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USE OF CHIA AND QUINOA PLANTS AS PARTIAL SUBSTITUTES FOR FAT AND/OR CAMEL MEAT TO PRODUCE SAUSAGE WITH FUNCTIONAL PROPERTIES

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SUMMARY

The aims of this study were to use quinoa seeds powder and/ or chia seeds powder for producing camel meat sausage as a functional food that purchase in the frozen form. Five experiments were done for sausage. The 1st treatment (control) consists of 70% Minced camel meat, 12% Camel fat, 1.2% Spices, 2.3 % Salt, 1.2% Fresh onion,1% garlic, 3% starch and 9.3% cold water. The 2nd treatment $QcS_{25\%}$ (25% Quinoa + 75% Camel meat), The 3rd treatment $CcS_{50\%}$ (50% Chia +50% fat), The 4th treatment $CcS_{15\%}$ (15% Chia + 85% meat), and the 5st treatment $CcS_{25\%+25\%}$ (25% chia + 75% meat and 25% Chia + 75% fat). Ash and fiber contents of sausage samples increased while moisture content decreased by the addition of chia and quinoa plants. The control sample had the lowest TBARS than other treatments. The cooking yield increased and cooking loss decreased in all treatments. Amino acids profile and fatty acids profile improved. It could be concluded that using Quinoa and chia seeds powder in producing functional sausage have considerable importance in industrial as well as nutritional applications and also are useful for human weight control, heart disease patients and some other diseases.

Keywords: *Camel meat, Sausage, Chia, Quinoa, functional foods.*

INTRODUCTION

Meat and meat products represent a food category that encompasses both beneficial and detrimental nutritional characteristics. These muscle foods serve as significant sources of various bioactive compounds, including iron, zinc, conjugated linoleic acid (predominantly from ruminants), and B vitamins (Jimenez-Colmenero *et al.*, 2001). Conversely, meats and processed meats are often linked to nutritional elements that are viewed negatively, such as elevated levels of saturated fatty acids, cholesterol, sodium, as well as high fat and caloric content (Whitney and Rolfes, 2002). the nutritional quality of meat products can be enhanced by incorporating potentially health-promoting nutrients. When determining suitable nutrients for functional foods, several considerations must be considered, including the current dietary intake levels of the bioactive compounds (e.g., whether an increase would be beneficial for consumers), their biological efficacy in humans, their stability within the food product, and their effects on quality attributes such as color, flavor, and texture (Decker and Park, 2010).

Meat-based functional foods are perceived as a means to enhance the perception of meat products while addressing the particular requirements of significant segments of the population. Concerning health-oriented components, numerous studies have investigated the incorporation of ancient grains and products, including chia and quinoa, which were historically acknowledged for their nutritional and therapeutic benefits (Fernandez-lopez *et al.*, 2021). Chia seeds (*Salvia hispanica L.*) serve as a natural source of omega-3 fatty acids, comprising 75% of the total oil content, as well as omega-6 fatty acids, specifically alpha-linoleic acid (ALA). In addition, these seeds are rich in dietary fiber, exceeding 30%, when compared to other fruits and seeds. They also provide high-quality proteins, natural antioxidants such as tocopherols and polyphenols, various vitamins, carotenoids, and essential minerals (Fernandez-lopez *et al.*, 2021).

Quinoa (*Chenopodium quinoa* Willd) seeds are widely recognized for their remarkable nutritional profile and potential health advantages. The protein content all essential amino acids that being highly bioavailable. Additionally, quinoa is rich in carbohydrates that possess a low glycemic index, dietary fiber at 10%, and oil comprising 6-7% of unsaturated fatty acids. It also provides essential minerals such as magnesium, zinc, iron, potassium, and phosphorus. Beyond these nutritional attributes, quinoa is a source of vitamins (including E, B-complex, and C) and bioactive compounds known for their health benefits, such as polyphenols, phytosterols, and flavonoids (Fernandez-lopez *et al.*, 2021).

Therefore, our objective was to use chia seeds powder and/ or quinoa seeds powder for producing camel meat sausage to be used as functional food and to evaluate the effects of adding on chemical composition, physical properties, amino acid profile, fatty acids profile, Microbiology and sensory attributes of camel meat sausage.

MATERIALS AND METHODS

Materials:

This study was carried out at the laboratories of Desert Research Center, Cairo, Egypt and Department of Food Science, Faculty of Agriculture, Ain Shams University, Cairo, Egypt. Fresh camel meat and fat were obtained from the slaughterhouse of Maryout Research Station, 35 kilometers southwest of Alexandria, Desert Research Center, Ministry of Agriculture and Land Reclamation. Samples were obtained from boneless rounds and trimmed from all subcutaneous fat as well as thick, visible connective tissue. Quinoa and chia seeds powder; salt and spice mixture (black pepper, red pepper, Chinese Kubaba, 7 spices, clove, cinnamon, ginger, coriander), fresh onion, garlic, starch, sheep hank were obtained from local Egyptian market.

