Effect of flaxseeds addition on the nutritional value of sausage made of camel meat

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Abstract

The present study aimed to investigate the effect of addition flaxseeds on the nutritional value of camel meat sausage at the ratio of 0 (control), 10, 20 and 30%. The chemical composition of both raw materials and the product were estimated using standard methods. Antioxidant activity in sausages were valuated by estimating the number of peroxide value and Thiobarbituricacid value. Also, microbiological analysis and sensory changes in sausage at zero time and during freezing period at -18°C for three and six months were estimated.

The results showed that flaxseeds are rich in fat, protein, crude fiber and elements such as calcium, iron, magnesium, phosphorus, potassium and zinc. The number of peroxide was apparent from the results that PV (mill. Equiv. /kg lipids) was ranged from 5.04±0.04 to 5.32±0.41 at zero time. The highest value of PV was noticed in control samples and the lowest value was found in prepared formula (4). During freezing and frozen storage, TBA values of prepared camel meat sausages were decreased from 1.17±0.03 to 1.11±0.07 malonaldehyde /kg meat at zero time till reached between 0.91±0.09 and 93±0.07 at the end of storage. Control sample recorded the highest number, meanwhile formula (4) had the lowest number spore forming bacteria was slightly decreased as the level of dried flaxseeds powder increased. Results revealed that total fungi and yeasts ranged from 2

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x 10^2 to 2.4 x 10^3 cell/g after processing. Total fungi and yeasts were slightly decreased.

The study recommends that flaxseeds can be used up to 30% in sausage manufacturing and was nutritionally and microbiologically valid for up to six months.

Key words: Flaxseed, Nutritional value, Camel meat, Chemical analysis, Peroxide Value, Microbiological analysis, Organoleptic test.

Introduction

Generally, meat and meat products have a good sources of high biological value proteins, fat-soluble vitamins, minerals, trace elements and bioactive compounds. Life style and socioeconomic factors changes in recent years have increased the consumer's preference for ready to eat foods including meat products. The processing of meat and meat products leads to generation of many functional compounds beneficial to human health but most of those foods are rich in fat, added salts but deficient in complex carbohydrates like dietary fiber and pose a health hazard that somehow is proved to be a predisposing factor for cardiovascular diseases, colon cancer, obesity including diabetes mellitus **(Verma and Banerjee, 2010; Biswas, et al., 2011 and Mehta, et al., 2015).**

Kimassoum et al., (2016) reported that world production of camel meat has been regularly increasing, mainly in the Central African subregion doubling during the past two decades, it is also presents high protein content. The amino acid and mineral contents of camel meat are often higher than beef **(Kadim et al., 2008)**.

The same author stated that camel meat is rich in many essential amino acids, minerals, vitamins, bioactives compounds such as carnosine, anserine, glutathione and essential fatty acids such as omega 3 fatty acids. In addition it is more beneficial for health because the meat contains lower fat and cholesterol levels than other red meats. Camel meat is also relatively high in polyunsaturated fatty acid (PUFA) in comparison to other red meat which contributes to its health promoting benefits. Consumption of camel meat can lead to a reduction in total fat and cholesterol intake and an increase in PUFA as compared with other conventional

meat sources **(Gheisari and Ranjbar, 2013 and Kadim, et al., 2014)**. Meat in general is considered a functional food for cures of many elments and for improved performance in many cultures around the world. Camel meat has been processed into burgers, patties, sausages and shawarma to add value. The nutritional value of camel meat is similar to other red meats (**Kadim et al., 2008).**

Xu, et al., (2008) studied that flaxseeds proteins exhibit antifungal properties against *Alternariasolani, Candida albicans*and *Aspergillus flavus* Flaxseeds has an amino acid profile comparable to that of soybean **(Oomah, 2001; Hongzhi, et al., 2004**).

Hall, et al., (2006) found that the protein content of flaxseeds varies from 20 to 30 %, constituting approximately 80% globulins (linin and conlinin) and 20 % glutelin. **Chung, et al., (2005) and Singh, et al., (2011)** showed that flaxseeds protein is rich in arginine, aspartic acid, glutamic acid, methionine, arginine, cysteine and aspartic acid, with low amounts of lysine, threonine and tyrosine, High cysteine and methionine contents improve the antioxidant levels , thus helps in reducing risk of cancer **(Oomah, 2001 ;Rabetafika, et al., 2011 ; Kajla, 2015**).

Oomah and Mazza, (1997) found that flaxseeds oil content of ranges from 38 to 44%.**Schmitz and Ecker, (2008)** reported that flax is naturally high in polyunsaturated fatty acids (PUFA), Alpha-linolenic acid (ALA) and linoleic acid (LA) are the essential fatty acids**. Morris, (2007)** found that flaxseeds contains very low level of carbohydrates (1 g/100 g) and thus contributing very little to total carbohydrates intake.

Flaxseeds are emerging as an important functional food ingredient because of its rich contents of α-linolenic acid (ALA, omega-3 fatty acid), lingans **(Singh, et al, 2011)**. Flaxseeds oil, fibers and flax lingans have potential health benefits such as in reduction of cardiovascular disease, atherosclerosis, diabetes, cancer, arthritis, osteoporosis, autoimmune and neurological disorders. Flax protein helps in the prevention and treatment of heart disease and in supporting the immune system. As a functional food ingredient, flax or flaxseeds oil has been incorporated into baked foods, juices, milk and dairy products, muffins, dry pasta

products, macaroni and meat products. **(Ankit, et al,.2014).** Flaxseeds are a promising candidate to cater for sustainable protein sources **(Marambe, and Wanasundara,. 2017).**

MATERIALS AND METHODS

Materials:

Flax Seeds were obtained from Agriculture Research Center in Giza Governorate, Egypt. Minced camel meat, fat, salt, onion, garlic, spices and cardamom were obtained from local market in Qalyubia Governorate. Chemicals were obtained from Alpha Chemicals.

