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Impact of Adding Chia Seeds (*Salvia hispanica*) on the Quality Properties of Camel Burger "Camburger" during Cold Storage

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A B S T R A C T

This study aimed to investigate the effect of adding chia seeds (*Salvia hispanica*) in the formulation of camel burger on the pH, TBA value, color measurements, microbiological analysis and sensory evaluation during cold storage at 4° C for 12 days. Results indicated that pH value of all camel burger samples slightly increased during the first 3 days of storage. No significant differences were found in pH value of control and formulated samples at any time of storage period. Addition of chia seeds showed significant effects on TBA values of formulated camel burger compared to control samples during storage. All burger samples significantly increased as the time of cold storage increased. Burger formulated with 5 % chia seeds had the lower TBA value than other burger samples. Significant differences were found in color measurements of control and formulated burger during storage. Total bacterial count of all burger samples slightly decreased during 6 days of cold storage whereas after day 6 there was gradual increase in all burger samples. Burger formulated with 3 and 5% of chia seeds showed lower count of psychrotrophic bacteria compared with control samples. Camel burger formulated with 3% chia seeds recorded the higher score in sensory attributes.

Introduction

Although fat is an important component in meat products, the demand for low fat meat products formulated with healthier lipid sources has greatly increased since high fat intake, especially saturated fats, is associated with obesity, cardiovascular and chronic diseases (AHA, 1996). Since fat contributes texture and flavor to meat products, reducing fat content in formulation may alter product quality; products with less fat content is firmer, more rubbery, less juicy, darker in color and more costly (Keeton, 1994). In order to conquer these problems, fat replacers are candidates to improve the texture and sensorial properties of low-fat meat products. Incorporation of some ingredients into foods such as flax seed and chia seed, as well as in oils rich in unsaturated fatty acids could be used as fat replacer.

Chia (*Salvia Hispanica* L.) is an annual herbaceous plant belonging to the Lamiaceae or Labiatae family. Chia seed is composed of protein (15–25%), fats (30–33%),

carbohydrates (26–41%), dietary fiber (18–30%), and ash (4-5%), it also contains a high amount of vitamins, minerals, dry matter (90–93%) and antioxidants (Ali *et al.,* 2012).

Chia seed contains between 30 - 33.5 g oil/100g with high concentrations of polyunsaturated fatty acids (PUFA), being α-linolenic acid (ALA), a n-3 fatty acid the main essential fatty acid present in it 57 - 65 g/100g (Ayerza, and Coates, 2011). In addition, it is known that the chia seeds contain a great amount of polyphenolic compounds with potent antioxidant activity, mainly flavonoids such as quercetin, kaempferol, myricetin and others (Ixtaina *et al.,* 2011).

Although CHIA is a potential ingredient in health and diet food products on its physicochemical properties, it is seldom used in meat products (Marineli *et al.,* 2015).

Therefore, the aim of this study is to investigate the effect of adding different levels of chia seeds in the formulation of camel burger on pH value, color measurements, lipid oxidation, microbiological quality and sensory evaluation during cold storage at 4°C for 12days.

Materials and Methods

Preparation of camel burger (Camburger)

Camel meat and humped fat obtained from local slaughter house were used in this study. Left round (*Biceps femoris*) muscles of 3-4 years aged camel were pooled to form an experiment unit, with three (batches) of lean ground meat being prepared from each burger formulation.

All knives – separable fat was removed from muscles and used with humped fat as fat source. Lean meat was ground through a 3mm plate grinder. Camel burger samples were prepared as follows ingredients; 10% onion, 0.5%black pepper, spices0.5%, salt 1.5%. Chia seeds were previously grinded. Camel burgers were prepared according to the following formulations:

Control: 20% fat 0 % chia seeds
Formula 1: 0% fat 1% chia seeds
Formula 2: 0% fat 3% chia seeds
Formula 3: 0 % fat 5% chia seeds

Batches of 2kg of each formula were handily mixed and formed by using manual burger press machine (1cm thickness, 10cm diameter and 60±2g weight). Burgers were placed in plastic foam meat trays, packed in polyethylene bags and stored at 4 ±1^{o}C for 12 days.

Physical analysis

pH value

pH value of raw camel burger samples was determined as described by Hood(1980). Ten grams of sample was homogenized with 100ml distilled water and measured using a digital pH-meter Jenway 3310 conductivity and pH meter. pH values were determined in triplicate for each sample at 0, 3, 6, 9 and 12 days of storage at 4°C.

Color measurements

Color of raw camel burger samples was measured by Chroma meter (Konica Minolta, model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer (CIE, 1976).

