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UTILIZATION OF SAGE (*Salvia officinalis*) IN PRESERVATION OF BEEF BURGER QUALITY AND PROLONGING OF SHELF LIFE.

By

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ABSTRACT: The addition of sage to beef burger leaded to preservation of sensory, physical, chemical and microbiological quality, whereas, the Thiobarbituric acid (TBA) values and Total Volatile Nitrogen (TVN) content decreased for samples contained sage, also sage improved Water holding capacity (WHC), plasticity and sensory properties and the microbial growth was lowered with addition of sage . During frozen storage, there occurred deterioration of beef burger quality, but the rate of deterioration was less for samples contained sage. The addition of sage prolonged the shelf life to 6 months of the samples contained 0.75 and 1.00 % sage and were acceptable organoleptically, physically, chemically and microbiologically.

INTRODUCTION

Lipid oxidation causes degradation of polyunsaturated fatty acids and generation of residual products, such as malonaldehyde (MDA) and lipid derived volatiles leading to sensory and nutritional deterioration of meat (Kanner et al.,1991) . Moreover , Lipid oxidation and bacterial contamination are the main factors that determine food quality loss and shelf-life reduction . Therefore, delaying lipid oxidation and preventing bacterial cross-contamination are highly relevant to food processors . The growth of microorganisms in meat products may cause spoilage or food borne diseases . Oxidative processes in meat lead to the degradation of lipids and proteins which , in turn, contribute to the deterioration in flavor , texture and color of displayed meat products (Decker et al., 1995).

Preservation of the lipid fraction of foods from oxidative deterioration represent an important aim from the point of view of quality and shelf life . It is indeed well known that the products derived from lipid oxidation reduce organoleptic quality and safety , besides reducing nutritional properties because of destruction of oxygensensitive vitamins (Vichi et al.,2001) .

Antioxidants have been widely used as food additives to provide protection against oxidative degradation of foods. Spices used in different types of food to improve flavors, since ancient times , are well known for their antioxidant properties (Madsen and Bertelsen,1995) .

Sage is a popular kitchen herb and is a member of the mint (Labiatae) family. It has been used in a variety of food preparation since ancient times . From its Latin name , " Salvia " meaning to cure and " Officinalis " meaning medical , it is clear that sage has a historical reputation for promotion of health and treatment of ailments (Kintzios , 2000) .The genus Salvia (sage) belongs to the Lamiaceae and encompasses 900 species worldwide of which 26 indigenous species are found in southern Africa . Salvia is the largest genus in this family and constitutes almost one quarter of the Lamiaceae . Salvia species are used in many parts of the world to treat various conditions. Many sages, if not all, form an integral part of traditional healing in South Africa particularly in regions where they occur in abundance . Several species are used to treat microbial infections, cancer, malaria, loss of memory, inflammation and to disinfect homes after sickness (Kamatou et al ., 2008).

Sage is an aromatic herb and thus was previously considered mainly for its essential oil content (Santos-Gomes & Fernandes-Ferreira, 2003). Due to the essential oil and antioxidant components of sage it is an economically interesting plant to study. The essential oil and flavourants of sage are used as basic material for various food, cosmetic and pharmaceutical preparations (Tucker & Maciarello,1990). Sage antioxidants can be used as an alternative to the well-known rosemary antioxidants for the protection and preservation of certain food and nutraceutical products to extend their shelf life (Shahidi, 2000; Wellwood & Cole, 2004). The possible toxicity of synthetic antioxidants and an increase in consumer preference for' all natural'' ingredients has motivated recent studies on antioxidants from sage. Sage extracts contain a wide range of phenolic compounds (Lu & Foo, 2002). The leaves of sage (Salvia Officinalis L., Lamiaceae) contain high amounts of phenolic diterpenes such as carnosol and carnosic acid. These compounds display antioxidant and anti-inflammatory effects in vitro(Reuter et al., 2007). Also , sage plant and extracts have antimicrobial effects of muscle and fat foods (Baxter and Holzapfel, 2006 and Ahn et al., 2007) .

