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Effect of Using Different Levels of Ginger (*Zingiber Officinale Roscoe*) Extract on The Quality Characteristics of Camel's Sausage

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Abstract**—** *The objective of the current study was to evaluate the effect of adding different levels of ginger extract in the formulation of camel sausage. Four treatments were investigated: T1 control and the other treatments (T2, T3 and T4) were treated with 5, 10, and 15 % ginger extract (v/w). Chemical, physical, sensory properties and histological examination were evaluated. Sausages treated with ginger extract had higher moisture, lower fat content and no significant differences in protein content. Collagen content was significantly increased in treated cooked sausages. Fat and moisture retention significantly increased in camel sausage treated with ginger extract. The addition of ginger extract significantly improved the color and shrinkage measurements. A Light micrograph of camel sausage treated with 10% ginger extract exhibited severely broken muscle fibers and severely destructed connective tissue. Sausage treated with 10% ginger extract recorded the highest score for texture, tenderness and overall acceptability.*

Keywords**— Camel sausage. Ginger extract. Quality characteristics.**

I. INTRODUCTION

Camel is an important source of meat production in Asia and Africa, especially in Arab countries. The high demand for camel meat may be due to its characteristics which make this meat a superior and healthier meat compared with other red meats (Abdel-Naeem et al. 2022). The low-fat content with high polyunsaturated fatty acids, low cholesterol, high proportion of proteins with high essential amino acids, High moisture content, and vitamins (Abdel-Naeem & Mohamed 2016). Furthermore, camel meat had the lowest microbial counts and zero pathogenic bacteria (Mohammed et al, 2020). Even though the fact that camel meat may be considered an excellent raw material for meat products processing (Farouk & Bekhit, 2013). The high content of connective tissue makes this meat the tough kind of meat and a challenging raw material for meat processors for processing acceptable meat products (Kadim et al., 2008). Therefore, different methods have been devised to increase the tenderness of camel meat to be suitable for further processing of different products. There are various conventional methods for meat tenderization such as chemical and mechanical methods (Verma et al, 2019). Recently, biological methods including proteolytic enzymes are becoming a popular method for meat tenderization. Lastly, proteolytic enzyme derived from plant sources has become an increasing focus of interest among food processors and meat technologists (Fernández-Lucas et al, 2017).

Proteolytic enzymes derived from ginger (*Zingiber officinale Roscoe*) were introduced as effective enzymes for tenderizing tough camel meat and other meat types (Mendiratta et al, 2010). Zingibain is a thiol proteinase extracted from ginger. It has optimal enzymatic activity at 60 ˚C and pH 5.5. Moreover, the proteolytic activity of zingibain is more effective on collagen than actomyosin (Thompson et al., 1973).

Most of the previous studies investigated the impact of using proteolytic enzymes on the tenderization of raw meat, However, the effect of incorporating these enzymes in the formulation of meat products for improving the quality characteristics of this meat as raw material is limited. Therefore, the current study aimed to study the effect of using different levels of ginger extract as a tenderizing agent in the formulation of camel sausage to improve the quality characteristics of the product.

II. MATERIALS AND METHODS

2.1. Preparation of camel sausage

Fresh camel meat and hump fat of ~ 5 years old Arabian one-humped camels (*Camelus dromedarius*) were obtained from a slaughterhouse (Cairo, Egypt) and transported to the laboratory for sausage processing. Camel meat and hump fat were separately ground through a 3- 4 mm plat meat grinder (K.R.SU: KMG1700. China). The following ingredients 65% lean camel meat, 20 % hump fat, 1.5% sodium chloride, 10% water, 3% starch, and 0.5% seasonings mix were used for sausage processing. The ground meat and fat were mixed with water, salt, starch, and seasonings. The mixture was divided into four treatment groups: (T1) Control group and the other treatments (T2, T3 and T4) were treated with 5, 10, and 15 % ginger extract (v/w). Three replicates for each sausage formula were processed. The mixture was transferred to a manual sausage maker and stuffed into natural casings. The sausage was tiered into 10-12 cm lengths and placed in plastic foam trays, packed in polyethylene bags and frozen at -20 ºC ±2 until further analysis.

2.2. Chemical analysis

2.2.1. Proximate composition

Proximate composition and collage content of raw and cooked camel sausage were determined by using the Food Scan™ Pro meat analyzer (Foss Analytical A/S, Model 78810, Denmark). The average of results was calculated from three replicates of each treatment.

