحظ في الاونة الاخيرة ازدياد الاهتمام باستخدام المواد النباتية وخاصة التوابل (السماق والروز ماري) في مجال مضادات الميكروبات الطبيعية. وقد أجريت هذه الدراسة لإطالة فترة الصلاحية للكفتة الخام (منتجات اللحوم النيئة مع التوابل) في ظل ظروف التجميد. واحتوت الخلطات على السماق والروز ماري كلا على حدا بنسبة صفر، ١، ١.٥، ٢%. تم تقييم الحمل الميكروبي للمواد المستخدمة (اللحم المفروم الخام، والتوابل) قبل التخزين في حين، تم تقييم عينات الكفتة الكنترول بعد إعدادها بثلاث ساعات وبعد تخزين لمدة ٣، ٦،٩، ١٢ شهرا بالتجميد. وقد تم استخدام طريقة التحمير في اعداد عينات الكفتة المطهية . وتم اجراء التقييم الحسي قبل التخزين وقد أظهرت النتائج ان القبول الحسى الافضل كان عند استخدام ٢% من السماق. وأشارت النتائج إلى أن العد الكلي للبكتيريا في السماق والروز ماري كان ١٠ x ٢ x ١٠، ٥ خلية / جم عينة على التوالي، في حين كان العدد الإجمالي للفطريات والخمائر ١٠x ١ ، ١٠ x٥ خلية / جم عينة على التوالي. ولم يتم الكشف عن المجموعة القولونية و البكتريا العنقودية والسالمونيلا في كل من التوابل. لوحظ ان زيادة نسبة السماق المضافة أو الروز ماري أظهرت انخفاضا في عدد جميع الكائنات الحية الدقيقة التي تم اختبارها. كما أظهرت النتائج أن كلا من السماق والروزماري مصدرا للألياف التى تعمل على تخفيف اضطرابات الجهاز الهضمي. وبعد ١٢ شهر من التخزين حدث انخفاض ملحوظ في عدد كل الكائنات الحية الدقيقة (العد الكلى للبكتيريا والفطريا ت والخمائر والسالمونيلا والبكتريا العنقودية) في العينات مقارنة من قبل التخزين . ويستنتج من الدراسة ان ثمار السماق يمكن ان تكون مصدر جيد من المركبات الفينولية، المواد المضادة للاكسدة .

الكلمات الافتتاحية : النشاط المضاد للميكروبات، والنشاط المضاد للأكسدة، الروزماري، السماق ، اختبارات ميكروبيولوجية.