The objective of this investigation is to study the effect of addition of different concentrations of sage on quality attributes of beef burger during frozen storage.

MATERIAL AND METHODS

Material :

Beef meat was obtained from local market and minced in our laboratory in 2009. Texturized soy protein (TSP) was obtained from the plant in Food Technology Research Institute . TSP was hydrated with water at the ratio (1:2, TSP : water w / v) before being added to the formula and other ingredients (such as , egg , dry Rusk , salt , spices and sage) obtained from local market in 2009.

Spices mixture (100g): 20g Black pepper + 10g Cubeb + 10g Laura leaves +10g Nutmeg + 20g Fennel + 10g Cinnamon + 10g Cardamom + 10g Clovers.

Methods :

Preparation of beef burger samples :

Beef burger was prepared according to the following recipe: minced meat 75 % + egg 7 % + dry Rusk 5 % + SP 10 % + salt 1.5 % + spices 1.5 % (control sample (0.0 % sage)). Beef burger samples contained sage were prepared by addition of sage with different concentrations (0.50 , 0.75 , 1.00 , 1.50 , 2.00 , 2.50 and 3.00 % sage of beef burger mixture). The ingredients were mixed and homogenized by a laboratory chopper , then the burger samples were shaped .All samples were stored in refrigerator for 24 hr to make diffusion of sage with other ingredients . Sensory evaluation was carried out for fried beef burger samples. The frying was in corn seed oil at 110 ° C. for 5 minutes.

Sensory evaluation :

Sensory evaluation was carried out for all burger samples at zero time (after 24 hours from preparation) and the end of storage time, but analytical methods were carried out for only accepted samples (0.0, 0.50, 0.75 and 1.00 % sage) at zero time and during storage periods at -18°C . Sensory evaluations of color , odor , taste , texture and overall acceptability were carried out by aid of 10 panelists according to Molander (1960) and judging scale was as : 9 – 8 (very good), 7.9 – 7.0 (good), 6.9 – 6.0 (accepted) and less than 6.0 was unaccepted. Conventional statistical methods of sensory properties were used to calculate means and LSD. Statistical analysis (ANOVA) was applied to determine significant differences ($P < 0.05$) according to Snedecor and Cochran,(1980) .

Physical analysis :

Water holding capacity (WHC) and plasticity of samples were measured using the method of Golavin (1969) .

Chemical analysis :

Thiobarbituric acid (TBA) value was determined as described by Pearson (1970) and Total Volatile Nitrogen (TVN) was determined according to the method published by Winton and Winton (1958).

Microbiological analysis :

Total Plate Count (TPC), Coliform group, Proteolytic bacteria, Lipolytic bacteria , Psychrophilic and Yeast and Mold counts of beef burger samples were determined by using Nutrient agar , MacConkey , Nutrient agar medium to which 10 % skim milk was added immediately before pouring , Tween agar , Nutrient agar and Potato Dextrose agar media , respectively according to the procedures described by APHA (1979) and Difco Manual (1984) . Incubations were carried out at 37°C / 48hr for TPC ; at 37°C / 24hr for Coliform ; at 30°C / 3 days for Proteolytic and Lipolytic bacteria; at 8° C / 10 days for Psychrophilic and 25 °C / 5 days for yeast and mold counts.

RESULTS AND DISCUSSION

Sensory quality :

From results in Table (1) it could be observed the effect of sage on sensory quality. Whereas , the burger samples contained 0.5 and 0.75 % sage were approximately resemble the control sample in scores of taste , odor , color , texture and overall acceptability , but the scores of taste , odor , color and overall acceptability of sample contained 1.0 % sage were significantly lower than scores of these properties for the control sample , except score of texture was slightly higher . These results were in agreement with results found by (Nuñez de Gonzalez et al ., 2008) Trained panel sensory evaluations indicated that the sample contained sage was acceptable to consumers as the control. Also in this investigation it was found that the scores of sensory properties for the burger samples contained 1.5, 2.0, 2.5 and 3.0 % sage were less than for control sample, except texture was the best than control sample. Therefore, the addition of sage improved the texture, but the bitterness taste appear from 1.5 % sage and gradually increased with increasing sage percentage. Also the scores of odor and color of all samples were decreased with increasing of sage, this confirmatory with overall acceptability. Therefore, the burger samples contained 1.5, 2.0, 2.5 and 3.0 % sage were refused organoleptically.