2.2.2. Fat retention and moisture retention (%)

Fat retention of camel sausage was determined according to Murphy et al. (1975).

$$\text{Fat retention (\%)} = \frac{\text{(Cooked sample weight)} \times \text{(\% Fat in cooked sample)}}{\text{(Raw sample weight)} \times \text{(\% Fat in raw sample)}} \times 100$$

Moisture retention was determined according to El-Magoli et al. (1996).

$$\text{Moisture retention (\%)} = \text{(Cooking yield \%} \times \text{Moisture \% in cooked sample)/100}$$

2.3. Physical analysis

2.3.1. pH value

pH values of raw camel sausage were determined by using a digital pH meter (Jenway 3320 conductivity and pH meter, England) as described by Khalil (2000).

2.3.2. Cooking measurements

Camel sausages were cooked in a preheated oven for 30 min. All cooking measurements were determined as described by Naveena et al. (2006) as follows:

$$\text{Cooking loss (\%)} = \frac{\text{(Uncooked sample weight) - (Cooked sample weight)}}{\text{(Uncooked sample weight)}} \times 100$$

$$\text{Cooking yield (\%)} = \frac{\text{(Cooked sample weight)}}{\text{(Uncooked sample weight)}} \times 100$$

2.3.3. Shear force value

The shear force value of each cooked camel sausage was determined by using Instron Universal Testing Machine (Model 2519-105, USA) three times at different positions. The average shear force was calculated from the three obtained results (Kg/f).

2.3.4. Shrinkage measurements

Raw and cooked camel sausages were measured for shrinkage measurements as described by Berry (1993) using the following equation:

$$\text{Reduction in width (\%)} = \frac{\text{(Uncooked sample width) - (Cooked sample width)}}{\text{(Uncooked sample width)}} \times 100$$

$$\text{Reduction in length (\%)} = \frac{\text{(Uncooked sample length) - (Cooked sample length)}}{\text{(Uncooked sample length)}} \times 100$$

Shrinkage (%): Dimensional shrinkage was calculated using the following equation as reported by Murphy et al. (1975)

$$= \frac{\text{(Raw length - Cooked length) + (Raw width - Cooked width)}}{\text{(Raw length +Raw width)}} \times 100$$

Color measurements

Color parameters (L*, a* and b*) of raw camel sausage were measured according to CIE (1976) by using a Chroma meter (Konica Minolta, model CR 410, Japan). The color was expressed as Lightness (L* value), redness (a* value) and yellowness (b* value).

2.4. Histological examination

Raw camel sausage samples (1 × 1 cm) were fixed for 24 h in 10% formalin and then, washed with running water. Fixed camel sausages were dehydrated in different concentrations of ethyl alcohol, followed by cleaning in xylene, and embedded in paraffin at 56 °C in a hot air oven for 24 h. Paraffin blocks were sectioned at 4–6 µm thickness, and stained with Haematoxylin and Eosin as reported by Banchroft et al. (1996).

2.5. Sensory Evaluation

Cooked camel sausage was subjected to organoleptic evaluation and scored appearance, texture, juiciness, flavor, tenderness and overall acceptability using a 9- point hedonic scale as described by A. M. S. A. (1995). The mean scores of the obtained results of the organoleptic evaluation were then statistically analyzed.

2.6. Statistical analysis

All data were analyzed using the statistical analysis system SAS (2000).

III. RESULTS AND DISCUSSION

3.1. Chemical composition

Results of the chemical composition and collagen content of raw and cooked camel sausages treated with different levels of ginger extract are shown in Table 1. Raw sausages treated with 5% ginger extract had the higher moisture content, followed by sausages treated with 15%, 10% ginger extract and the control group with non-significant ($p<0.05$) change. No significant differences were found in protein content among sausage treatments. Raw sausage treated with 5% ginger extract showed the lowest fat content followed by sausages treated with 10 and 15 %, while sausage of the control group had the highest fat content. Collagen content was higher in the control group than in sausages treated with different levels of ginger extract. However, cooked sausages exhibited a reduction with non-significant differences in moisture content. The control group had the higher protein content, while sausages with ginger extract showed the highest fat content Regard to collagen content, the raw sausage of the control group had a higher content than sausages treated with ginger extract. Contrarily, a significant increase was found in collagen content in cooked sausages treated with ginger extract. These results are consistent with Abdel-Naeem & Mohamed (2016) who found that raw camel burgers treated with 7% ginger extract significantly increased the moisture content and decreased fat content with non-significant changes in protein content. Karpinska-Tymoszczyk et al. (2022) stated that moisture content was higher in meatloaf treated with different levels of ginger extract, no significant differences were found in protein content with a non-significant increase in fat content. Conversely, Abdeldaiem & Ali (2014) indicated that the addition of different levels of ginger extract as a tenderization agent in camel meat had no significant effect on the proximate composition. However, the resultant higher moisture content in ginger-treated sausages indicates an improvement in the hydrophilic characteristics. Meanwhile, the reduction in protein content may be due to the degradation of protein by proteolytic enzymes resulting in the release of free amino acids and peptides (Abdel-Naeem & Mohamed, 2016). Results of collagen content are inconsistent with Abdeldaiem & Ali (2014) who found that the addition of different levels of the ginger extract significantly increased the collagen content. Similar results were found by Abdel-Naeem et al. (2022).