Methods

Preparation of flax seeds powder:-

Flax seeds were cleaned from impurities and were dried in solar energy unit in the National Central Research, Dokki, Egypt. Then ground into fine power in an electrical grinder very well and packed in polyethylene bags and kept in the refrigerator at - 18 °C.

Preparation of camel sausages :

Sausage was prepared by mixing minced camel meat with the other ingredients according to the method described by **Azizkhani and Tooryan,. (2014).** Four formulae of sausage were prepared with replace camel meat with flaxseeds powder at ratio (0, 10, 20 and 30%) as showing in table (1).

Table (1) : the percentage of food materials used in prepared camel sausages (g/100g on fresh weight basis).

Formulae / Ingredients(%)	1	2	3	4
Minced camel meat	70	60	50	40
Minced camel fat	10.00	10.00	10.00	10.00
Flaxseed powder	0.00	10.00	20.00	30.00
Chopped raw onion	3.00	3.00	3.00	3.00
Minced raw garlic	3.00	3.00	3.00	3.00
Sodium chloride	2.00	2.00	2.00	2.00
Spices mixture	2.00	2.00	2.00	2.00
Cooled water	10.00	10.00	10.00	10.00

Chemical analysis:

Moisture, protein, fat, fiber and ash were determined according to the method described by **AOAC, (2005).**And carbohydrates were calculated by difference. % Total Carbohydrates = 100 - % [Protein + Fat + Ash + Fibers]. Results calculated as g/ 100g on dry weight basis). Approximate value of the materials were calculated using the appropriate factor as described by **FAO/WHO, (1985)** as following equation: Energy value (Kcal) = [(carbohydrates × 4.0) + (fat × 9.0) + (protein × 4.0)].

Determination of Minerals:

Potassium (K), sodium (Na), magnesium (Mg), iron (Fe) zinc (Zn) were determined in flaxseeds according to the method described by **AOAC, (2005)** using Atomic Absorption in Agricultural Center Research, Giza, Cairo, Egypt.

Determination of peroxide value (PV) :

Peroxide value (PV) of samples was determined according to method described by **AOAC, (2005)**.

Thiobarbituric acid value (TBA) :

The TBA values of samples were determined as outlined in the **AOCS, (1998)**. The TBA value calculated as mg malonaldehyde/Kg sample.

Determination of pH:

The pH value of camel Sausage formulae were determined immediately after preparation of the samples. The pH value was measured by digital pH-meter (HM-5 S; TOA Electric Industrial Co. Ltd., Tokyo, Japan).

Microbiological Analysis :

Total bacterial count, total psychrophilic count, spore forming bacteria and fungi and yeasts count of the prepared camel Sausage was determined according to **ICMSF, (1978).**

Organoleptic tests:

Organoleptic evaluation i.e. color, odor, texture, taste and overall acceptability of both Sausage formulae and minced cooked meat by using dried flax seeds were evaluated by the panelists of the stuff members of Department of Home Economics, Faculty of Specific Education, Benha

University after cooking. According to the method described by **Watts, et al., (1989)**.

Statistical analysis:

Statistical calculations were carried out by SPSS version 10.0 software **(SPSS, 1998).**

Results

Data showed in table (2) illustrates the chemical composition of raw camel meat. The obtained results showed that moisture content was 71.80%, protein 18.05 %, fat 7.36 %, ash 1.73 % and carbohydrates 0.79 %.These results are confirmed by **Mohamed, (1998)** who reported that moisture content of camel meat 77.80%, protein 18.45%, fat 2.80% and ash 0.95%, respectively**.** And**, Fakhre El-Din, (2006)** found that moisture 72.07 %, protein 18.51 %, fat 7.40 %, ash 1.18 % and carbohydrates 0.84 %.

Table (2) Chemical composition of raw camel meat (W.W):

Component (%)	raw camel meat
Moisture	71.80
Total Protein	18.05
Total Fat	7.63
Total Ash	1.73
Carbohydrates	0.79

Table (3) illustrates the chemical composition of dried flaxseeds were expressed as (g/100g dry weight basis).The obtained results showed that moisture content was 3.97 %, protein 18.36 %, fat 44.42 %, crude fiber 26.90 %, ash 2.80 % and carbohydrates 3.55 %. These results are confirmed by **Morris, (2007) and DeClercq, (2012)** who found the average composition of commercial flaxseed was fat 41 %, protein 20 %, total dietary fiber 28%, moisture 7.7 %, and ash 3.4 %. The obtained results proved that dried flax seeds powder are considered as a good sources of plant protein, fat and fiber content.

Tabel (3) Chemical composition of flaxseeds (g/100 g).

Component (%)	Flaxseeds
Moisture	3.97
Protein	18.36
Oil	44.42
Crude fiber	26.90
Ash	2.80
Carbohydrates	3.55

Table (4) illustrates the amino acids contents of dried flaxseeds powder as **g/100g** protein. Generally flaxseeds are rich in amino acids such as Glutamic acid was a high content (4.04 %) flowed by Aspartic acid (2.04 %). These results correspond to the results mentioned by **Rabetafika, et al., (2011), Bernacchia, et al., (2014) and Kajla, et al., (2015).**Flaxseeds protein is rich in aspartic acid, glutamic acid, arginine, Glycine and leucine, while tryptophan is limiting. **Hall, et al., (2006)** studied that the protein content of flaxseeds varies from 20 to 30 %, constituting approximately 80% globulins (linin and conlinin) and 20 % gluten.