The color was expressed as *L** (lightness), *a** (the redness), *b** (the yellowness), *C** (saturation index) and *h** (hue angle). The average of three spectral readings at different locations was obtained for each treatment during storage periods.

Determination of T.B.A value

Measurement of lipid oxidation: The extent of lipid oxidation in raw camel burger was assessed by measuring 2- thiobarbituric acid reactive substances (TBARS), as described by AOCS (1998).

TBARS values were determined in triplicate for each sample at 0, 3, 6, 9 and 12 days of storage at 4°C.

Microbiological analysis

The analyses of total bacterial count and psychrotrophic bacteria at 0, 3, 6, 9 and 12 days of storage at 4°C were determined according to Ercolini *et al.,* (2009).

Sensory evaluation

Camel burger was subjected to organoleptic evaluation as described by A. M. S. A. (1995). Twenty trained panelists of staff members of Food Science Department, Faculty of Agriculture, Ain-Shams University were scored appearance, texture, juiciness, flavor, tenderness and overall acceptability using a 9-point hedonic scale.

The samples of each treatment were cooked in preheated oven at 180°C for 3 min each side (internal temperature 70°C ±5). Samples were coded, cut and served in white disposable dishes.

Statistical analysis

All data generated from each treatment were analyzed using statistical analysis system (SAS, 2000).

Two- way ANOVA was applied for pH, TBA, color measurements and microbiological analyses. In case of sensory evaluation one – way ANOVA was applied.

Results and Discussion

pH value

Data of pH value of camel burger formulated with different levels of chia seeds during cold storage are shown in Table 1. No significant differences were found in pH value between control and formulated samples at zero time. The pH value of all camel burger samples slightly increased during the first 3 days of storage. However, no significant differences were found in pH value of control and formulated samples at any time of storage period. These results are close to that obtained by Scapin *et al.,* (2015) they found that the pH value of pork sausage treated with different concentrations of chia seeds extract were not significantly different between treatments during 28 days of storage at 4°C.

T.B.A value

Results of TBA value of camel burger formulated with chia seeds during storage at 4°C for 12 days are presented in Table 2. As can be seen, there was a significant increase in TBA values of control samples during storage period. Addition of chia seeds showed significant effects on TBA values of camel burger compared to control samples during storage. All camel burger samples significantly increased as the time of cold storage increased. However, at any time of cold storage, burger formulated with 5 % chia seeds had the lower TBA value than other burger samples. These results are close to that obtained by Scapin *et al.,* (2015) they found that a significant increase in TBA value for all pork sausage (control and treated with chia extract) during cold storage at 4°C for 28 days. Also, Melo *et al.,* (2015) found that TBARS increased in all hamburger samples (control and treated with chia seeds extract) during frozen storage at -18°C for 120 days. Riernersman *et al.,* (2016) reported that

TBARS values of formulated burger was considerably lower than the control for each sampling during storage, indicating high protection of whole chia flour against lipid oxidation in cooked fish burger. This antioxidant effect of chia on the formation of TBARS can be due to the presence of polyphenolic compounds with antiradical activity and reducing power before determined (Ixtaina *et al.*, 2011).

Color measurements

Color measurements of camel burger formulated with different levels of chia seeds during cold storage at 4°C for 12 days are given in Table (3). Fresh control sample showed higher *L** value while, no significant differences were found between formulated samples. As can be seen, *L** value was significantly increased in control samples during cold storage. While, burger treated with 1 and 5% chia seeds showed significant higher in *L** value after 6 days of storage and no significant differences were found after 9, and 12 days. However, addition of chia seeds had no significant effect on *L** value during storage. These results are close to that obtained by Mokhtar *et al*. (2014) they reported that slight increased was found in *L** value of beef patties after 6 days of storage and no significant differences were found after 12 and 15 days of storage at 4°C. From the same table, it can be found that fresh control sample had the higher *a** value and no significant differences were between other formulated burger. These results are consistent with Scapin *et al.* (2015) they reported that there was significant difference ($p < 0.05$) between the control and the other treatments; the control showed higher results. During cold storage, *a** value were significantly decreased in all burger samples. These results are agreed with Mokhtar *et al*. (2014). However, addition of 1 and 3% chia seeds significantly improved the color stability and retention of red color in camel burger during cold storage for 12 days at 4°C.

The *b** values of control and formulated burger during cold storage were presented in Table 3. Fresh control sample had the higher *b** value followed by burger formulated with 5% chia seeds. No significant differences were found between camel burger formulated with 1 and 3% chia seeds. During cold storage significant increase were found in all camel burger samples.