3.2. Physical properties

3.2.1. pH value

Results of pH values of camel sausage treated with different levels of ginger extract are shown in Table 2. No significant differences were found in pH values of treated sausages with ginger extract and the control group. These results are close to that obtained by Abdel-Naeem & Mohamed (2016) they found that slight non-significant differences were found in camel patties treated with 7% ginger extract. Also, Abdel-Naeem et al. (2022) found that a slight decrease was found in camel meat treated with 7% ginger extract and 5% ginger + 0.5% papain. Also, Abdeldaiem & Ali (2014) postulated that no significant differences were found in pH values of camel meat treated with different levels of ginger extract. On the other hand, Karpinska-Tymoszczyk et al. (2022) demonstrated that the pH values of meatloaves treated with ginger were higher than the control sample, but these differences were not significant.

3.2.2. Shear force

Sausages treated with different levels of ginger extract exhibited a non-significant decrease in shear force values than the control group (Table 2). Data of shear force values are close to that obtained by Abdel-Naeem & Mohamed (2016) they found that camel patties treated with ginger extract alone or combined with papain powder showed the lowest shear force value than control patties. Similar results were found by Abdel-Naeem et al. (2022) who found that camel meat treated with different levels of ginger extract and papain powder showed a significant decrease in shear force values than the control group. In addition, Abdeldaiem & Ali (2014) found that camel meat treated with different levels of ginger extract exhibited significant decrease in shear force value than control group. Generally, the reduction in shear force value in treated sausage with ginger extract may be due to the tenderizing effect of the proteolytic enzyme (Zingibain).

Table 1 Chemical analysis of camel sausage treated with ginger extract

Proximate Composition (%)	Treatments				
	T1	T2	T3	T4	SEM
Raw sausages					
Moisture	59.24[b]	63.12[a]	61.76[ab]	62.44[a]	0.055
Protein	15.81	15.61	15.64	14.98	0.007
Fat	18.87[a]	13.72[c]	16.25[b]	16.18[b]	0.144
Collagen	1.66[a]	0.86[b]	0.68[c]	0.97[b]	0.026
Cooked sausages					
Moisture	54.54	56.83	56.59	56.65	0.051
Protein	23.23[a]	22.06[ab]	21.03[c]	21.64[b]	0.065
Fat	13.90[b]	14.02[b]	14.88[a]	15.31[a]	0.109
Collagen	3.24[a]	2.03[c]	3.16[b]	2.89[b]	0.031

[a-c] means within the same row with different superscripts letters are different ($p<0.05$). T1: control, T2: contains 5% Ginger extract, T3: contains 10 % Ginger extract and T4: contains15 % Ginger extract. SEM: standard error of means.

Table 2 Physical properties of camel sausage treated with ginger extract

Physical properties	Treatments				SEM
	T1	T2	T3	T4	
pH value	5.80	5.68	5.66	5.59	0.029
Shear force (Kg/f)	3.06	2.58	2.68	2.59	0.091
Cooking loss (%)	36.53[b]	32.95[c]	39.63[a]	37.27[b]	0.542
Color measurements					
*L**	46.0[a]	44.21[b]	46.39[a]	46.13[a]	0.003
*a**	10.94	10.78	11.09	11.12	0.017
*b**	8.53[b]	8.48[b]	9.00[ab]	9.66[a]	0.714

[a-c] means within the same row with different superscripts letters are different ($p<0.05$). T1: control, T2: contains 5% Ginger extract, T3: contains 10 % Ginger extract and T4: contains15 % Ginger extract. SEM: standard error of means.

Moreover, the solubilized collagen derived from the connective tissues after treatment with ginger extract has excellent water- holding capacity (Badr, 2008). While the higher shear force values of control sausages are due to the high amount of connective tissue in camel meat.

3.2.3. Cooking loss

Significant differences were found in the cooking loss of camel sausages (Table 2). The lowest cooking loss was found in sausage treated with 5% ginger extract, followed by the control group and sausage treated with 15%. The results of cooking loss are consistent with the results of Abdel-Naeem & Mohamed (2016) they found that camel patties treated with ginger extract and papain powder showed higher cooking loss than control patties. Similar results were found by Abdel-Naeem et al. (2022) who found that the cooking loss of camel burgers treated with different levels of ginger extract and papain powder was higher than control group. Contrarily, Abdeldaiem & Ali (2014) indicated that treated camel meat with different levels of ginger extract significantly decreased the cooking loss and increased the cooking yield in the control group. While Moeini et al. (2022) proved that no significant differences in cooking loss between control and camel meat treated with ginger extract and citric acid.