Table (4) Amino acid profile of flaxseeds (g/100 g protein)

Amino acid	Flaxseeds
Glutamic acid	4.04
Aspartic acid	2.04
Arginine	1.89
Glycine	1.25
Leucine	1.22
Valine	1.07
Serine	0.97
Phenylalanine	0.95
Alanine	0.92
Isoleucine	0.88
Lysine	0.85
Proline	0.79
Threonine	0.76
Tyrosine	0.49
Histidine	0.46

Cystine	0.34
Methionine	0.36
Tryptophan	0.29

Table (5) showed that, the minerals contents of dried flax seeds powder (mg/100g on dry weight basis). Results indicated that dried flax-seeds powder contained Ca, K, Mg, P, Fe and Zn (253, 812, 387, 646, 5.70 and 4.32 mg/100g on dry weight basis), respectively. These results were in accordance with those mentioned by **Carter, (1993)**who found that flaxseeds serves as a good source of minerals especially, phospho-rous (650 mg/100 g), magnesium (350–431 mg/100 g), calcium (236–250 mg/100 g) and has very low amount of sodium (27 mg/100 g). And, **Morris, (2007)** who showed that it contains highest amount of potassium 560–920 mg/100g among various foods.

Table (5): Minerals of dried flax seeds powder (mg/100 g)

Element (mg/100 g)	Flaxseeds
K	812
P	646
Mg	387
Ca	253
Zn	4.32
Fe	5.7

Chemical composition of prepared camel sausages supplemented with different ratio of dried flaxseeds powder in either at zero time was shown in table (6) Chemical composition was calculated as g/100g on dry mat-ter. Results showed that prepared camel sausages contained moisture ranged from 50.52±0.51 % to 61.64±0.04 %. Formula (1) showed the highest value of moisture and the lowest value was found in formula (4). Statistical analysis of the data showed that there were a high significantly differences ($P \leq 0.05$) between formulae among treatments during frozen storage period.

It is obvious from the same table that, protein content of all formu-lae was ranged between 17.81±0.13 % and 18.72±0.08 %. The highest

value of protein was found in formula (4), followed by formula (3) and (2), but formula (1) was the lowest value of protein content. The higher value of protein in prepared formulae by using dried flaxseeds powder may be due to the higher value of protein in flaxseeds as shown in the previously results. Statistical analysis of the data showed that there were a significantly differences ($P \leq 0.05$) of formulae (1 and 4), but there was no significantly differences ($P \leq 0.05$) of formula (2 and 3).

It was evident from results that oil content of prepared camel sausages ranged from 13.45±0.21 % to 18.16±0.18 %. The highest value was found in formula (3) and the lowest value was noticed in formula (1). These results were due to high oil content in flaxseeds as mentioned in the previously results. Statistical analysis of the data showed that there were a significant difference ($P \leq 0.05$) of formulae (1and 2), but there was no significantly differences ($P \leq 0.05$) of formula (3 and 4).

Results also showed that cured fiber content of prepared camel sausages formulae ranged from 1.29±0.05 % to 4.98±0.05 %. The highest value of fiber content was noticed in formula (4) and the lowest value was found in formula (1). Statistical analysis of the data showed that there were a significantly differences ($P \leq 0.05$) between formulae.

It was obvious from the same table that, ash content of all formulae was ranged between 1.54±0.05 % and 1.86±0.05 %. The highest value of ash was found in formula (4) followed by formula (3) and (2), but formula (1) was the lowest value of ash content. Statistical analysis of the data showed that there were a significantly differences ($P \leq 0.05$) of formulae.

Recorded the highest value of carbohydrates in formula (4): 5.74±0.04 % while the lowest value was in formula (1) 3.99±0.36 %. Statistical analysis of the data showed that there were a significantly differences ($P \leq 0.05$) of formulae.

It was evident from results that energy content of prepared camel sausages formulae ranged from 208±3.85 % to 261±2.13 %. The highest value was found in formula (4) and the lowest value was noticed in formula (1). Statistical analysis of the data showed that there were a significantly differences ($P \leq 0.05$) between formulae.

It is worthy to mention that, chemical composition of prepared camel sausages formulae was in the permissible limits according to recommendation of **Egyptian Standard Specifications (ESS), (1991).**

Table (6): Chemical composition of prepared sausages formulae supplemented with different levels of dried flaxseeds powder.

Component(%)	Control	10%	20%	30%
Moisture	61.64^{a}±0.04	58.28^{b}±0.01	52.32^{c}±0.07	50.52^{d}±0.51
Protein	17.81^{c}±0.13	18.17^{b}±0.02	18.32^{b}±0.02	18.72^{a}±0.08
Oil	13.45^{c}±0.21	15.72^{b}±0.29	17.77^{a}±0.34	18.16^{a}±0.18
Crude fiber	1.29^{b}±0.05	2.01^{b}±0.01	4.73^{a} ±.70	4.98^{a}±0.05
Ash	1.54^{c}±0.05	1.60^{c}±0.02	1.75^{b}±0.07	1.86^{a}±0.05
Carbohydrates	3.99^{c}±0.36	4.21^{c}±0.01	5.34^{b}±0.06	5.74^{a}±0.04
Energy	208^{d}±3.85	231^{c}±3.46	254^{b}±4.10	261^{a}±2.13

Peroxide value:

Peroxide value (PV) was determinate in camel sausages samples supplemented with dried flaxseeds powder during subsequent freezing storage at -18^{o}C for 6 months are shown in table (7). The peroxide value is a parameter of lipid oxidation; it is used for the evaluation of the fat quality. A high PV is an index of undesirable changes in the fats. It is apparent from the results that PV (mill. Equiv. /kg lipids) was ranged from 5.04±0.04 to 5.32±0.41 at zero time. The highest value of PV was noticed in control samples and the lowest value was found in prepared formula (4). It is interesting to note that PV reduced parallel with increasing the replacement rate of dried flaxseeds powder. This decreasing of PV is mainly due to that flaxseeds powder has an antioxidant properties because it delays the oxidation process. In the end, it could be concluded that PV of all camel sausages formulae which contained dried flaxseeds

powder had a lowest values at zero time or during frozen storage. This may be due to flaxseeds powder which have an antioxidant property. Statistical analysis of the data showed that there were no significant difference ($P \leq 0.05$). But there were a significant difference ($P \leq 0.05$) at zero time and during storage period.