Results of *C** value of camel burger indicated that fresh control burger had the higher *C** value and no significant differences were found in camel burger formulated with different levels of chia seeds. Also, it can be found that all burger samples trend to decrease as the time of cold storage increased. The *h** values of camel burger were significantly increased as the time of cold storage increased. Scapin *et al.*, (2015) found that on the 1st, 7th and 28th days of storage there was significant difference ($p < 0.05$) between control and the other treatments, where the control samples showed higher results than the other treatments.

Microbiological analysis

Total bacterial count and psychrotrophic bacteria of camel burger formulated with different levels of chia seeds were shown in Table 4. No significant differences were found in total bacterial count of fresh control and formulated burger. Total bacterial count of all burger samples slightly decreased during 6 days of cold storage whereas after day 6 there was gradual increase in all burger samples. No significant differences were found in total bacterial count between control and treated samples during 6 days of storage but significant decrease was found in burgers formulated with chia during 9 and 12 days of storage.

Table.1 pH value of camel burger formulated with different levels of chia seeds during storage at 4°C for 12 days

Treatments	Storage periods (days)					
	0	3	6	9	12	SEM
	pH					
Control	5.48±0.39^{Ab}	5.79±0.04^{Aa}	5.53±0.02^{Ab}	5.58±0.04^{Aab}	5.47±0.08^{Ab}	0.06
1% Chia seeds	5.45±0.22^{Aa}	5.68±0.12^{Aa}	5.58±0.04^{Aa}	5.61±0.01^{Aa}	5.60±0.04^{Aa}	0.06
3% Chia seeds	5.60±0.01^{Aa}	5.74±0.02^{Aa}	5.56±0.04^{Aa}	5.60±0.05^{Aa}	5.57±0.08^{Aa}	0.06
5% Chia seeds	5.62±0.05^{Aab}	5.80±0.04^{Aa}	5.50±0.02^{Ab}	5.54±0.03^{Ab}	5.41±0.03^{Ab}	0.06

$^{a-b}$ means within the same row with different superscripts letters are different ($p<0.05$).
^{A} means within the same column with different superscripts letters are different ($p<0.05$).
Means ± standard deviation. SEM: standard error of means.

Table.2 TBA value of camel burger formulated with different levels of chia seeds during storage at 4°C for 12 days

Treatments	Storage periods (days)				
	0	3	6	9	12
	T.B.A value (mgMDA/kg)				
Control	0.38±0.008^{Bd}	0.50±0.001^{Ac}	1.12±0.005^{Ab}	1.15±0.007^{Ab}	1.19±0.01^{Aa}
1% Chia seeds	0.15±0.003^{Ce}	0.23±0.001^{Bd}	0.50±0.004^{Bc}	0.88±0.001^{Bb}	0.95±0.001^{Ba}
3% Chia seeds	0.15±0.001^{Cd}	0.17±0.001^{Cd}	0.33±0.003^{Cc}	0.80±0.003^{Bb}	0.90±0.002^{BCa}
5% Chia seeds	0.60±0.005^{Ab}	0.17±0.001^{Cd}	0.31±0.001^{Cc}	0.66±0.005^{Cb}	0.87±0.11^{Ca}
SEM	0.01	0.01	0.01	0.01	0.01

$^{a-e}$ means within the same row with different superscripts letters are different ($p<0.05$).
$^{A-C}$ means within the same column with different superscripts letters are different ($p<0.05$).
Means ± standard deviation. SEM: standard error of means.

Table.3 Color measurements of camel burger formulated with different levels of chia seeds during storage at 4°C for 12 days