3.2.4. Color measurements

Color measurements of camel sausages are shown in Table 2. No significant differences were found in L* values among sausages treatments and control group except for sausage treated with 5% ginger extract which exhibited the lowest value. On the hand, no significant differences were found in a* values despite sausages treated with higher levels of the ginger extract showing higher a* values. While slight significant differences were found in b* values. Sausages treated with 15% ginger extract had the highest b* value followed by sausage with 10 % ginger extract while, no significant differences were found in sausages of 5% ginger extract and control the group. Data of color measurements are close to that obtained by Abdel-Naeem & Mohamed (2016) they found that treated camel patties with ginger extract and papain powder had a slightly significant effect on L* values, a non-significant effect on a* values, while a significant effect was found in b* values among treated patties. Contrarily, Abdel-Naeem et al. (2022) found that treated camel meat with different levels of ginger extract and papain powder significantly affected a* values and had no significant effect on L* and b* values. On the other hand, Karpinska-Tymoszczyk et al. (2022) demonstrated that treated meatloaf with different levels of ginger extract significantly affected L* values, decreased a* values and had no significant effect on b* values.

3.3. Fat retention, moisture retention and shrinkage measurements (%)

Data of fat retention, moisture retention and shrinkage measurements % are shown in Table 3. Sausage treated with 5% ginger extract had the higher fat retention, followed by sausages with 15 and 10 %, while the control group had the lowest fat retention. Concurrently, sausage with 5% ginger extract had higher moisture retention. No significant differences were found between other sausage treatments. Fat retention significantly increased in camel sausage treated with different levels of ginger extract. These results are inconsistent with the findings of Abdel-Naeem & Mohamed (2016) who stated that camel burger patties treated with ginger extract (7%) resulted in significantly lower fat retention compared to control patties. On the other hand, the results of moisture retention are consistent with Abdel-Naeem & Mohamed (2016) who indicated that camel patties with 7% ginger extract resulted in a non-significant increase in moisture retention.

Table 3 Fat retention, moisture retention and shrinkage measurements of camel sausage treated with ginger extract

Parameters	Treatments				
	T1	T2	T3	T4	SEM
Fat retention (%)	46.69^{c}	68.39^{a}	55.18^{bc}	59.44^{b}	2.250
Moisture retention (%)	34.62^{b}	40.00^{a}	34.19^{b}	35.50^{b}	0.329
Shrinkage (%)	19.11^{a}	12.20^{b}	13.24^{b}	13.35^{b}	0.813
Reduction in length (%)	16.10^{a}	11.56^{b}	12.46^{b}	11.93^{b}	2.315
Reduction in width (%)	26.74^{a}	14.54^{c}	16.84^{c}	20.32^{b}	6.005

$^{a-c}$ means within the same row with different superscripts letters are different ($p<0.05$). T1: control, T2: contains 5% Ginger extract, T3: contains 10 % Ginger extract and T4: contains15 % Ginger extract. SEM: standard error of means.

Shrinkage measurements of camel sausages are shown in Table 3. It can be noticed that sausages treated with different levels of ginger extract had a lower reduction in length, width and shrinkage than control sausage. Treated sausages with different levels of ginger extract significantly improved the reduction in shrinkage measurements. Also, it can be found that the results of shrinkage measurements are concordant with the results of fat, moisture retention and cooking loss. This finding came by the results of Naeem & Mohamed (2016) who postulated that cooking loss reflects the losses of moisture and fat content during cooking, while fat and moisture retentions reflect the amount of fat and moisture remaining in meat after cooking.

3.4. Histological evaluation

The histological examination of camel sausages treated with different levels of ginger extract stained with H&E are shown in Figures (1, 2, 3, and 4) Light micrograph of control (untreated camel sausage) displayed intact muscle fibers (MF) which were closely bound to each other and large amount of intact connective tissue (CT) as showed in (Fig. 1). Treated sausages with 5% ginger extract resulting in moderated broken muscle fibers (MF) and moderate destructed connective tissue (CT) as found in (Fig. 2). Camel sausage treated with 10% ginger extract revealed severe muscle fragmentation (MF) and severe destructive

connective tissue (CT) as showed in (Fig.3). However, light micrograph of camel sausage treated with 15% ginger extract exhibited slight breaks across the muscle fibers (MF) and mild degradation in connective tissue (CT) as found in (Fig.4). These microscopic observations are concordant with the scanning electron micrographs of camel burger treated with ginger extract reported by Abdel-Naeem & Mohamed (2016) and the scanning electron micrographs of camel meat treated with ginger extract examined by Abdel-Naeem et al. (2022).