Table (1) : Sensory properties of beef burger samples with added sage (0.0 , 0.5 , 0.75 , 1.0 , 1.5 , 2.0 , 2.5 and 3.0 %) at zero time .

Samples	Sensory Properties				
	Taste	Odor	Color	Texture	Overall acceptability
Control	9.00 a	8.33 a	8.17 a	8.33 a	8.46 a
0.5	9.00 a	8.33 a	8.33 a	8.50 a	8.54 a
0.75	8.83 a	8.33 a	7.83 a	8.50 a	8.38 a
1.0	8.00 a	7.16 b	6.67 b	8.50 a	7.58 b
1.5	5.67 b	6.83 b	6.17 bc	8.83 a	6.88 c
2.0	5.33 b	6.17 bc	5.67 c	8.83 a	6.50 c
2.5	3.83 c	5.50 c	4.83 d	9.00 a	5.79 d
3.0	3.00 c	4.67 d	4.67 d	9.00 a	5.33 e
LSD	0.935	0.829	0.728	0.612	0.388

Results in Table (2) shows sensory properties of beef burger samples with added sage (0.0 , 0.5 , 0.75 and 1.0 %) at the end of frozen Storage. It was observed that the scores of taste, odor and texture were significantly higher for the samples contained sage than for control sample, but score of color was significantly higher for the control sample and it was found that the 0.5, 0.75 and 1.0 % sage samples still accepted than control sample as reported by(Nuñez de Gonzalez et al ., 2008) that the sausage samples contained sage was acceptable to consumers at the end of frozen storage and in general, warmed-over flavor notes were not appeared after storage period. Therefore, it was noticed that the addition of sage to the beef burger prolonged the shelf life as reported by (Shahidi, 2000; Wellwood & Cole, 2004).

Table (2) : Sensory properties of beef burger samples with added sage (0.00 , 0.50 , 0.75 and 1.00 %) at the end of frozen Storage .

Samples	Sensory Properties				
	Taste	Odor	Color	Texture	Overall acceptability
Control	4.50 b	5.33 c	6.83 a	4.67 b	5.33 b
0.5	6.00 a	6.17 b	6.67 ab	6.00 a	6.21 ab
0.75	6.17 a	6.67 ab	6.33 ab	6.17 a	6.34 a
1.0	6.33 a	7.17 a	6.17 b	6.33 a	6.50 a
LSD	0.901	0.543	0.543	0.815	0.949

a b c ... means having the same common letter within each column are insignificantly different at 0.05 level of probability.

Chemical quality :

From Table (3) it could be observed that TBA values of beef burger samples as affected by addition of sage , whereas , sage reduced the level of malonaldehyde in all sample at zero time and during frozen storage , possibly because sage has antioxidant effect, due to polyphenols content as reported by (Shahidi, 2000; Lu & Foo, 2002 and Wellwood & Cole, 2004) . During frozen storage period, there was increasing of TBA values of all samples , but the increasing percentage was lowered with increasing of sage , the increasing of TBA values was higher in control than in treated samples, therefore, addition of sage improved chemical quality, as confirmed (Estevez et al., 2007) that the oxidative degradation of PUFA caused a gradual increase of TBA during refrigerated storage of liver pates. TBA values increased after 90 days of refrigerated storage, but with this increase being significantly low in ' SAGE' pates.