Treatments	Storage periods (days)					
	0	3	6	9	12	SEM
	*L**					
Control	36.69±0.21^{Ab}	36.52±0.13^{Ab}	38.32±1.02^{Aa}	37.17±0.28^{Aab}	37.94±0.12^{Aa}	0.23
1%Chia seeds	30.31±0.06^{Bb}	30.31±0.03^{Bb}	33.47±1.24^{Ba}	30.86±0.25^{Bb}	30.82±0.14^{Bb}	0.23
3% Chia seeds	30.85±0.18^{Ba}	30.43±0.12^{Ba}	30.02±0.47^{Db}	30.56±0.11^{Ba}	30.95±0.09^{Ba}	0.23
5% Chia seeds	31.08±0.15^{Bb}	31.19±0.15^{Bb}	32.40±0.18^{Ca}	31.09±0.07^{Bb}	30.67±0.05^{Bb}	0.23
	*a**					
Control	15.57±0.10^{Aa}	14.30±0.06^{Ab}	9.97±1.13^{Ad}	12.07±0.10^{Ac}	7.13±0.06^{Ae}	0.20
1% Chia seeds	11.17±0.04^{Ba}	10.75±0.11^{Ba}	9.13±0.93^{ABb}	8.52±0.21^{Bb}	5.97±0.07^{Bc}	0.20
3% Chia seeds	11.64±0.08^{Ba}	10.20±0.19^{Bb}	8.42±0.04^{Bc}	8.03±0.13^{Bc}	6.03±0.02^{Bd}	0.20
5% Chia seeds	10.99±0.15^{Ba}	8.61±0.09^{Cb}	7.68±0.20^{Bc}	6.26±0.06^{Cd}	5.13±0.02^{Ce}	0.20
	*b**					
Control	8.78±0.04^{Ac}	9.81±0.03^{Aa}	7.93±0.55^{Ad}	9.46±0.09^{Aab}	9.97±0.05^{Aa}	0.10
1% Chia seeds	5.15±0.02^{Cd}	5.75±0.06^{Cc}	6.82±0.47^{Ba}	5.95±0.07^{Cc}	6.26±0.01^{Bab}	0.10
3% Chia seeds	5.77±0.06^{Cb}	6.41±0.03^{Ba}	5.66±0.21^{Cb}	6.19±0.05^{BCa}	6.22±0.05^{Ba}	0.10
5% Chia seeds	6.07±0.02^{Bb}	6.15±0.08^{Bb}	6.57±0.08^{Ba}	6.46±0.02^{Bb}	6.21±0.01^{Bb}	0.10
	*C**					
Control	17.88±0.10^{Aa}	17.35±0.06^{Aa}	13.51±1.10^{Ac}	15.34±0.14^{Ab}	12.26±0.08^{Ad}	0.21
1% Chia seeds	12.30±0.04^{Ba}	12.19±0.13^{Ba}	11.40±1.01^{Bb}	10.39±0.21^{Bc}	8.64±0.06^{Bd}	0.21
3% Chia seeds	12.99±0.10^{Ba}	12.05±0.17^{Bb}	10.14±0.11^{Cc}	10.14±0.13^{Bc}	8.66±0.05^{Bd}	0.21
5% Chia seeds	12.56±0.13^{Ba}	10.59±0.12^{Cb}	9.95±0.46^{Cb}	8.99±0.05^{Cbc}	8.05±0.01^{Bc}	0.21
	*h**					
Control	29.43±0.12^{Ad}	34.52±0.10^{Ac}	37.75±0.87^{Bb}	38.09±0.02^{Bb}	54.40±0.07^{Aa}	0.28
1% Chia seeds	24.77±0.07^{Ce}	28.15±0.11^{Cd}	36.85±1.39^{Bb}	34.95±0.51^{Cc}	46.33±0.28^{Ca}	0.28
3% Chia seeds	26.39±0.08^{Be}	32.15±0.39^{Bd}	33.91±1.08^{Cc}	37.59±0.32^{Bb}	45.88±0.23^{Ca}	0.28
5% Chia seeds	28.92±0.29^{Ae}	35.55±0.15^{Ad}	40.53±0.41^{Ac}	45.91±0.21^{Ab}	50.43±0.17^{Ba}	0.28

$^{a-e}$ means within the same row with different superscripts letters are different ($p<0.05$). $^{A-C}$ means within the same column with different superscripts letters are different ($p<0.05$). Means ± standard deviation. SEM: standard error of means.

Table.4 Total bacterial count and psychrotrophic bacteria count of camel burger formulated with different levels of chia seeds during storage at 4°C for 12 days

Treatments	Storage periods (days)					
	0	3	6	9	12	SEM
	Total bacterial count (Log CFU/g)					
Control	6.11±0.07^{Ab}	6.41±0.05^{Ab}	5.54±0.20^{Ab}	7.84±0.06^{Aa}	7.91±0.01^{Aa}	0.33
1% Chia seeds	6.30±0.09^{Ab}	6.25±0.05^{Ab}	5.70±0.04^{Ab}	6.56±0.01^{Bb}	7.74±0.09^{Ba}	0.33
3% Chia seeds	6.67±0.11^{Aa}	6.88±0.07^{Aa}	5.57±0.18^{Aa}	6.17±0.06^{Ba}	6.47±0.07^{Ca}	0.33
5% Chia seeds	6.67±0.19^{Ab}	6.82±0.14^{Ab}	6.14±0.06^{Ab}	6.56±0.19^{Bb}	7.67±0.19^{Ba}	0.33
	Psychrotrophic bacteria (Log CFU/g)					
Control	6.44±0.06^{Ac}	4.96 ±0.24^{Ad}	5.34±0.06^{Acd}	7.39±0.09^{Aa}	7.14±0.09^{Ab}	0. 93
1% Chia seeds	6.30±0.04^{Ab}	3.90±0.05^{Ab}	5.15±0.03^{Ab}	6.42±0.12^{Cb}	7.13±0.13^{Aa}	0. 93
3% Chia seeds	6.32±0.08^{Aa}	4.59±0.11^{Ab}	5.95±0.03^{Aa}	6.40±0.05^{Ca}	6.62±0.06^{Ba}	0. 93
5% Chia seeds	6.71±0.01^{Aa}	4.78±0.04^{Ac}	5.90±0.02^{Ac}	6.91±0.05^{Ba}	6.16±0.15^{Bb}	0. 93