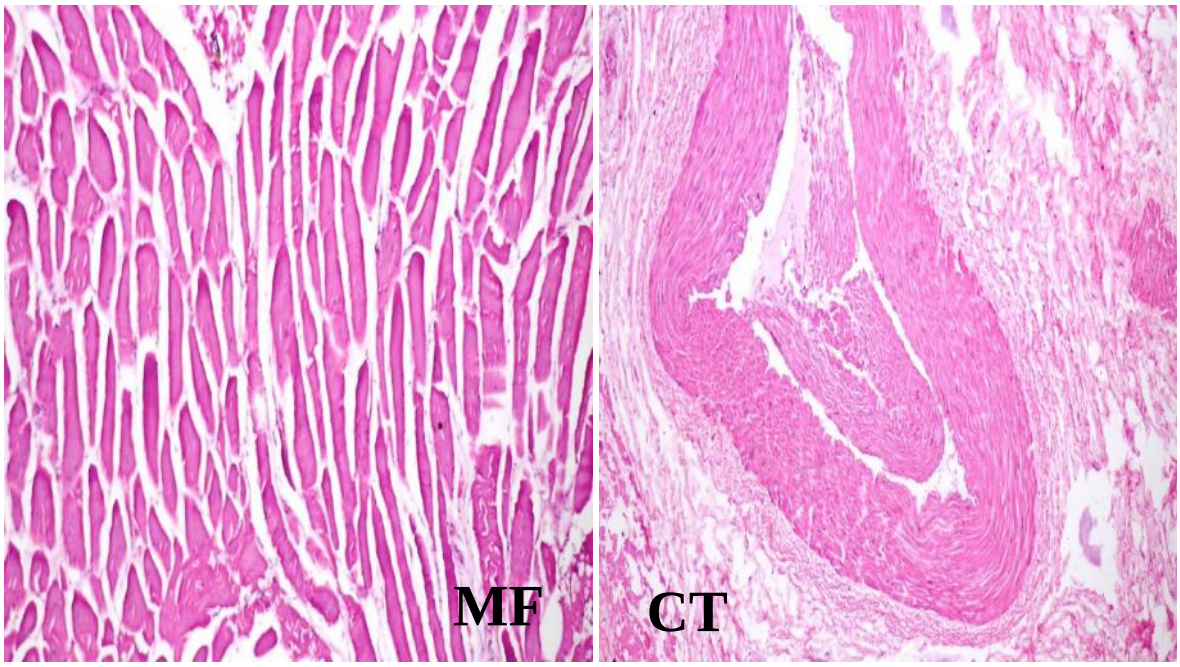

Fig.1. Light micrograph of control camel sausage stained with H&E (×200). MF: muscle fiber; CT: connective tissue.