Methods:

Sausage treatments:

Camel meat and fat were run separately through an electrical meat mincer. Experiment design included five treatments varied in the replacement percentage of meat or fat as follows and as presented in Table (1): control treatment, C (12% fat), the second QcS25% (25% quinoa + 75% camel meat), the third CcS50% (50% Chia +50% fat), the fourth CcS15% (15% chia + 85% meat) and the fifth CcS25%+25% (25% chia + 75% meat and 25% chia + 75% fat). The formula of control treatment consists of 70% minced camel meat, 12% camel fat, 1.2% spices mixture, 2.3% salt, 1.2% fresh onion, 1% garlic, 3% starch and 9.3% cold water as mentioned by Zaki (2013).

Table (1): Recipes of camel meat sausage (%) with different meat or fat replacers.

	Treatments %*				
Ingredients	**C**	**QcS25%**	**CcS50%**	**CcS15%**	**CcS25%+25%**
Minced camel meat	70	52.5	70	59.5	52.5
Camel fat	12	12	9	12	9
Quinoa seed powder	-	17.5	-	-	-
Chia seed powder	-	-	3	10.5	20.5
Spices mixture**	1.2	1.2	1.2	1.2	1.2
Salt	2.3	2.3	2.3	2.3	2.3
Fresh onion	1.2	1.2	1.2	1.2	1.2
Fresh garlic	1	1	1	1	1
Starch	3	3	3	3	3
Cold water	9.3	9.3	9.3	9.3	9.3

**C = control, QcS25%= quinoa powder 25%, CcS50%= chia powder 50%, CcS15%= chia powder 15%, CcS25%+25%= chia powder 25+25%.*

Minced meat and other ingredients were thoroughly mixed and mixture was reground through a 5 mm plate and finally each sausage treatment was stuffed into natural sheep casings using manual sausage maker. The resulted sausages were tied for 10 cm length and about 500g of each treatment was packaged into foam plate wrapped with polyethylene films, and immediately stored at –18˚ C until analysis. Before analysis, samples were thawed overnight at 4◦C±1. All samples were analyzed immediately after processing.

The selected ratios of replacement with quinoa or chia seed powders and suggested names of such new camel meat product were shown in Table (3).

Table (2): Spices mixture (100g) used for making camel meat sausage.

Weight (%)	Spice
30	Black pepper
8	Red pepper
8	Chinese Kubaba
15	7 spices
8	Clove
15	Cinnamon
8	Ginger
8	Coriander

Table (3): Replacement ratios of camel meat sausage (%) with different meat or fat replacers and their suggested names as new products

Camel product	% of replacement	Abb.	Suggested name
Quinoa seeds powder			
Sausage	0	C	Control
	25	QcS	Quinycam sausage
Chia seeds powder			
Sausage	50	CcS	Chiacam sausage
	15	CcS	Chiacam sausage
	25+25	CcS	Chiacam sausage

Sausage samples were grilled in preheated grill for 10 min for the sensory evaluation.

Chemical and physical analysis:

Proximate chemical composition; i.e. moisture, protein, fat, ash, fiber contents were determined according the methods recommended in A.O.A.C (2005). The total carbohydrate content was calculated by difference. Total calorie (Kcal) for control and treatments samples were calculated using Atwater values for fat (9 Kcal⁄g), protein (4.02 Kcal⁄g) and carbohydrates (3.87 Kcal⁄g) as described by Ali *et al.* (2011). The formations of Thiobarbituric acid reactive substances (TBARS) were determined as described by ÖZER and SEÇEN (2018). Acid value of camel meat products was determined according to the A.O.A.C (2005). Cooking loss and cooking yield were determined according to Khalil (2000). For detecting amino acids profile (Pellet and Young, 1980) method using Amino Acids Analyzer available at Desert Research Center (DRC), Ministry of Agriculture and Land Reclamation, Cairo, Egypt. The Gas Liquid Chromatography Technique found at Desert Research Center (DRC), Ministry of Agriculture and Land Reclamation, Cairo, Egypt was applied to detect the fatty acids profile as mentioned by Fryer *et al.*, (1960), Nelson *et al.*, (1969), Farag *et al.*, (1986).

Antioxidant properties of raw replacement sources:

The hydrogen atom or electron donation abilities of the corresponding extracts were measured from the bleaching of the purple- colored methanol solution of 2,2 -diphenyl -1-picrylhydrazyl (DPPH). This spectrophotometric assay was done using the stable radical DPPH as a reagent according to the method of Burits and Bucar (2000). The method that described by Kaur and Kapoor (2002) was applied for determining the total phenolic content. The total phenolic content was calculated from the calibration curve, and the results were expressed as mg of gallic acid equivalent per g dry weight.