Table (7): Peroxide value (PV) of prepared camel sausage formulae supplemented with different levels of dried flaxseeds powder at zero time and during frozen storage period (mille equiv. /kg fat).

Formulae	Zero time	Three months	Six months
Control	$5.32^{a}\pm0.41$	$5.05^{a}\pm0.05$	$5.04^{a}\pm0.04$
10%	$4.63^{b}\pm0.07$	$4.60^{b}\pm0.07$	$4.59^{b}\pm0.07$
20%	$4.35^{c}\pm0.05$	$4.31^{c}\pm0.08$	$4.27^{c}\pm0.07$
30%	$4.01^{d}\pm0.07$	$4.00^{d}\pm0.08$	$4.37^{d}\pm0.07$

Thioparbituric acid value:

Thioparbituric acid of prepared camel sausages samples at zero time and during freezing storage at -18^{o}C for three and six months was illustrated in table (8).

The TBA values were reduced parallel with increasing the levels of dried flaxseeds powder. This improving of fat TBA is mainly due to that flaxseeds powder has an antioxidant effects during freezing and frozen storage, adding of flaxseeds powder to sausages formula caused decrease in TBA as compared to control formula. The results had decrease from 1.17±0.03 to 0.91±0.09 in zero time. While, the decreasing in TBA was 1.11±0.07 to 0.93±0.07 after six months storage period. Statistical analysis of the data showed that there were no significant difference ($P \leq 0.05$) of formula (1) at zero time and during storage period. But, there were a significantly differences ($P \leq 0.05$) between samples. Camel meat showed the higher TBARS than cattle and chicken and the values increased with an increase in storage time **Gheisari, (2011)**. Also, **Maqsood and Benjakul, (2011)** reported that camel meat is known to

contain high amount of myoglobin and other hem compounds which function as pro-oxidants to promote lipid oxidation. Therefore, the presence of high amount of PUFA and pro- oxidants likehem pigment (myoglobin and hemoglobin) makes camel meat highly prone to lipid oxidation. It could be concluded that TBA values were decreased as the addition of dried flaxseeds powder increased in either after processing or during frozen storage, but did not reached to the permissible limit according to **Egyptian Standard Specifications (ESS), (1991)** for frozen minced meat and their products not exceed than 0.9 mg malonaldehyde /kg meat.

Table (8): Thioparbituric acid value (TBA) of prepared camel sausages formulae supplemented with different levels of dried flaxseeds powder at zero time and during frozen storage period(malonaldehyde /kg)

Concentrations	zero time	Three months	Six months
Control	1.17^{a}±0.03	1.16^{a}±0.03	1.11^{a}±0.07
10%	0.99^{b}±0.09	0.99^{b}±0.07	1.01^{a}±0.11
20%	0.96^{b}±0.09	0.92^{b}±0.07	0.96^{a}±0.08
30%	0.91^{b}±0.09	0.88^{b}±0.08	0.93^{a}±0.07

PH value:

PH values of prepared camel sausages formulae supplemented with dried flaxseeds powder at zero time and during frozen storage at -18^{o}C for three months and six months were illustrated in table (9). PH values of all prepared camel sausages formulae were ranged from 5.40±0.48 to 5.61±0.13 at zero time. During frozen storage, PH value of all prepared formulae increased till reached 5.50±0.31 to 5.72±0.25at the end of storage period. Statistical analysis of PH-Values of all sausages formulae indicated that there were no significantly differences ($p \leq 0.05$) in either at zero time or during frozen storage period for six months. Such results are in accordance with those mentioned by **Kadim, et al., (2006)** who found that the ultimate pH of camel meat ranges between 5.5 and 6.6. Camels younger than three years had greater pH than camels older than

six years. **McCarthey, et al. (2001)** showed that the increasing in PH might be due to the accumulation of metabolites by bacterial action in meat and denaturation of protein.

Table (9): pH value of prepared camel Sausage formula supplemented with different levels of flaxseeds powder at zero time and during frozen storage at -18°C for three months and six months.

Formulae	Zero Time	Three Months	Six Months
Control	$5.40^{a}\pm0.48$	$5.43^{a}\pm0.62$	$5.50^{a}\pm0.31$
10%	$5.42^{a}\pm0.42$	$5.49^{a}\pm0.10$	$5.54^{a}\pm0.44$
20%	$5.51^{a}\pm0.12$	$5.52^{a}\pm0.13$	$5.60^{a}\pm0.12$
30%	$5.61^{a}\pm0.13$	$5.63^{a}\pm0.49$	$5.72^{a}\pm0.25$

Microbiological evaluation of prepared camel sausages formulae:

Table (10) illustrated that total bacterial counts of sausages formulae supplemented with flaxseeds powder at zero time and during freezing at -18°C for zero, 3 and 6 months. Results indicated that, total bacterial counts of camel sausages ranged from 5×10^4 to8×10^5cfu/g. The results indicated that the formula (4) which supplemented with 30% flaxseeds had the lowest number of total bacterial as compared to control which had the largest number of total bacterial: It is worthy to mention that these microbial populations were slightly decreased with the increment of flaxseeds powder level during preparation of sausages. This decrease of microbial load may be due to the reduction of moisture content in sausages samples by increasing flaxseeds powder. In addition to, sausages containing flaxseeds powder had considerably lower bacterial counts than control sausages. These results due to that water activity (wa) of flaxseeds powder. During frozen storage, total bacterial counts of all prepared sausages formulae were decreased gradually as the prolonged of storage time. Total bacterial counts of all samples ranged from 8×10^4 to 5×10^5cfu/g at zero time and its decreased gradually as the prolonged of

storage time till reached between 8 x 10^3 and 5 x 10^4after six months. However, the high ratio of flaxseeds powder caused a low number of bacteria. This trend of results was in accordance with those found by **El-Gazar, (1997).** This decrease in microbial load might be due to drastic condition of freezing and frozen storage. The reduction of total bacterial counts during freezing and frozen storage could be due to mechanical effect on ice crystal formation of cell proteins in microorganisms resulting from freezing. Also, this decrease may be due to that dried flaxseeds powder has an antioxidant and antibacterial effect. Freezing process of beef patties caused a slight decrease in aerobic bacteria after 6 months as reported by **Berry, (1990)**. It is worthy to mentioned that all camel sausages were in the permissible limits according to the Egyptian standard Specifications **Egyptian Standard Specification (ESS), No .1972, (1991)** which reported that total bacterial counts should not exceed than 10^6cfu/g.

