QUALITY IMPROVEMENT OF CAMEL MEAT BURGER FORMULATED WITH FAT REPLACERS DURING FROZEN STORAGE

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SUMMARY

The objective of this study was to improve the quality of camel meat burger by replacing camel meat fat with two levels (5 and 10%) of barley grains and wheat bran as fat replacers. The obtained results of fat-replaced treatments scored higher content of moisture, crude protein, total ash, crude fibres and lower content of fat, compared with those of control sample. Also, the total energy value was 254.49/100g kcal for fresh, while low-fat levels of treated samples were 175.10 (10% fat) and 207.43 kcal/100g (15 % fat) before cooking, respectively. The pH values of all treatments were significant higher (P≥0.05) than those of control one. Meanwhile, Thiobarbituric acid values (TBA) of the treated burger samples were significantly lower (P≥0.05) than those of control sample. Furthermore, the impact of storage on the quality attributes of the camel meat burger was as per the following: slight decrease in pH values was noticed in all treatments, an increase in TBA values in all treatments. Water holding capacity (WHC) of the treatments with fat-replacers which was significantly higher (P≥0.05) than the control counterpart decreased during frozen storage for all treatments. Cooking loss and shrinkage percentage of fat-replacer treatments were significantly lower than those of control and by progressive frozen-storage period, noticed an increase in both of cooking loss and shrinkage, meanwhile, the cooking yield was decreased. The total bacterial count as well as psychrophilic count was significantly higher in fat–replaced treatments than those of control one. The number of bacterial count increased with decreasing the fat level for 45 days of storage periods then number of bacterial count decreased until the end of frozen storage. Concerning the sensory evaluation, the overall acceptability was higher due to fat-replaced samples. It could be concluded that using wheat bran and barley grains for producing camel meat burger led to an improvement in quality characteristics and an improvement in the overall acceptability of the treatments. The best treatment was camel burger which prepared with 10% barley grain + 10% fat content.

***Keywords**: Camel burger, fat, wheat bran, barley, fat replacers.*

INTRODUCTION

The camel (*Camelus dromedarius*) plays a key role in the lifestyle of the people of many countries, especially those in dry zones. Besides providing various labor, transportation and sports services, camel contributes to the economy and food security of humans by providing milk and meat (Benkerroum *et al.*,2004). Camel meat had moister, less fat and ash, meanwhile, protein content was similar to beef, lamb, goat and chicken meats (El Gasim and AlKanhal, 1992 and Mansour and Ahmed, 2000).

Because of the meat and meat products lead to certain diseases, the meat industry has been worst hit by adverse publicity. The role of fat as one of the main causes of cardiovascular disease has been well documented (Rossum *et al.*, 2000). Fat, trans fatty acids (FAs), cholesterol and saturated FAs of meat products have also been associated with obesity and cancers (especially colon, prostate and breast) in developing countries (Grundy, 1994; Slattery *et al.*, 1999). Extensive researches have been performed on fat replacement to improve quality of many products (Lucca and Tepper, 1994; Allen *et al.*, 1999 and Jimenez-Colmenero, 2000).

It has been reported that, carbohydrates, protein or fat-based replacers could be used to reduce fat content of meat products (Egbert *et al.*, 1991 and Giese, 1996). Among these, fiber has many health benefits besides improving technological properties of the products (Mansour and Khalil, 1997). High-fiber low-fat foods tend to reduce the risk of colon cancer, obesity, cardiovascular diseases and several other disorders (Tungland and Meyer, 2002). In recent years, cereals and their ingredients have been

accepted as functional foods, primarily due to constant promotion of dietary fiber, proteins, energy, minerals, vitamins and antioxidants required for human health.

Previous studies have been performed to evaluate the effects of adding dietary fibre (DF)-rich cereal materials to meat products with a reduced fat content, for examples being rye bran, oat fibre, barley B-glucan, and wheat fibre (Petersson, 2012). According to "Regulations on Nutrition Claims for Conventional Foods", food products marked as "high fiber" must contain at least 6 g of dietary fiber for every 100 g of solid food; food products marked as "containing dietary fiber" must contain at least 3 g of dietary fiber for every 100g of solid food (Huang *et al.,* 2011).

In Egypt, the production area of barley attained about 67.520 hectares at 2011 and the total yield is about 18.112.26 Hg/Ha and the production is 122.294 tones according to FAOSTAT (2011). On the other hand, the production area of wheat attained about 1.284.950 hectares at 2011 and the total yield in about 65.427.68 Hg/Ha and the production is 8.407.130 tones according to FAOSTAT (2011).

Therefore, our objectives was to improve the quality of camel meat burger by replacing camel meat fat with two levels (5 and 10%) of barley grains and wheat bran as fat replacers. Also, to study the effect of storage at -18ºC for 3 months on the products.

MATERIALS AND METHODS

Fresh camel meat and fat were obtained from Maryout Research Station, Desert Research Center. Samples were taken from boneless rounds that had been trimmed of all subcutaneous fat and thick, visible connective tissues. The meat samples were kept frozen at -18°C until they were used. Wheat bran and barley grains were obtained from Agricultural Research Center. They were ground to be a powder using a (Moulinex Mill) and then used as a fat substitute in the preparation of low-fat camel meat burgers. Fresh onion, milk powder, salt and spice mixture (black pepper, nutmeg, Chinese kebab, laura paper, cardamom, cinnamon) were purchased from a local market.