Microbiological analysis:

The total bacterial and psychrophilic bacterial counts were determined using plate count agar medium according to the procedure described by (APHA, 1992). Yeasts and moulds were determined using rose Bengal chloromephenicol agar (APHA, 1992). All the previous counts were expressed as Log cfu/gm.

Sensory evaluation:

Cooked camel meat burger and sausage samples were sensory evaluated immediately after cooking. All cooked samples were cut to small pieces and coded with random numbers as described by AMSA (1995). Ten panelists from Desert Research Center, Ministry of Agriculture and Land Reclamation, evaluated five parameters as taste, odor, colour, texture and overall acceptability using a 9-point hedonic scale, as follows: 8-9 very good, 6-7 good, 4-5 fair, 2-3 poor and 0-1 very poor. Means were statistically analyzed.

Statistical analysis:

All data generated from each experiment were analyzed by using statistical analysis system (SAS, 2001). Also, it has been used (Schobot) for academic research, to facilitate accurate efficient access to required information.

RESULTS AND DISCUSSION

Chemical composition:

Table (4) shows the results of Proximate composition of camel sausage with various quinoa and chia seeds powder stored at -18°C at zero time. The moisture content of sausage treatments was lower than that of control sample. These results agree with those obtained of beef burger and frankfurters by Shokry (2016) and Fernandez-Lopez *et al.* (2019). On the contrary, the moisture content of all uncooked beef burger samples was higher than control (Salama *et al.*, 2022) who studied the quality characteristics of low-fat camel burger as affected by fat replacer.

The fat content in replacement treatments were significantly higher ($P \leq 0.05$) than control sample in all treatments. The increase in the fat content would come from chia oil. These results agree with those obtained of beef burger and frankfurters by Shokry (2016) and Fernandez-Lopez *et al.* (2019). On the contrary, the fat content of all uncooked beef burger samples was lower than control (Salama *et al.*, 2022).

The protein content of control sample was slightly higher than other treated samples, the differences were not significant. Similar results were obtained by Mohamed *et al.* (2024) found that the protein contents of burger samples decreased by the addition of quinoa. While, (Salama *et al.*, 2022) reported that there were significant differences ($P>0.05$) in protein content among all treatments. The ash content of replacement treatments was significantly higher ($P>0.05$) than that of control sample. Similar results were obtained in beef burger by Fernandez-Lopez *et al.* (2019) and Mohamed *et al.* (2024). While, Mansour and Khalil (1999) reported that the ash content was decreased by adding wheat fibres. fibres content in replacement treatments were significantly higher ($P \leq 0.05$) than that of control sample. These results may be due to the high fibre content of these additives. Results agreed with the findings of Fernandez-Lopez *et al.* (2019).

Carbohydrate content was significantly higher ($P>0.05$) than control sample in both QcS25% and CcS25%+25% treatments, which was attributed to the presence of carbohydrates in additives. Similar results were obtained by Mohamed *et al.* (2024). Calories in control sample was lower than all other treatments. Similar results were obtained by Fernandez-Lopez *et al.* (2019). There were differences in total energy (Kcal/100g) between treatments prepared by using chia and quinoa seeds.

Table (4): Proximate composition of camel sausage with various quinoa and chia seeds powder stored at -18°C at zero time.

Treatments	Moisture	protein	fat	ash	fiber	Carbo. *	Caloric v.
C	59.40^{a}	16.41^{a}	16.61^{d}	0.79^{d}	0.91^{d}	5.88^{c}	238.65^{a}
QcS25%	57.22^{b}	14.81c	17.30^{c}	1.31^{c}	1.55^{bc}	7.81^{b}	246.18^{a}
CcS50%	59.01^{a}	15.49^{b}	17.80^{c}	1.75^{c}	2.12^{b}	3.83^{d}	237.48^{a}
CcS15%	55.42^{c}	15.85^{b}	18.31^{ab}	2.11^{ab}	2.80^{b}	5.51^{c}	250.23^{a}
CcS25%+25%	49.80^{d}	16.13^{a}	19.53^{a}	2.66^{a}	3.04^{a}	8.84^{a}	275.65^{a}

Means followed by different superscripts letters within the same column) a, b, c) are significantly different P>0.05
**Carbohydrates were calculated by difference. ±SD*

Physicochemical properties:

Results in Table (5) show the TBARS value (as OD at 538 nm) of camel sausage with various quinoa and chia seeds powder stored at -18°C/ 3 months. The TBARS values in control sample was significantly ($P>0.05$) lower than other treatments with chia seeds (0.059, 0.104, and 0.158, respectively). However, the replacement treatment had the highest TBARS value, which may be due to its high fat content. On the contrary, The TBARS values in QcS25% sample was significantly ($P>0.05$) lower than other treatments. These results agree with that obtained by ÖZER and SEÇEN (2018).