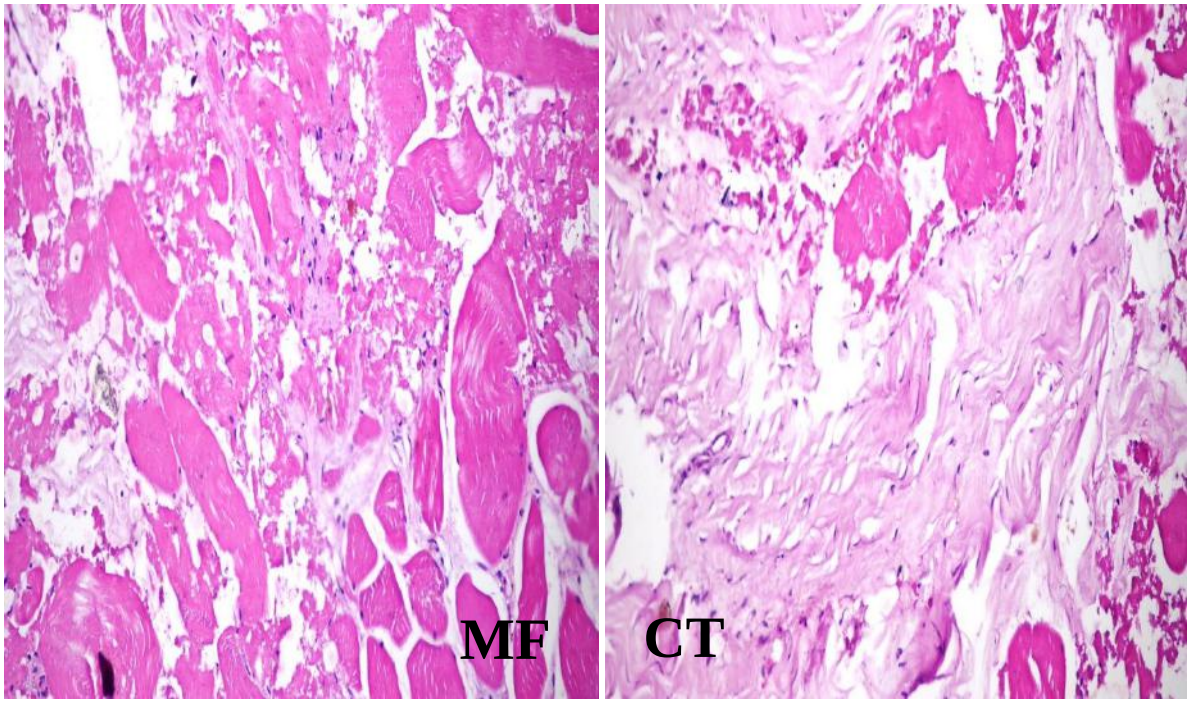

Fig.2. Light micrograph of camel sausage treated with 5% ginger extract stained with H&E (×200). MF: muscle fiber; CT: connective tissue.

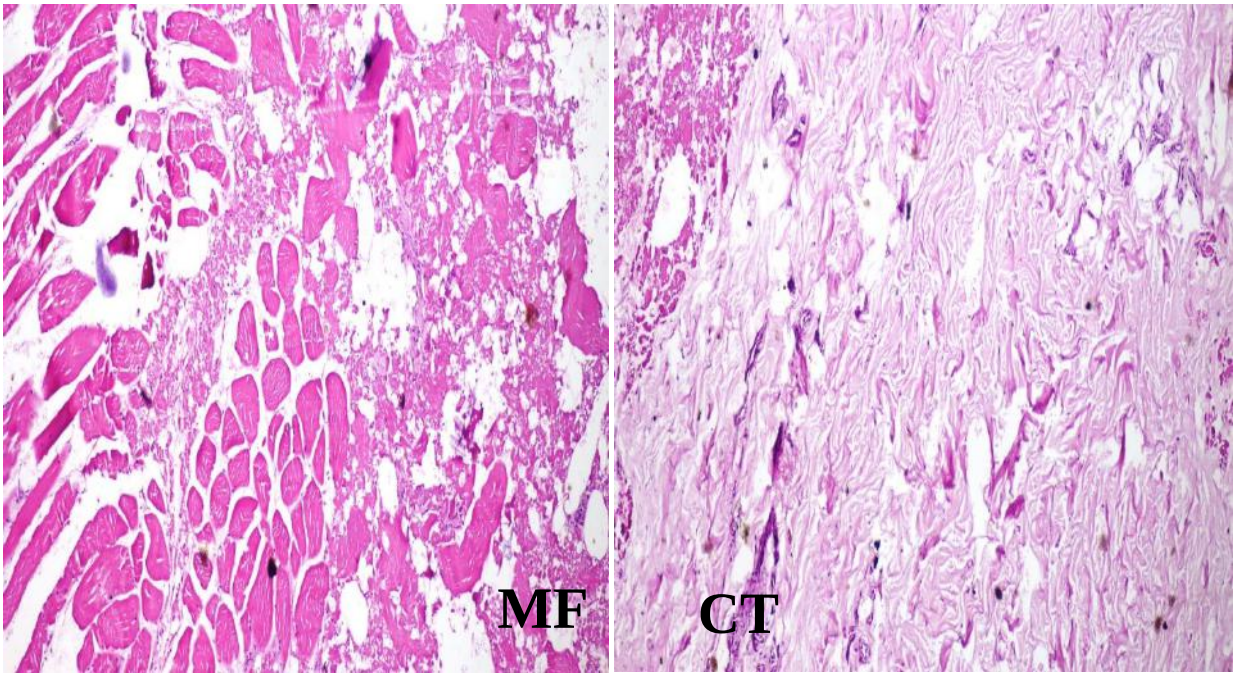

Fig.3. Light micrograph of camel sausage treated with 10% ginger extract stained with H&E (×200). MF: muscle fiber; CT: connective tissue.