Data in Table (4) shows the effect of sage on chemical quality of beef burger during frozen storage .It was found that the addition of sage reduced the content of TVN ,during frozen storage the TVN content increased of all samples . Yamagata and Low (1995) found that VB- N levels for banana shrimp increased from 3.83 mg / 100 g on 0-day to 10.93 mg / g after 4 months at – 2o° C . But the rate of increase was higher for control sample than the burger samples contained sage , probably was due to the increase in TPC of control sample Table (7)

Table (3) : Changes in thiobarbituric acid (TBA) value (mg malonaldehyde / kg) of beef burger samples containing sage (0.00 , 0.50 , 0.75 and 1.00 %) during frozen storage .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	0.1518	0.1517	0.1502	0.1465
1	0.2738	0.1979	0.1903	0.1852
2	0.3957	0.2441	0.2301	0.2239
3	0.5177	0.2904	0.2703	0.2627
4	0.6397	0.3366	0.3101	0.3014
5	0.7616	0.3829	0.3503	0.3401
6	0.8836	0.4290	0.3900	0.3788

Table (4) : Changes in total volatile nitrogen (TVN) content (mg / 100 g) of beef burger samples containing sage (0.00 , 0.50 , 0.75 and 1.00 %) during frozen storage

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	6.80	6.75	6.68	6.50
1	9.70	9.28	8.94	8.55
2	12.60	11.83	11.19	10.60
3	15.51	14.37	13.45	12.66
4	18.41	16.90	15.70	14.71
5	21.31	19.44	17.96	16.75
6	24.21	21.98	20.22	18.81
Increasing %	8	8	8	8

Physical quality :

From the results in Table (5) it could be noticed that the addition of sage for beef burger improved the WHC, whereas, WHC increased with the addition of sage. During frozen storage, WHC decreased for all samples, but the rate of decrease was less for the samples contained sage and with increasing of sage percentage, this indicated that the loss of water of 0.50, 0.75 and 1.00 % sage samples was lower than for 0.00 % sage sample. Therefore, sage preserved the physical quality of burger.

Table (5) : Changes in water holding capacity (WHC) of beef burger samples containing sage (0.00 , 0.50 , 0.75 and 1.00 %) during frozen storage (cm^2) .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	0.96	0.85	0.81	0.78
1	1.52	1.10	1.00	0.91
2	1.97	1.35	1.19	1.07
3	2.43	1.60	1.38	1.23
4	2.88	1.84	1.57	1.39
5	3.34	2.09	1.76	1.55
6	3.79	2.34	1.95	1.71
Increasing %		63.7	58.5	

From the results in Table (6) it could be noticed that plasticity followed a pattern similar to that of WHC , whereas , plasticity was higher for the samples contained sage than for the control sample and it was increased with the increasing of sage percentage . During frozen storage , plasticity was decreased for all samples ,but the rate of decrease was high for control sample , while was less for the samples contained sage.

Table (6) : Changes in plasticity of beef burger samples containing sage (0.0 , 0.50 , 0.75 and 1.00 %) during frozen storage (cm^2) .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	3.50	3.58	3.60	3.62
1	3.36	3.43	3.47	3.51
2	3.22	3.27	3.34	3.39
3	3.09	3.12	3.21	3.28
4	2.95	2.96	3.07	3.16
5	2.81	2.81	2.94	3.05
6	2.17	2.65	2.81	2.93
Decreasing %		20.3	17.2	14.9

Microbiological quality :

From Table (7) it could be noticed effect of addition of sage on Total Plate Count (TPC) of beef burger samples during frozen storage . It was observed that (TPC) decreased with addition of sage and the rate of decrease was increased with increasing of sage percentage . During frozen storage , (TPC) slightly decreased from zero time to the 2 month for 0.0 and 0.5 % sage samples and to the 3 month for 0.75 and 1.0 % sage samples , may be due to the effect of freezing of inhibition for the microbial growth, after that the (TPC) increased of all burger samples , but the rate of increase was higher for control sample than for samples contained sage, due to the sage has antimicrobial effects as reported by (Shelef et al., 2006 – Baxter & Holzapfel, 2006 and Ahn et al., 2007) .