Table (6) shows Acid value (mg KOH/ g fat) of camel sausage with various quinoa and chia seeds powder stored at -18°C/ 3 months. The Acid values of replacement treatments were significantly higher ($P>0.05$) than control sample. Regarding cooking loss, it decreased and cooking yield increased in all replacement sausage treatments were significantly ($P>0.05$) than control sample. Using quinoa flour in burger can decrease the cooking loss and increase the cooking yield (Özer and Seçen, 2018). This may be due to the high carbohydrate content in Plant sources. On the other hand, the control patty samples showed the lowest yield and highest cooking loss, which was attributed to the high loss of fat and moisture during cooking (Abolgasem., 2011).

Table (5): TBARS value of camel sausage with various quinoa and chia seeds powder stored at -18°C/ 3 months.

Storage period (months)	Treatments				
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%
0	0.012^{Dd}	0.007^{Dd}	0.059^{Cd}	0.104^{Bd}	0.158^{Ad}
1	0.02^{Dc}	0.011^{Dc}	0.092^{Cc}	0.135^{Bc}	0.167^{Ac}
2	0.021^{Db}	0.023^{Db}	0.103^{Cb}	0.156^{Bb}	0.26^{Ab}
3	0.023^{Da}	0.023^{Da}	0.106^{Ca}	0.179^{Ba}	0.344^{Aa}

Means followed by different superscripts letters within the same column (A, B, C) or row (a, b, c) are significantly different at P>0.05.

Table (6): Acid value (mg KOH/ g fat) of camel sausage with various quinoa and chia seeds powder stored at -18°C/ 3 months.

Storage Period (month)	Treatments				
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%
0	0.02^{Db}	0.059^{Ab}	0.019^{Dcb}	0.034^{Bcb}	0.031^{Bb}
1	0.028^{Db}	0.063^{Ab}	0.02^{Dcb}	0.037^{Bcb}	0.042^{Bb}
2	0.032^{Da}	0.065^{Aa}	0.056^{Dca}	0.049^{BCa}	0.055^{Ba}
3	0.036^{Da}	0.068^{Aa}	0.042^{Dca}	0.05^{BCa}	0.056^{Ba}

Means followed by different superscripts letters within the same column (A, B, C) or row (a, b, c) are significantly different at P>0.05.

Table (7): Cooking yield% of camel sausage with various quinoa and chia seeds powder stored at -18°C/ 3 months

Storage period (month)	Treatments				
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%
0	64.37Ca	92.78Aa	89.13Aa	78.49Ba	88.00Aa
1	61.92Cb	90.11Ab	88.12Aa	76.25Bb	85.10Ab
2	61.03Cb	87.93Ac	86.71Aba	75.15Bbc	87.11Aa
3	59.78Cc	86.52Ac	85.24Ac	74.32Bd	85.80Ad

Means followed by different superscripts letters within the same column (A, B, C) or row (a, b, c) are significantly different at P>0.05.

Table (8): Cooking loss % of camel sausage with various quinoa and chia seeds powder stored at -18°C/ 3 months.

Storage period (month)	Treatments				
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%
0	35.63^{Ec}	7.22^{Ad}	10.87^{Bd}	21.51^{Dd}	12.00^{Cb}
1	38.08^{Eb}	9.89^{Ac}	11.88^{Bc}	23.75^{Dc}	14.90^{Ca}
2	38.97^{Eb}	12.07^{Ab}	13.29^{Bb}	24.85^{Db}	12.89^{Cb}
3	40.22^{Ea}	13.48^{Aa}	14.76^{Ba}	25.68^{Da}	14.20^{Ca}

Means followed by different superscripts letters within the same column (A, B, C) or row (a, b, c) are significantly different at P>0.05.

Amino acids profile:

The Amino acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C are given in Table (9) and fig. (1).

Table (9): Amino acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C.

Amino acid	C	$QcS_{25\%}$	$CcS_{50\%}$	$CcS_{15\%}$	$CcS_{25\%+25\%}$
Aspartic	7.44	9.80	8.30	13.10	9.20
Therionine*	3.48	4.20	4.20	3.90	4.50
Serine	3.48	4.10	3.30	5.70	4.20
Glutamic	17.97	18.10	18.50	18.20	16.40
Glycine	5.99	7.50	2.80	5.40	5.30
Alanine	4.83	10.00	0.60	7.00	9.20
Cystine	4.25	5.40	6.70	0.70	7.60
Valine*	5.99	0.90	1.60	3.90	0.60
Methionine*	1.64	3.20	4.10	1.50	4.00
Isoleucine*	3.67	8.60	7.90	3.40	8.80
Leucine*	8.89	2.90	2.20	6.20	2.00
Tyrosine*	3.28	5.00	4.60	2.50	5.60
Phenylalanine*	4.44	4.00	4.10	3.70	4.80
Histidine*	3.09	1.00	0.70	3.90	0.60
Lysine*	9.18	7.40	21.40	5.30	7.70
Argnine*	7.53	6.30	7.10	8.90	7.50
Proline	4.85	1.60	1.90	6.70	2.00
Total A.A.	100.00	100.00	100.00	100.00	100.00