$^{a-c}$ means within the same row with different superscripts letters are different ($p<0.05$).
$^{A-C}$ means within the same column with different superscripts letters are different ($p<0.05$).
Means ± standard deviation. SEM: standard error of means.

Table.5 Sensory evaluation of camel burger formulated with different levels of chia seeds

Treatments	Appearance	Texture	Juiciness	Flavor	Tenderness	Overall acceptability
Control	7.5±0.52^{bc}	7.53±0.52^{cb}	7.26±0.46^{c}	7.80±0.41^{b}	7.26±0.46^{c}	7.40±0.51^{bc}
1% Chia seeds	7.8±0.74^{b}	7.86±0.35^{b}	7.86±0.74^{b}	7.86±0.35^{b}	7.66±0.49^{b}	7.73±0.46^{b}
3% Chia seeds	8.90±0.21^{a}	8.93±0.18^{a}	9.00±0.04^{a}	8.95±0.11^{a}	8.80±0.19^{a}	9.00±0.53^{a}
5% Chia seeds	7.33±0.49^{c}	6.80±0.56^{d}	7.00±0.53^{c}	6.80±0.41^{c}	8.00±0.85^{b}	7.06±0.80^{c}
SEM	0.13	0.10	0.11	0.08	0.13	0.13

$^{a-c}$ means within the same column with different superscripts letters are different ($p<0.05$).
Means ± standard deviation. SEM: standard error of means.

These results are coincided with Scapin *et al.*, (2015) they reported that no significant difference was found in control or treated pork sausage with chia seeds extract on 1st and 14th of cold storage at 4°C.

Also, Ibrahim *et al.*,(2010) reported that remarkable increase was found in aerobic plate count throughout cold storage especially in control patties at 6 and 9th days.

In general, significant decrease was found for all treated patty compare with control sample during storage period (3-9 days).

No significant differences were found in psychrotrophic bacteria of camel burger samples at zero time. All camel burger significantly decreased after 3 and 6 days of storage and increased again during 9 and 12days of storage period. However, burger formulated with 3 and 5% of chia seeds showed lower count of psychrotrophic bacteria compared with control samples. These results disagree with Scapin *et al.*, (2015) they reported that the psychrotrophic count varied between control and treated pork sausage with chia extract over all the period of cold storage. Also, they found that on the

7th and 28th days of storage sausage treated with highest concentration of chia 2% had the higher count of psychrotrophic bacteria than the other samples. Maqsood *et al.,* (2015) reported that natural phenolic compounds had significant effect on microbial quality of ground camel meat during refrigerator storage for 9 days. Among all the samples, control had higher psychrophilic bacterial count, followed by samples treated with natural phenolic compounds at day 9 of storage.

Sensory evaluation

Sensory evaluation of camel burger formulated with different levels of chia seeds are shown in Table 5. As can be seen camel burger formulated with 3% chia seeds recorded higher score in sensory attributes compared with control burger. Also, it can be found that burger formulated with 5% chia seeds showed lower score for all sensory attributes. No significant differences were found between control and burger formulated with 1% chia seeds. These results are close to that obtained by Scapin *et al.,* (2015) they found that there was no significant difference sensory attributes between the control sausage and the sausage with added extract of chia seed. In general terms, the pork sausages containing 2% chia seed extract showed the best results compared to the other concentrations.

The results of the current study indicated that addition of chia seeds in the formulation of camel burger significantly decreased the lipid oxidation during cold storage. However, addition of 1 and 3% chia seeds significantly improved the color stability and retention of red color in camel burger during cold storage for 12 days at 4°C. Camel burger formulated with 3% chia seeds recorded higher score in sensory attributes compared with control burger. Camel burger "camburger" formulated with chia seeds can be recommended as healthier low fat meat products.

Further studies on the effects of adding chia seeds on the quality characteristics of meat products are suggested.

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