Table (7) : Changes in TPC of beef burger samples containing sage (0.0 , 0.50 , 0.75 and 1.00 %) during frozen storage .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	7.80×10^3	5.95×10^3	4.75×10^3	2.70×10^3
1	7.25×10^3	5.10×10^3	4.21×10^3	2.35×10^3
2	7.06×10^3	4.77×10^3	3.96×10^3	2.15×10^3
3	1.71×10^4	5.10×10^3	3.58×10^3	2.0×10^3
4	8.86×10^4	1.21×10^4	8.14×10^3	6.60×10^3
5	2.76×10^5	6.16×10^4	1.75×10^4	1.03×10^4
6	8.87×10^5	3.20×10^5	8.60×10^4	5.35×10^4

The data presented in Table (8) shows effect of addition of sage on Coliform group of beef burger samples during frozen storage . It was observed that Coliform group was detected at zero time of control and o.5 % sage samples , this may be due to the cross-contamination of the burger during preparation , but it was not detected for 0.75 and 1.0 % sage samples, may be due to the effect of the higher concentration of sage. A concentration of 0.3% of sage in the media was inhibited of bacterial growth for the most of strains . In general, higher spice levels are required to effect inhibition in foods than in culture media (Shelef et al., 2007). During frozen storage, Coliform group was decreased at the first three months for the control and 0.5 % sage samples and increased from the 4 month for both samples, but the rate of increase was high for control sample . While Coliform group was not detected in the samples contained 0.75 and 1.00 % sage throughout frozen storage.

Table (8) : Changes Coliform group of beef burger samples containing sage (0.0 , 0.50 , 0.75 and 1.00 %) during frozen storage .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	8.5×10^1	2.5×10^1	ND	ND
1	8.0×10^1	2.5×10^1	ND	ND
2	7.0×10^1	2.0×10^1	ND	ND
3	5.5×10^1	2.0×10^1	ND	ND
4	7.5×10^1	3.0×10^1	ND	ND
5	1.05×10^2	4.50×10^1	ND	ND
6	2.10×10^2	9.0×10^1	ND	ND

The data presented in Table (9) shows effect of addition of sage on Lipolytic bacteria of beef burger samples during frozen storage . It was observed that Lipolytic bacteria detected at zero time of control and o.5 % sage samples, from the second month for 0.75 % sage sample and from the 4 month for 1.00 % sage sample during frozen storage, after that Lipolytic bacteria number increased to the end of frozen storage period for all samples ,but the rate of increase was higher for control sample than for the samples contained sage, due to that the sage has antibacterial activity as reported by (Shelef et al., 2006).

Table (9) : Changes Lipolytic bacteria of beef burger samples containing sage (0.0 , 0.50 , 0.75 and 1.00 %) during frozen storage .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	4.00×10^1	1.00×10^1	ND	ND
1	2.00×10^2	$6.0\ 0\times 10^1$	ND	ND
2	7.50×10^2	1.05×10^2	1.50×10^1	ND
3	3.17×10^3	3.78×10^2	5.00×10^1	ND
4	6.95×10^3	7.85×10^2	9.50×10^1	2.50×10^1
5	9.27×10^3	2.60×10^3	2.80×10^2	5.50×10^1
6	1.10×10^4	4.75×10^3	9.22×10^2	9.00×10^1

The data presented in Table (10) shows effect of addition of sage on Proteolytic bacteria of beef burger samples during frozen storage . It was observed that Proteolytic bacteria detected at zero time for control and o.5 % sage samples, from the second month for 0.75 sage % sample and from the three month for 1.00 % sage sample during frozen storage, after that Proteolytic bacteria number increased to the end of frozen storage period for all samples ,but the rate of increase was higher for control sample than for the samples contained sage, due to the sage has antibacterial activity as reported (Suhr & Nielsen, 2003) that the spices have antimicrobial properties.