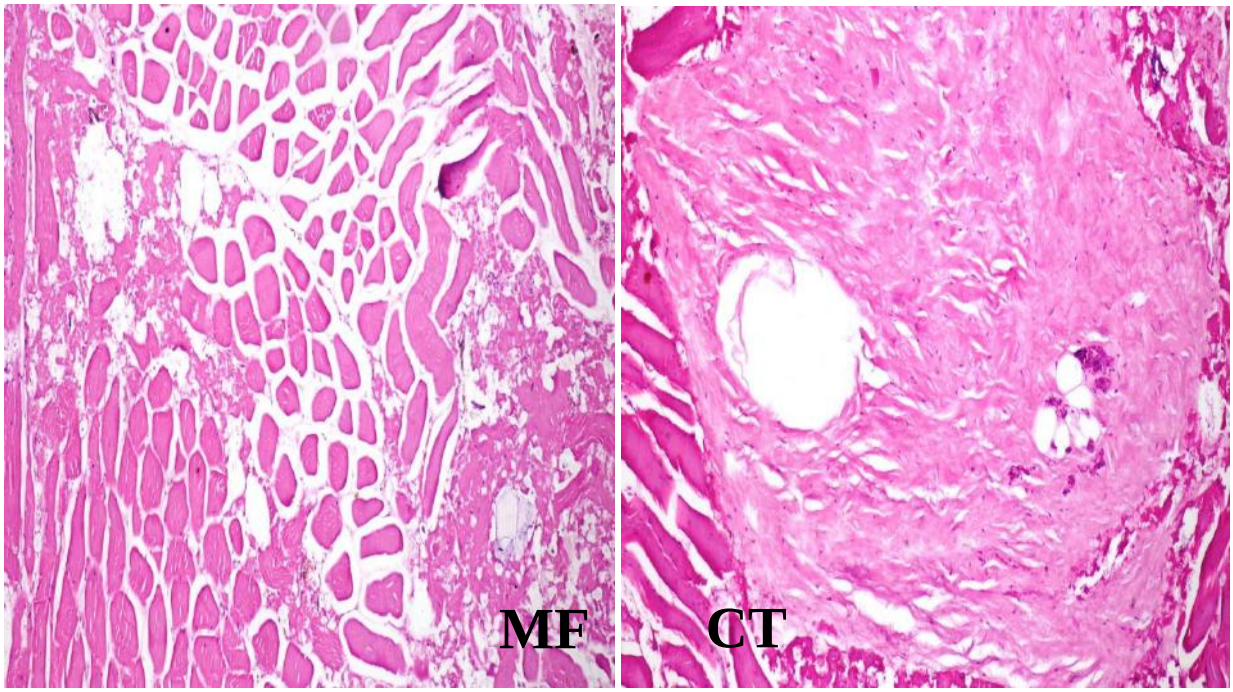

Fig.4. Light micrograph of camel sausage treated with 15% ginger extract stained with H&E (×200). MF: muscle fiber; CT: connective tissue.

3.5. Sensory Evaluation

The sensory attributes of camel sausages treated with different levels of ginger extract are presented in Table 4. No significant differences were found in appearance and juiciness scores between sausages treatments and the control group. Sausage of 10% recorded the highest score for texture, followed by control and sausage of 5% ginger extract. Slight significant differences were found in flavor scores among sausage treatments. The highest score of tenderness was found in the sausage with 10 % ginger extract. However, sausage with 10% ginger extract recorded the highest score for overall acceptability. Camel sausages

treated with different levels of ginger extract significantly improved the sensory attributes of sausage. However, the evaluation of sensory attributes for meat and meat products treated with different levels of ginger extract has been reported by different authors (Abdeldaiem & Ali, 2014; Naeem & Mohamed, 2016; Abdel-Naeem et al., 2022; Karpinska-Tymoszczyk et al., 2022; Moeini et al., 2022).

Table 4 Sensory evaluation of camel sausage treated with ginger extract

	Treatments				
Sensory attributes	T1	T2	T3	T4	SEM
Appearance	6.6[a]	6.6[a]	6.8[a]	6.6[a]	0.007
Texture	6.8[b]	6.7[b]	7.0[a]	6.2[c]	0.011
Juiciness	6.7	6.9	6.9	6.6	0.009
Flavor	6.7[ab]	6.7[ab]	7.1[a]	6.3[b]	0.057
Tenderness	6.2[c]	6.8[b]	7.1[a]	6.7[b]	0.025
Overall acceptability	6.8[b]	6.7[b]	7.5[a]	6.3[c]	0.082

[a-c] means within the same row with different superscripts letters are different ($p<0.05$). T1: control, T2: contains 5% Ginger extract, T3: contains 10 % Ginger extract and T4: contains15 % Ginger extract. SEM: standard error of means.

IV. CONCLUSIONS

View on the current study, it could be concluded that the addition of fresh ginger extract to the mature camel meat during the formulation of camel sausage significantly improved the color measurements, decreased the cooking loss, and shrinkage measurements, and increased the fat and moisture retention. Moreover, the addition of ginger extract resulted in significant degradation in muscle fibers and destruction of connective tissue and significantly increased sensory attributes. These effects may encourage meat manufacturers to use mature camel meat as raw material in the processing of meat products that can be accepted by consumers.