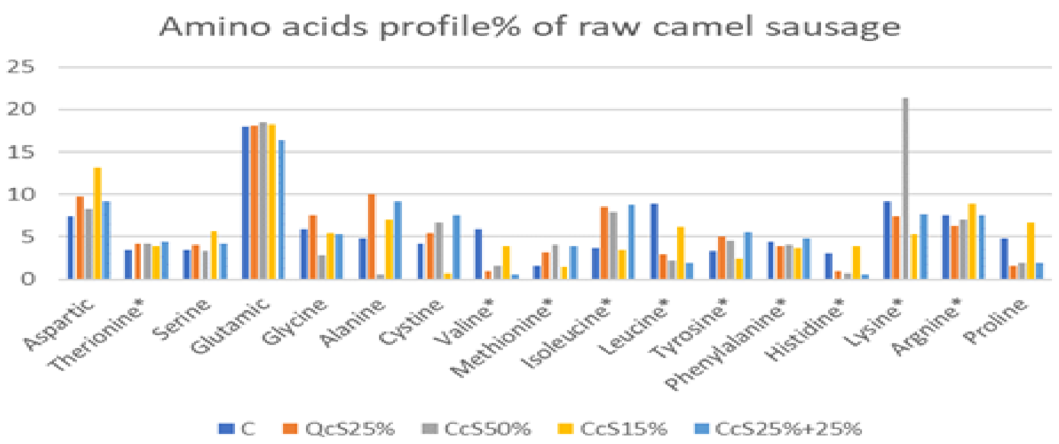

Fig. (1) Amino acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C

A from this table and figure it could be seen that glutamic acid is a predominant amino acid either in control sample that recorded 17.97 % or in replacement treatment which came with (18.10, 18.50, 18.20, 16.40%). It means that replacement treatment enhanced amino acid profiles. These results agree with that obtained by Abd EL-Gaber (2018) Also, aspartic acid behaved a similar trend, it was in the control sample with (7.44) and in replacement treatment with (9.80, 8.30, 13.10, 9.20%). On the other hand, and regarding to the total essential amino acids (Table 10, Fig. 2), it could be concluded that such replacement treatment (CcS50%, CcS25%+25%) led to increase in sum of essential amino acids, and replacement treatment (QcS, CcS15%) led to decrease in sum of essential amino acids.

Table (10): Essential amino acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C.

Amino acid	C	$QcS_{25\%}$	$CcS_{50\%}$	$CcS_{15\%}$	$CcS_{25\%+25\%}$
Therionine*	3.48	4.20	4.20	3.90	4.50
Valine*	5.99	0.90	1.60	3.90	0.60
Methionine*	1.64	3.20	4.10	1.50	4.00
Isoleucine*	3.67	8.60	7.90	3.40	8.80
Leucine*	8.89	2.90	2.20	6.20	2.00
Tyrosine*	3.28	5.00	4.60	2.50	5.60
Phenylalanine*	4.44	4.00	4.10	3.70	4.80
Histidine*	3.09	1.00	0.70	3.90	0.60
Lysine*	9.18	7.40	21.40	5.30	7.70
Argnine*	7.53	6.30	7.10	8.90	7.50
Total A.A.	51.19	43.50	57.90	43.20	46.10