Table (10) : Changes Proteolytic bacteria of beef burger samples containing sage (0.0 , 0.50 , 0.75 and 1.00 %) during frozen storage .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	5.50×10^1	2.00×10^1	ND	ND
1	9.50×10^1	4.20×10^1	ND	ND
2	3.60×10^2	8.00×10^1	6.00×10^1	ND
3	5.55×10^2	2.15×10^2	1.00×10^2	5.00×10^1
4	9.80×10^2	6.50×10^2	4.50×10^2	1.25×10^2
5	2.10×10^3	1.75×10^3	8.75×10^2	5.20×10^2
6	6.75×10^3	3.35×10^3	1.10×10^3	9.85×10^2

From Table (11) it could be noticed effect of addition of sage on Psychrophilic bacteria of beef burger samples during frozen storage . It was observed that Psychrophilic bacteria decreased with addition of sage . During frozen storage, number of Psychrophilic bacteria increased of all samples, but the rate of increase was higher for control sample than for the samples contained sage.

Data in Table (12) shows effect of addition of sage on Yeast and Mould of beef burger samples during frozen storage. It was noticed that the Mould not detected of all samples throughout the frozen storage and these results were for the Yeast. It was found that addition of sage decreased Yeast numbers, the rate of decrease was increased with increasing of sage percentage. During frozen storage, Yeast numbers increased of all samples, but the rate of increase was higher for control sample than for the samples contained sage. Studies in the last decade confirm growth inhibition of yeast and mold by sage and other spices (Koga et al., 1999 and Feres et al., 2005) . Sage has antimicrobial, antifungal activity and antioxidant activities as observed (Bozin et al ., 2007) and this antimicrobial activity was tested against 13 bacterial strains and 6 fungi, the most important antibacterial activity of essential oils .

Table (11) : Changes Psychrophilic bacteria of beef burger samples containing sage (0.0 , 0.50 , 0.75 and 1.00 %) during frozen storage .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	1.75×10^2	1.15×10^2	6.50×10^1	3.50×10^1
1	4.92×10^2	2.67×10^2	9.80×10^1	7.5×10^1
2	5.50×10^2	3.88×10^2	1.67×10^2	9.70×10^1
3	8.65×10^2	7.10×10^2	5.40×10^2	3.26×10^2
4	3.75×10^3	1.87×10^3	1.17×10^3	7.65×10^2
5	9.10×10^3	6.76×10^3	5.78×10^3	1.16×10^3
6	4.25×10^4	1.81×10^4	8.46×10^3	4.80×10^3

Table (12): Changes Yeast of beef burger samples containing sage (0.0 , 0.50 , 0.75 and 1.00 %) during frozen storage .

Storage Time (months)	Samples			
	Control	0.5 % sage	0.75 % sage	1.0 % sage
0	7.5×10^1	6.0×10^1	2.5×10^1	0.5×10^1
1	9.0×10^1	8.0×10^1	3.50×10^1	2.0×10^1
2	1.15×10^2	1.0×10^2	6.0×10^1	4.0×10^1
3	1.40×10^2	1.15×10^2	8.0×10^1	5.0×10^1
4	1.90×10^2	1.65×10^2	1.05×10^2	7.0×10^1
5	2.30×10^2	1.90×10^2	1.30×10^2	8.50×10^1
6	4.25×10^2	2.60×10^2	1.65×10^2	9.50×10^1

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الملخص العربي

الانتفاع بالمرمرية فى المحافظة على جودة برجر اللحم البقرى وإطالة فترة الصلاحية

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إضافة المرمرية لبيرجر اللحم البقرى أدي إلي المحافظة على الجودة الحسية والطبيعية والكيميائية والميكروبيولوجية ، حيث قلت أرقام حمض الثيوباربتيورك ومحتوى النتروجين الكلى في العينات المحتوية على المرمرية ، أيضا حسنت المرمرية القدرة على إمساك الماء والبلاستيكية والصفات الحسية وقللت إضافة المرمرية النمو الميكروبي . وخلال التخزين بالتجميد ، حدث تدهور في جودة البيرجر ولكن معدل التدهور كان أقل في العينات المحتوية على المرمرية وأطالت إضافة المرمرية فترة التخزين إلى ٦ أشهر . والعينات المحتوية على ٠,٧٥ و ١,٠ % مرمرية كانت مقبولة حسيا وطبيعيا وكيميائيا وميكروبيا .