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REFERENCES

[1] AMSA. American Meat Science Association. (1995). Research guidelines for Cookery, Sensory Evaluation and Instrumental Tenderness Measurements of Fresh Beef. Chicago, IL, USA.

[2] Abdeldaiem MH, Ali HGM. (2014). Tenderization of camel meat by using fresh ginger (*Zingiber officinale*) extract. Food Science and Quality Management. 23: 25-38.

[3] Abdel-Naeem HHS, Mohamed HMH. (2016). Improving the physico-chemical and sensory characteristics of camel meat burger patties using ginger extract and papain. Meat Science. 118: 52–60.

[4] Abdel-Naeem HHS, Mohammed MT, Kálmán I, Morar A, Herman V, El-Nawawi FAM. (2022). Structural changes, electrophoretic pattern, and quality attributes of camel meat treated with fresh ginger extract and papain powder. Foods. 11: 1876-1891.

[5] Badr HM. (2008). Tenderness properties and microbial safety of spent hen meat treated by papain and gamma irradiation. Journal of Radiation Research and Applied Sciences. 1: 443–462.

[6] Banchroft J D, Stevens A, Turner D R. (1996). Theory and practice of histological techniques (4th ed.). New York, London, San Francisco, Tokyo: Churchil Livingstone.

[7] Berry BW. (1993). Fat level and freezing temperature affect sensory, shear cooking and composition properties of ground beef patties. Journal of Food Science. 58(1):34-42.

[8] CIE (Commission International de l'E´ clairage). (1976). Official recommendations on uniform colour spaces. Colour difference equations and metric colour terms, Suppl. No. 2. CIE Publication No. 15 Colourimetry. Paris.

[9] El-Magoli SB, Laroia S, Hansen PTM. (1996). Flavor and texture characteristics of low-fat ground beef patties formulated with whey protein concentrate. Meat Science. 42: 179–193.

[10] Farouk MM, Bekhit AE. (2013). Processed camel meats. In Kadim I T. Mahgoub O, Faye B, Farouk, MM. (Eds.), Camel meat and meat products. Oxfordshire, UK and Bostan, MA, USA: CAB International.

[11] Fernández-Lucas J, Castañeda D, Hormigo D. (2017). New trends for a classical enzyme: papain, a biotechnological success story in the food industry. Trends Food Science and Technology 68:91–101.

[12] Kadim IT, Mahgoub O, Purchas RW. (2008). A review of the growth, and of the carcass and meat quality characteristics of the one-humped camel (*Camelus dromedarius*). Meat Science. 80:555–569.
[13] Karpinska-Tymoszczyk M, Draszanowska A, Danowska-Oziewicz M. (2022). The effect of ginger rhizome addition and storage time on the quality of pork meatloaf. Foods. 11: 3563.
[14] Khalil AH. (2000). Quality characteristics of low-fat beef patties formulated with modified corn starch and water. Food Chemistry. 68: 61-68.
[15] Mendiratta SK, Sharma BD, Narayan R, Mane BG. (2010). Effect of proteolytic enzyme treatments and pressure cooking on quality of spent sheep meat curry. Journal of Muscle Foods. 21: 685–701.
[16] Moeini R, Zamindar N, Najvani FA. (2022). The effect of marination by using ginger extract and citric acid on physicochemical characteristics of camel meat. Food Science and Technology International. 16:1-12.
[17] Mohammed HHH, Jina G, Maa M, Khalifaa I, Shukatc R, Elkhedira AE, Zenga Q, Noman AE. (2020). Comparative characterization of proximate nutritional compositions, microbial quality and safety of camel meat in relation to mutton, beef, and chicken. LWT-Food Science and Technology. 118:108714.
[18] Murphy EW, Criner PE, Grey B C. (1975). Comparison of methods for calculating retentions of nutrients in cooked foods. Journal of Agricultural and Food Chemistry. 23:1153–1157.
[19] Naveena B M, Muthukumar M, Sen A R, Babji Y, Murthy T R K. (2006). Quality characteristics and storage stability of chicken patties formulated with finger millet flour (Eleusine coracana). Journal of Muscle Foods. 17: 92-104.
[20] SAS. User's Guide Statistics. (2000). SAS Institute, Inc. Cary, N.C., USA.
[21] Thompson EH, Wolf ID, Allen CE. (1973). Ginger rhizome: A new source of proteolytic enzyme. Journal of Food Science. 38: 652–655.
[22] Verma AK, Umaraw P, Singh VP, Kumar P, Mehta N. (2019). Tender meat attracts consumers: beneath other mechanical processes in the meat industry tenderization is used globally. Fleischwirtschaft international: journal for meat production and meat processing. 3:36–43.