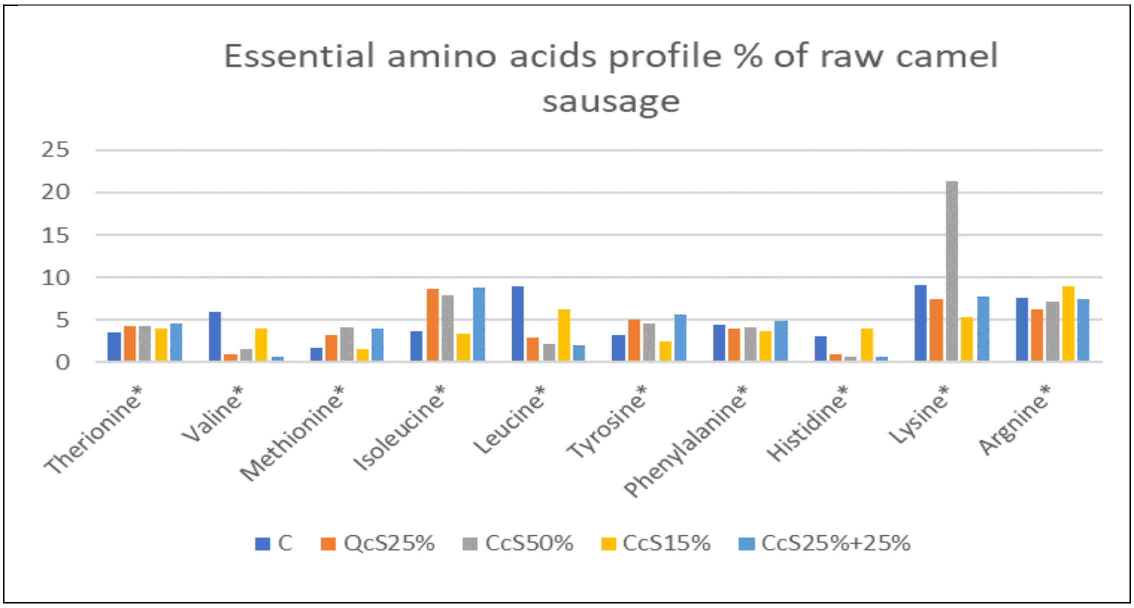

Fig. (2): Essential amino acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C.

Fatty acids profile:

Data given in Table (11) indicate Saturated fatty acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C. from table (11) it could be seen that the Heneicosanoic acid (C21:0) was the predominant saturated fatty acid in either control sample or replacement treatment (CcS50%, CcS25%+25%). On the other hand, and regarding to the total saturated fatty acids, it could be concluded that such replacement treatment (QcS25%, CcS25%+25%) led to decrease in sum of saturated fatty acids, and replacement treatment (CcS50%, CcS15%) led to increase in sum of saturated fatty acids.

Regarding to Table (12) which indicate Unsaturated fatty acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C. It could be seen that three unsaturated fatty acids were detected. The predominant unsaturated fatty acids were Erucic Acid (C22:1) then Arachidonic Acid (C20:4) which is Essential for brain function, immune response, and blood clotting, and finally Palmitoleic Acid (C16:1) which is beneficial for reduce inflammation, enhance insulin sensitivity, blood sugar control, reduce the risk of skin disorders and Some studies suggest that palmitoleic acid may help with weight management by increasing metabolism.

Table (11): Saturated fatty acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C.

Fatty acid	Treatments*				
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%
C 4:0	0	10.66	0	0	1.48
C 6:0	0	1.42	0	0	2.73
C 7:0	0	0.16	0	0	0.3
C 8:0	0	0	0	0	0.56
C 10:0	0	0.37	0	0	0.82
C 11:0	0	0.17	0	0	0.23
C 13:0	0	0.39	0	0	0.54
C 16:0	0	0.16	0	0	0.26
C 21:0	33.42	0	33.25	47.76	0
Total SFA	33.42	13.33	33.25	47.76	6.92

Table (12): Unsaturated fatty acids profile % of raw camel sausage with various quinoa and chia seeds powder stored at -18°C.

Fatty acid	Treatments*				
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%
C 16:1 ω-7	0	0	0	0	0.17
C 20:4 ω-6	1.74	0	1.63	0	0
C 22:1 ω-9	16.33	0	27.72	18.49	0
Total SFA	18.07	0	29.35	18.49	0.17

Antioxidant properties of raw replacement sources:

The Antioxidant properties of Quinoa and Chia seeds powder was shown in Table (13). From this table it could be seen that, quinoa seeds had higher DPPH scavenging % and phenolic content % (56.42, 0.41) than chia seeds which was (40.19, 0.30). This mean that quinoa seeds had stronger antioxidant activity than chia seeds. This finding goes in parallel with the results that obtained by Nsimba *et al.*, (2008). Moreover, from Table (14) it could be noticed that IC50 (ug/ml) of Quinoa and Chia seeds powder. IC50 Value is the concentration of the antioxidant required to inhibit DPPH radical by 50%. Lower IC50 values indicate higher antioxidant potency.

Table (13): Antioxidant properties of Quinoa and Chia seeds powder.

Antioxidant parameters	Quinoa seeds powder	Chia seeds powder
DPPH scavenging %	56.42	40.19
Phenolic content (mg/g)	0.41	0.30

Microbiological evaluation:

Total bacterial and psychrophilic counts of camel meat sausage for all treatments are shown in Table (15). Total bacterial counts in such replacement treatments (QcS25%, CcS25%+25%) were slight lower than control sample. Moreover, the mean values of total bacterial count for camel sausage were within the limits permitted by the Egyptian standard (ES, 2005) for frozen sausage. Psychrophilic bacteria count in such replacement treatments (QcS25%, CcS15%) were slight lower than control samples. This may be due to high moisture content and total bacterial load in control and the rest of treatments (Table 4). On the contrary, (Abd EL-Gaber, 2018) reported that all chicken sausage was free from Yeasts and Moulds in all of investigated samples except in control sample at the end of its storage periods (18 days).

Table (14): IC50 (ug/ml) of Quinoa and Chia seeds powder.