Psychrophilic bacterial counts of camel sausages were illustrated in table (10). Generally, the results showed increasing of psychrophilic bacteria in sausage samples during storage period. It is obvious from the data that, total psychrophilic bacteria ranged from 1.8 x 10^1 to 5.9 x 10^1cells /g at zero time. While formula (4) recorded the lowest number of psychrophilic bacteria. Meanwhile control sample had the highest number. It is worthy to mention that the number of total psychrophilic bacteria was slightly decreased as the percentage of flaxseeds powder increased. This decrease of bacteria may be due to the reduction of moisture in camel sausages as shown in table (6) with increment of percentage dried flax seeds powder. Also, formulae containing flaxseeds powder had considerably lower psychrophilic bacterial counts than control. This result may be due to that water activity (wa) of flaxseeds powder which caused to decrease in moisture as shown in the previously results. During subsequent frozen storage period, total psychrophilic bacterial counts of all samples were slightly increased upon storage period. Control sample increased from 5.9 x 10^1 to 6.0 x 10^2 cell /g.

El-Adl, (1995) reported that Psychrophilic bacterial counts may influence the development of total bacterial count during storage period. When psychrophilic bacteria were not detected in sausage samples, the total bacterial count was increased. It is apparent from the results that at any time of storage, total Psychrophilic counts was a low with the percentages of flaxseeds increased; adding flaxseeds powder to camel sausages caused a reduction of microbial populations. The same trend of results was in agreement with those obtained by **El-Harery, (1997).** It is worthy to mention that total Psychrophilic bacterial counts, under investigation, was lower than the permissible limits of Egyptian Standard level in either after processing or during storage period at – 18^{o}C for 6 months.

Table (10) show spore forming bacteria of prepared camel sausages supplemented with different percentages of flaxseeds powder during frozen storage at – 18^{o}C for 3 and 6 months. Results showed that the number of spore forming bacteria ranged from 1.0 $x10^{1}$ to 2.0 x 10^{1} cell/g at zero time. Control sample recorded the highest number, meanwhile formula (4) had the lowest number i.e. spore forming bacteria was slightly decreased as the level of dried flaxseeds powder increased. This decrease could be attributed to the lowering of camel sausages contamination in by increasing the addition of dried flaxseeds powder.

During freezing storage, there was a gradual decrease in spore forming bacteria of all camel sausages at any given time of storage period. This conclusion was mentioned by **Emam, (2003).**

Dave and Ghaly, (2011) noted that meat and meat products are prone to microbial spoilage during slaughtering, processing and storage because its possess an ideal nutrient matrix that can favor the proliferation of micro-organisms especially pathogenic ones. Mostly, water activity of fresh meat fall in the range of 0.85–0.98 and it's also providing an optimum pH for the growth of microorganism, so the chances of microbial contamination are evident.

Results in the same table also demonstrated that spore forming bacteria were decreased from 1.2 x $10^1$to 1.0x 10^1 cell /g in control samples at the end of storage. This decrease might be due to drastic condition of freezing process. The results are in the line with **Shady, (1999)** who found that freezing and frozen storage for 2 months of fresh meat samples caused destruction in spore forming bacteria. Also, the results were in agreement with those showed by **Russel (1996)** who noted that freezing process and frozen storage for both meat and their products which caused a reduction of microbial populations.

The changes occurring in fungi and yeasts of different prepared camel sausages by adding various levels of dried flax seeds during freezing storage period at – 18^{o}C for 3 and 6 months are tabulated in table (10). Results revealed that total fungi and yeasts ranged from 2 x 10^2 to 2.4 x 10^3 cell/g after processing. Total fungi and yeasts were slightly decreased; this decrease could be attributed to the lowering of contamination in camel sausages by increasing dried flaxseeds powder.

During freezing storage, there was a slightly decrease of total fungi and yeasts of all samples under investigated, with the increment of storage time till reached to 2 x10^2 to 2.5 x10^3cfu/g. It is worthy to mention that, the higher level of dried flaxseeds powder, the lower number of fungi and yeasts. The same conclusion was found by **Emam, (2003) and El-Bassyoni, Ghada, (2003).**

Table (10): Total bacterial counts, Psychrophilic bacteria, Spore forming bacteria and Fungi and yeasts of camel sausages and formulae supplemented with different levels of flaxseeds at zero time and during storage at -18°C for three and six months.

Samples	Zero time	Three Months	Six months
	Total bacterial counts		
Control	5×10^5	4×10^5	5×10^4
10%	4×10^5	3×10^5	3.9×10^3
20%	3×10^5	2×10^5	4.4×10^3
30%	8×10^4	7×10^4	8×10^3
	Psychrophilic bacteria		
Control	5.9×10^1	5.8×10^2	6.0×10^2
10%	3.5×10^1	3.1×10^2	3.4×10^2
20%	2.4×10^1	2.5×10^2	3.0×10^2
30%	1.8×10^1	2.3×10^2	2.0×10^2
	Spore forming bacteria		
Control	2.0×10^1	1.6×10^1	1.2×10^1
10%	1.5×10^1	1.3×10^1	1.1×10^1
20%	1.2×10^1	1.1×10^1	1.0×10^1
30%	1.0×10^1	1.0×10^1	1.0×10^1
	Fungi and yeasts		
Control	2.4×10^3	2.4×10^2	2.5×10^3
10%	2×10^3	1×10^2	1.1×10^3
20%	4×10^2	3.8×10^1	4×10^2
30%	2×10^2	2×10^1	2×10^2

Sensory properties of camel sausage formulae supplemented with different levels of dried flaxseeds powder are shown in Table (11). It was obvious from the results that Appearance of prepared camel sausage was ranged from 8.20±0.44 to 8.80±0.29, the lowest score was found in formula (1) and the highest score was found in formula (4).

The results in the same table revealed that the color score of prepared camel sausage samples was ranged from 7.70±0.60 to 8.10±0.28

the lowest score was found in formula (1) and the highest score was found in formula (2) .Statistical analysis of the data showed that there were no significant difference ($P \leq 0.05$) of color score among treatments during frozen storage period. **Abu-Salem, et al.,(2014)** showed that this reduction may due to discoloration of meat products , namely lipid oxidation outcomes between the formation of pro-oxidation successful over reacting together with oxymyoglobin, who propulsion after metmyoglobin composition, so it caused to drip loss, off-odor and of-flavor development , and the production of potentially toxic compounds

Results revealed that texture score of prepared camel sausage was highly acceptable and ranged from 7.80±0.39to8.10±0.31. Formula (2) had recorded the best results of texture score. This decrease of texture score could be due to that meat and the products becomes more and more tender due to the hydrolysis of protein and the growth of microorganisms **(Emam, 1990).** Statistical analysis of the data showed that there were no significant difference ($P \leq 0.05$) among formulae during frozen storage period.

Results showed that prepared sausage showed the higher score of taste after processing, it reached from 6.80±0.42 to 8.40±0.5. The highest score was found in formula (1) and the lowest score was in formula (3). Statistical analysis of the data showed that there were a significant difference ($P \leq 0.05$) of taste score among prepared samples during frozen storage period. It could be noticed that taste score of formula (1) and (2) samples were highly acceptable for the panelists in either at zero time or at the end of storage.

Results indicated that odor score ranged from 7.20±0.36 to 7.90±0.53 just after processing. The highest score of odor was found in formula (1) and the lowest value was found in formula (4). This decrease in odor score may be due to the increasing of TBA and peroxide value of sausage as shown in the previously results in tables. **Warries, (2000)** showed that oxidation of meat fats lead to production of disagreeable odor and flavor in cooked meat and their products**.** Statistical analysis of

the data revealed that there were no significant difference ($P \leq 0.05$) of odor score of sausage among all during frozen storage period. It could be concluded that all samples were highly acceptable in odor score at zero time or during storage period.

Results indicated that all prepared camel sausage were highly acceptable for the panelists in either after processing or during freezing and frozen storage. However, formula (2) showed the best results of overall acceptability. Statistical analysis of the data showed that there were no significant decreased ($P \leq 0.05$) of overall acceptability among formulae during frozen storage.

Finally it could be concluded that all cooked camel sausage were highly acceptable of all sensory properties, i.e. color, texture, taste, odor and overall acceptability for the panelists in either after processing or during frozen storage. However, all organoleptic evaluation properties no significantly decreased ($P \leq 0.05$) with the prolong time of storage proceeded, but all formulae recorded higher score of sensory properties and also acceptable for human consumption . In addition , Formula (2) recorded the highest value of these properties.

Table (11) Sensory properties of camel sausage formulae supplemented with different levels of dried flaxseeds.

Properties	control	10%	20%	30%
Appearance	8.20 ± 1.39^{a}	8.6 ± 1.07^{a}	8.6 ± 1.07^{a}	8.8 ± 0.92^{a}
Color	7.70 ± 1.88^{a}	8.1 ± 0.99^{a}	8.1 ± 0.88^{a}	8.1 ± 0.88^{a}
Texture	8 ± 1.33^{a}	8.1 ± 0.99^{a}	7.8 ± 1.23^{a}	7.9 ± 1.29^{a}
Taste	8.4 ± 1.57^{a}	8.1 ± 0.99^{ab}	7.5 ± 1.51^{ab}	6.8 ± 1.32^{b}
Odor	7.9 ± 1.66^{a}	7.8 ± 1.03^{a}	7.7 ± 0.82^{a}	7.2 ± 1.14^{a}
Overall acceptability	8.1 ± 1.79^{a}	8.5 ± 0.85^{a}	8.2 ± 0.92^{a}	7.7 ± 1.49^{a}

References

Abu-Salem, M.F., Mahmoud ,H.M., El-Kalyoubi ,H.M., Gibriel, A.Y and Abou-Arab, A.A. (2014): Antioxidant and antimicrobial properties of peptides as bioactive components in beef burger. Inter .j. of Biological, Food, Veterinary and Agricultural Engineering:8 (7): 312-315.

Ankit, G., Vivek, Sh., Neelam, U., Sandeep G and Manvesh S. (2014) : Flax and flaxseed oil: an ancient medicine and modern functional food J Food Sci Technol. Sep; 51(9): 1633–1653.

AOAC, (2005): Official Methods of Analysis, 19th Edition, Washington: International. D.C. Association of Official Analytical Chemists.

AOCS, (1998): Official and Atentative Methods of American Oil Chemists Society (5th ed.), AOCS 35East Vaker Drive, Chicago, Illinois, USA.

Azizkhani, M. and Tooryan, F. (2014): Antioxidant and antimicrobial activities of rosemary extract, Mint extract and a mixture of tocopherols in beef sausage during storage at 4ºC. J. Food Saf., 35(1):128-136.

Bernacchia, R.; Preti, R. and Vinci, G. (2014): Chemical composition and health benefits of flaxseed. Austin J. Nutr. Food Sci,2: 1045.