Conc. Sample	Quinoa	Chia
1000mg	0.147	0.052
500g	0.475	0.056
250g	0.617	0.331
125g	0.869	0.725
0.062g	0.941	0.855
0.031g	0.998	0.960
0.015g	0.889	1.008

Table (15): Microbiological analysis (Log cfu/gm) of camel sausage with various quinoa and chia seeds powder stored at -18°C for 3 months

Microbial count	Treatments				
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%
Total bacterial count	6.70a	5.48a	6.74a	6.78a	5.23a
Psychrophilic bacterial count	3.40a	3.30a	3.48a	3.30a	3.85a
Yeasts & moulds count	ND	ND	3.3a	3.48a	3.3a

Means followed by different superscripts letters within the same row are significantly different at P>0.05.

Sensory evaluation:

Data of sensory evaluation, taste, odor, color, texture and overall acceptability of control and replacement treatments are presented in Table (16). there were no-significant differences between the control and replacement treatments (CcS50%, CcS15%) in all characteristics. These results agreed with those obtained by (Abd EL-Gaber, 2018). On the contrary, ElKatry and Elsawy (2021) found there were no-significant (p>0.05) differences between the tested fortified burger at all levels of quinoa seeds powder, when compared to the control sample.

Table (16): Sensory evaluation of camel sausage with various quinoa and chia seeds powder % stored at -18°.

Item	Treatments					
	C	QcS25%	CcS50%	CcS15%	CcS25%+25%	±
Taste	8.78Aa	7.50Ba	8.72Aa	8.27Aa	6.47Ca	0.345
Odor	8.63Aa	7.30Ba	8.42Aa	8.03Aa	6.31Ca	0.349
Color	8.77Aa	7.42Ca	8.88Aa	8.17Ba	6.34Da	0.347
Texture	8.68Aa	7.15Ba	8.78Aa	8.60Aa	6.32Ca	0.350
Overall Acceptability	8.62Aa	7.60Ba	8.73Aa	8.60Aa	6.31Ca	0.467

Means followed by different superscripts letters within the same column (A, B, C) or row (a, b, c) are significantly different at P>0.05.

CONCLUSION

It could be concluded that using Quinoa and Chia seed powders in producing functional sausage has considerable importance in industrial as well as nutritional applications and also is useful for human weight control, Heart disease patients and some other diseases. Moreover, the improving in sensory and physical properties of camel meat sausage.

REFERENCES

Abolgasem F.S. (2011). M.Sc. Dissertation, Food Science and Technology Department, Faculty of Agriculture, Cairo University, Egypt,122 p.

Abd EL-Gaber, H. K. (2018). Development and Assessment of some chicken products as functional foods. M.Sc. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt,112 p.

Ali, R.F.; El-Anany, A.M. and Gaafar, A.M. (2011). Effect of Potato Flakes as Fat Replacer on the Quality Attributes of Low-Fat Beef Patties. Adv. J. Food Sci. Technol., 3(3): 173-180.

A.M.S.A. (1995). American Meat Science Association. Research Guidelines for Cookery, Sensory Evaluation and Instrumental Tenderness Measurements of Fresh Beef, Chicago, IL, U.S.A. pp 240.

A.O.A.C. (2005). Official Methods of Analysis, 18th Ed. Association of Official Analytical Chemists, Washington, USA.

A.P.H.A. (1992). In Standard methods for the examination of dairy products. 16th (Ed) by Marshall, R. T. American Public Health Association. Washington, USA.

Burits, M. and Bucar, F. (2000). Antioxidant activity of Nigella sativa essential oil. Phytotherapy Research 1 4; 3 23–328.

Decker, E. A. and Park, Y. (2010). Healthier meat products as functional foods. Journal of Meat Science, 86(1): 49-55.

Egyptian Standards. (2005). Frozen sausage. Egyptian Organization for Standardization and Quality Control, Ministry of Industry and Technological Development, Arab Republic of Egypt, (E.S. No. 1972).

ElKatry, H. O. and Elsawy, H. A. (2021). Preparation of beef burger supplemented with quinoa seeds powder as healthy food. Int. J. of family studies, Food Science and Nutrition Health, 4(1): 68-93.

Farag, R. S.; Ahmed, A. I.; Rashed, S. E. and Ewies, M. A. (1986). Unsaponifiable matter of six pollens collected by honey bees in Egypt. J. of Agric. Res., 19: 4 52 – 58.

Fernandez-Lopez, J.; Lucas-Gonzale, R.; Viuda- Barbera, M.; Sayas-Barbera, E.; Navarro, C.; Haros, C. M. and Perez-Alvarez, J.A., (2019). Chia (*Salvia hispanica. L.)* products as ingredients for reformulating frankfurters: Effects on quality properties and shelf-life. Journal of Meat Science, 156: 139-145.

Fernandez-Lopez, J.; Viuda- Barbera, M. and Perez-Alvarez, J.A., (2021). Quinoa and chia products as ingredients for healthier processed meat products: Technological strategies for their application and effects on the final product. Current Opinion in Food Science, 40:26–32.

Fryer, F.H.; Ormand, W.L. and Crump, G. M. (1960). Triglycerides elution by gas chromatography. JAOCS, 37: 589 – 590.

Jimenez-Colmenero, F.; Carballo, J. and Cofrades, S. (2001). Healthier meat and meat products: their role as functional foods. Meat Science, 59(1), 5−13.

Kaur, C. and Kapoor, H.C. (2002). Anti-oxidant activity and total phenolic content of some Asian vegetables. Int. J. Food Sci. Technol., 37: 153-161.

Khalil, A. H. (2000). Quality characteristics of low-fat beef patties formulated with modified corn starch and water. Food Chemistry 68:61-68.

Mansour, E. H. and Khalil, A. H. (1999). Characteristics of low-fat beef burgers as influenced by various types of wheat fibres. Journal of the Science of Food and Agriculture, 79:493-498.

Mohamed, R. A. A.; Youssif, M. R.G. and Kodous, M. F.S.A. (2024). Utilization of Quinoa Flour in Meat Burger Preparation. World J. Dairy & Food Sci., 19 (1): 01-09.

Nelson, J.P.; Milum A.J. and Fister H.D. (1969). Gas chromatographic determination of tocopherols and sterols in soya sludges and residues. An improved method, JAOCS, 47: 259-261.

Nsimba, R. Y.; Kikuzaki, H. and Konish, Y. (2008). Antioxidant activity of various extracts fractions of Chenopodium quinoa and Amaranthus spp. seeds. Food Chem., 106: 760-766.

Özer, C. O. and Secen, S. M. (2018). Effects of quinoa flour on lipid and protein oxidation in raw and cooked beef burger during long term frozen storage. Food Sci. Technol., Campinas, 38(Suppl. 1): 221-227.

Pellet, P.L. and Young V.R. (1980). In "Nutritional Evaluation of Protein Foods". Published by the United Nations University, pp: 546.

Salama, N. A.; Helmy, S. A.; Shehata, M.F. and Mohamed, A.T.A. (2022). Quality improvement of camel meat burger formulated with fat replacers during frozen storage. Egyptian Journal of Nutrition and Feeds, 25(1):53-66.

Shokry, A.M., (2016). The usage of quinoa flour as a potential ingredient in production of meat burger with functional properties. Middle East Journal of Applied Sciences, 6(4): 1128-1137.

Statistical Analysis Systems (SAS) 2001. User’s guide. 6.12 Ed, Statistical Analysis Systems Institute Inc. Cary NC 27511-8000, USA.

Whitney, E. N. and Rolfes, S. R. (2002). Understanding nutrition, Ninth edn Belmont, CA: Wadsworth.

Zaki, E. F. (2013). Effect of desert environmental factors on the quality of some fresh meats and their products. Ph.D. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt, 107 p.

استخدام نباتات الشيا والكينوا كبدائل جزئية للدهون و/أو لحم الإبل لإنتاج سجق ذو خصائص وظيفية

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كان الهدف من هذه الدراسة استخدام مسحوق بذور الكينوا و/أو مسحوق بذور الشيا لإنتاج سجق لحم الإبل لاستخدامه كغذاء وظيفي يتم شراؤه في صورة مجمدة. تم إجراء خمس تجارب على السجق. تتكون المعاملة الأولى (الكنترول) من 70% لحم جمل مفروم، 12% دهن جمل، 1.2% بهارات، 2.3% ملح، 1.2% بصل طازج، 1% ثوم، 3% نشا و9.3% ماء بارد. المعاملة الثانية QcS25% (25% كينوا + 75% لحم جمل)، المعاملة الثالثة CcS50% (50% شيا + 50% دهن)، المعاملة الرابعة CcS15% (15% شيا + 85% لحم)، والمعاملة الخامسة 25%+CcS25% (25% شيا + 75% لحم و25% شيا + 75% دهن). زاد محتوى الرماد والألياف في عينات السجق بينما انخفض محتوى الرطوبة بإضافة نباتات الشيا والكينوا. احتوت العينة الضابطة على أقل نسبة TBARS مقارنة بالمعاملات الأخرى. زاد ناتج الطهي وانخفض الفقد فى الطهي في جميع المعاملات. تحسنت مستويات الأحماض الأمينية والدهنية في هذه المنتجات. ويمكننا أن نستنتج أن استخدام مسحوق بذور الكينوا وبذور الشيا في إنتاج السجق الوظيفي له أهمية كبيرة في التطبيقات الصناعية والتغذوية كما أنه مفيد للتحكم في وزن الإنسان ومرضى القلب وبعض الأمراض الأخرى.

الكلمات المفتاحية: *لحم الإبل، السجق، الشيا، الكينوا، الأغذية الوظيفية.*