Berry, B.W. (1990) : Low-fat Level effects on sensory, shear, cooking and chemical properties of ground beef patties. J. Food Sci., 57 (3): 537-541.

Biswas, A. K., Kumar, V., Bhosle, S., Sahoo, J. and Chatli, M. K. (2011): Dietary fibers as functional ingredients in meat products and their role in human health. Int J Livest Prod, 2(4):45–54.

Carter, J. (1993): Potential of flaxseed and flaxseed oil in baked goods and other products in human nutrition. Cereal Foods World 38, 753–759.

Chung, Y.C., Bakalinsky, A and Penner, M.H. (2005): Enzymatic saccharification and fermentation of xylose-optimized dilute acid-treated lignocellulosics. *Appl Biochem Biotechnol* 121-124:947-61.

Dave, D. and Ghaly, A. E.(2011): Meat spoilage mechanisms and preservation techniques: a critical review. Am J AgriBiol Sci. 6:486–510.

DeClercq, D. R. (2012): Flaxseed quality in Canada. Available at: http://www.grainscanada.gc.ca/flax-lin/trend-tendance/qfc-qlceng.htm Accessed 20.06.13.

Egyptian Standard Specification (ESS), No. 1972, (1991): Frozen Sausage, Egyptian Organization for Standardization and Quality Control, Arah Republic of Egypt.

El-Adl, O.E. (1995) : Chemical, Physical and Technological Studies on Wheat Germ. M.Sc. Thesis, Faculty of Agriculture, Mansoura Univ., Egypt.

El-Bassyoni, Ghada, M.M. (2003): Preparation of Some Food Stuffs by Using Weath Germ M.Sc. Thesis, Faculty of Specific Education, Benha Univ Egypt.

El-Gazar, N.H. (1997): Effect of Placing Materials and Pakin condition on Shelf Life of Meat and Meat Products. M.Sc. Thesis, Faculty of Agriculture, Cairo Univ., Egypt.

El-Harery, A.S. (1997): Effect of Cardamom Oil on Chemical Microbiological and Sensory Attributes of Beef Sausage. M.Sc. Thesis, Faculty of Agriculture, Cairo Univ., Egypt.

Emam, O.A. (1990): Effect of Irradiation on some food stuffs and their products. Ph.D. Thesis, Faculty of Agriculture, Mansoura Univ., Egypt.

Emam, O.A. (2003): Quality-Properties evaluation of burgers processed from spent laying hens' meat .J. Agric .Sci. Mansoura Univ., 28(6): 4341-4352.

Fakhre El-Din Mahmoud. (2006): Utilization of Camel and Catfish Meats in Baby Food Formula. Ph. D. Thesis, Fac. of Home Economics, Minufiya Univ.

FAO/WHO, (1985): protein and energy requirements, WId. J. HLth. Org., 57: 65–79.

Gheisari, H. R. (2011): Correlation between acid, TBA, peroxide and iodine values, catalase and glutathione peroxidase activities of chicken, cattle and camel meat during refrigerated storage. Veterinary World 4, 153–157.

Gheisari, H.R., and Ranjbar, V. R. (2013): Antioxidativeand antimicrobial effects of garlic in ground came lmeat. Turkish Journal of Veterinary and Animal Sciences, 36 (1), 13–20.

Hall, C,.Tulbek, M, C. and Xu,Y . (2006): Flaxseed. Adv Food Nutr. Res., 51:1–97.

Hongzhi, Y., Zhihuai and T. Hequn. (2004): Determination and removal methods of cyanogenic glucoside in flaxseed. ASAE/CSAE meeting presentation: 04066.

ICMSF, (1978): International Commission on Microbiological Specification for Foods, Microorganisms in Food. Univ of Toronto Press. Torontoand Buffalo, Canada.

Kadim, I.T, Mahgoub, O., Al-Marzoogi, W., Al-Zadjali, S., Annamalai, K. and Mansour, M, H. (2006): Effects of age on composition and quality of muscle long issimusthoracis of the Omani Arabian camel (*Camelus dromedaries*). Meat Sci. 73:619625.

Kadim, I.T., Mahgoub, O. and Purchas, R.W. (2008): A review of the growth, and of the carcass and meat quality characteristics of the one-humped camel (*Camelus dromedaries*). *Meat Science*, 80: 555-569.

Kadim, I.T., Mahgoub, O., Al-Marzooqi, W., Khalaf, S.K. and G Raiymbek (2014): Nutritive Value, Quality and Health Aspects of the Dromedary *(Camelus dromedaries*) and Bactrian (*Camelus bacterianus)* Camel Meats: A review. SQU *Journal of Agriculture and Marine Sciences*(in press).

Kajla, P., Sharma, A. and Sood, D.R.(2014): Flaxseed—A potential functional food source. J. Food Sci. Technol., 52:1857–1871.

Kimassoum, D., Bawe, N. M., Nadjilem, D., Nji, A. M., Tidjani, A., Bughe, R. N and Mbacham, W. F. (2016): Evaluation of some nutritional and physicochemical properties of camel meat originating from Chad. African Journal of Food Science, 10(12), 368-373.

Maqsood, S andBenjakul, S. (2011): Comparative studies on molecular changes and prooxidative activity of Haemoglobin from different fish species as influenced by pH. Food Chemistry, 124: 875–883.

Marambe, H. K. and Wanasundara. J.P.D. (2017): Sustainable Protein Sources: Elsevier., 133–144.

McCarthey, T.L., Kerry, J.P., Lynch, J.F. and Buckley, P.B. (2001): Assessment of the antioxidant potential of natural food and plant extracts in fresh and previously frozen pork patties. J. Meat Sci; 57:177-184.

Mehta, N., Ahlawat, S. S., Sharma, D. P. and Dabur, R. S.(2015): Novel trends in development of dietary fiber rich meat products—a critical review .(2013) . J Food Sci Technol ., 52(2):633–647.

Mohamed, A. A. Hesham. (1998): Palatability of Camel Meat as Influenced by Different Cooking Methods. M.Sc. Thesis, Fac. of Home Economics, Minufiya Univ.

Morris, D.H. (2007): Flax: A Health and Nutrition Primer; Flax Council of Canada: Winnipeg, MB, Canada, 45.

Oomah, B. D. (2001): Flaxseed as afunctional food source .J Sci Food Agric 81(9):889–894 .

Oomah, B. D. and Mazza, G. (1997): Effect of dehulling on chemical composition and physical properties of flaxseed. LWT - Food Sc. Technol., 30 (2): 135-140.

Rabetafika, H.N.; Van Remoortel, V.; Danthine, S.; Paquot, M. and Blecker, C. (2011): Flaxseed proteins: Food uses and health benefits. Int. J. Food Sci. Technol., 46: 221–228.

Russel, S.M. (1996): The effect of refrigerated and frozen storage on populations of measophilic and coliform bacteria on fresh broiler chicken carcasses. J. Poultry Sci., 75:2057-2060.

Schmitz, G. and Ecker, J. (2008): The opposing effects of n-3 and n-6 fatty acids. J of Lipid Res., 47:147–155.

Singh, K. K., Mridula, D. Rehal, J. and Barnwal, P. (2011): Flaxseed- a potential source of food, feed and fiber. Crit Rev Food Sci Nutr., 51:210–222.

SPSS, (1998): Statistical package for Science Computer Software, Ver, SPSS Company London UK.

Thompson, L.U. and Cunnane, S.C. (eds) (2003): Flaxseed in Human Nutrition. 2nd edition. AOCS Publishing, Champaign, IL.

Verma, A.K. and Banerjee, R. (2010): Dietary fiber as functional ingredient in meat products: a noval approach for healthy living–a review. J Food Sci.Technol., 47(3):247–257.

Warriss, P. D. (2000): Fisheries Technologies for Developing Countries, National Academy Press. U.S.A., PP 144-151.

Watts, B.M., Yamaki, G.L., Jeffery, L.E. and Elias, L.G. (1989): Basic Sensory Methods for Food Evaluation. Ist Ed. The International Development research Center Pub. Ottawa, Canada.

Xu, Y., Hall, C. III. and Wolf-Hall, C. (2008): Antifungal activity stability of flaxseed protein extracts using response surface methodology. J Food Sci; 73:M9–M14.

الملخص العربي

تأثير إضافة بذور الكتان على القيمة الغذائية للسجق المصنوع من اللحم الجملى

يهدف هذا البحث إلى دراسة تأثير إضافة بذور الكتان على القيمة الغذائية للسجق المصنع من لحم الجمل بنسبة (٠، ١٠ ، ٢٠ و ٣٠ ٪). تم تقدير التركيب الكيميائي لكل من المواد الخام والمنتج باستخدام الطرق القياسية. تم تقييم نشاط مضادات الأكسدة في السجق من خلال تقدير عدد قيمة البيروكسيد وقيمة حمض الثيوباربيتوريك. تم تقدير التحليل الميكروبيولوجي والتغيرات الحسية في السجق في وقت الصفر وخلال فترة التجمد عند -١٨ درجة مئوية لمدة ثلاثة وستة أشهر. أظهرت النتائج أن بذور الكتان غنية بعناصر مثل الكالسيوم والحديد والمغنيسيوم والفوسفور. ودلت النتائج على أن إضافة بذور الكتان المجفف أدى إلى انخفاض تدريجي فى رقم البيروكسيد لجميع عينات السجق ولوحظ كلما زادت نسبة الإضافة من بذور الكتان المجففة كلما قل رقم البيروكسيد. وبنهاية فترة التخزين التجميد كانت أقل قيمة في العينة (٤). أظهر حامض الثيوباربيتوريك انخفاض في قيمته وذلك بزيادة نسبة الإضافة من بذور الكتان ، وخلال التخزين لوحظ أن العينة (٤) كانت أقل قيمة . أوضحت النتائج زيادة قيمة في جميع العينات وكلما زادت نسبة بذور الكتان زادت قيمتها ، وبنهاية فترة التخزين كانت العينة (٤) هي الأعلى(PH)

.حدث انخفاض في أعداد البكتريا الكلية والمتجرثمة والفطريات والخمائر في جميع خلطات السجق بزيادة مسحوق بذور الكتان المجففة عقب التصنيع مباشرة وأيضا خلال فترة التخزين بالتجميد حدث انخفاض تدريجي في أعداد البكتريا محل الدراسة ، وعلى العكس زادت أعداد البكتريا المحبة للبرودة تدريجيا بتقدم فترة التخزين وكانت جميع أعداد البكتريا في حدود المواصفات القياسية المصرية المصرح بها وكانت جميعها أمنه صحيا.دلت نتائج التقييم الحسي لعينات السجق المصنعة كاللون والقوام الطعم والرائحة والقبول العام بأن جميعها مقبولة بدرجة عالية لدي المحكمين وسجلت درجات عالية فى جميع الخواص الحسية سواء عقب التصنيع مباشرة أو خلال فترة التخزين بالتجميد. كما لوحظ العينة رقم (٢) سجلت أعلى درجات التقييم فى الخواص الحسية تليها العينة رقم (٣). توصي الدراسة بأنه يمكن استخدام بذور الكتان بنسبة تصل إلى ٣٠٪ في صناعة السجق وكانت صالحة من الناحية التصنيعية والتغذوية والميكروبيولوجية لمدة تصل إلى ستة أشهر.

الكلمات الاسترشادية : بذور الكتان ـ القيمة الغذائية ــ لحم الجمل ـــ التحليل الكيميائي – رقم البيروكسيد – التحليل الميكروبيولوجي – التقييم الحسى .