Camel meat burger formulation:

Separately, meat and fat were minced in an electrical meat mincer. The experimental design included five treatments that differed in the percentage of fat replaced at different quantities of dietary fiber, as shown in Table 1. Meat and other ingredients were carefully mixed by hand before being minced for all treatments and then shaped into 70g as burger. Then placed into foam plates coated with polyethylene layer and stored at –18 ºC until analysis, as Farouk and Bekhit described in (2013). Samples were thawed overnight at 4ºC before chemical analysis. All samples were tested immediately after processing and grilled (zero time) and once a month for three months during storage according to Ali *et al.* (2011). All treatments were performed in triplicates.

Table (1): Formulation of camel meat burgers (%) with different fat replacers.

Ingredient	Treatment %				
	C	W5	W10	B5	B10
Minced camel meat	70	70	70	70	70
Camel fat	20	15	10	15	10
Wheat bran powder	-	5	10	-	-
Barley grains powder	-	-	-	5	10
Spice mixture	2	2	2	2	2
Milk powder	3	3	3	3	3
Salt	2	2	2	2	2
Fresh onion	3	3	3	3	3

C = control, W5= wheat bran 5%, W10= wheat bran 10%, B5= barley grains 5%, B10= barley grains 10%.

Chemical and physical analysis:

The moisture, ether extract, crude protein content, total ash content and crude fibers was determined according to the method described by the A.O.A.C., (2005). Total carbohydrates content was calculated by difference. Total calorie (Kcal) for uncooked and cooked burgers were calculated based on 100 g

sample using Atwater values as described by Ali *et al*. (2011). The pH value of raw burgers samples was measured using a digital pH meter (model 3305, Jenway) according to the method described in AOAC (2005). Thiobarbituric acid (TBA) value of samples was determined according to the method of Vyncke (1970). The water holding capacity (WHC) of raw burger samples was estimated according to Ali *et al.* (2011). The shrinkage percentage of samples after cooking was calculated as described by Serdaroğlu and Değirmencioğlu (2004). Cooking loss and cooking yield of the prepared camel burgers were determined according to Khalil (2000).

Microbiological analysis:

According to American Public Health Association (APHA, 1992) Total aerobic mesophilic bacterial count (TABC) and Psychrophilic bacterial count (SBC) were determined using standard plate count agar medium for all treatments during storage period.

Sensory evaluation:

Cooked camel burger samples were sensory evaluated immediately after cooking during storage period. All cooked camel burger samples were cut to small pieces and coded with random numbers as described by AMSA (1995). Eight panelists from Desert Research Center, Ministry of Agriculture and Land Reclamation, evaluated five parameters as taste, odor, texture, color and overall acceptability. The means of obtained results from sensory evaluation were statistically analyzed.

Statistical Analysis:

Results of the chemical composition, physical properties, microbiological analysis and sensory evaluation were statistically analyzed by the General Linear Model procedure according to SAS (2001).

RESULTS AND DISCUSSION

Chemical composition:

Table (2) shows moisture content of the camel burger during the storage and cooking period affected by different fat replacers.

The highest moisture content of raw and cooked camel burgers was recorded for sample contains 10% B followed by sample contains 5% B with significant differences ($P \leq 0.05$) between all treatments. Hussein (2015) found that moisture content of low-fat sausage prepared with fat replacers was affected of type and fat replacers. Generally, moisture content increment was by substitution ratio increased but during frozen storage in all treatments whether raw or cooked were significantly decreased. These results agree with those obtained by Ali (2008).

It could be observed from Table (2) that during storage time, the ether extract content was significantly ($P \leq 0.05$) increased for all fat replacer treatments. This might be attributed to the decrease in moisture content throughout the frozen storage period. These results in agreement with those obtained by Osheba (2003), Abolgasem (2011), Hamza (2011) and Hussein (2015).

Results presented in Table (3) showed the crude protein content of raw and cooked camel burger samples during storage period. It could be observed that, there were significant differences ($P \leq 0.05$) in protein content among all treatments studied at any time of storage. During frozen storage at -18°C, the protein content progressively increased along the period of storage for all treatments. Also, increased in crude protein content for cooked camel meat burger samples. These results may be occurring due to the moisture loss during frozen storage (Lin and Chao, 2001).

Results in Table (3) showed the crude fiber content of different studied treatments during storage period at -18ºC. With prolongation of frozen storage, crude fiber content slightly increased in all treatments. This probably may be due to losses in moisture content during the frozen storage. Similar results obtained by Hussein (2015) observed that low-fat sausage prepared with fat replacers at different fat levels showed higher crude fiber contents than high fat sausage controls.

Results in Table (4) demonstrated the total carbohydrates content of different studied treatments during storage period at -18ºC. It could be observed that, there were significant differences ($P \leq 0.05$) among all studied treatments in total carbohydrates content. These results may be occurring due to the presence of total carbohydrates in original additives as fat-replacers. the highest total carbohydrates

Table (2): Moisture and ether extract content of camel meat burger samples as affected by adding different fat replacers % during frozen storage at -18°C and cooking.

	Storage period (months)	C	W5	W10	B5	B10	C	W5	W10	B5	B10
		Raw					cooked				
Moisture		59.60Ac	59.75Abc	59.89Ab	60.14Aa	60.22Aa	50.69Ac	50.80Abc	51.80Ab	54.03Aa	54.13Aa
		58.85Bc	58.92Bc	59.66Ba	59.09Bb	59.80Ba	50.10Be	50.42Bd	51.37Bc	53.37Bb	53.89Aa
		58.26Cc	58.50Cb	58.79Cb	58.24^{Cc}±0.5	59.13Ca	49.61Ce	50.08Cd	50.89Cc	52.12Cb	53.58Aa
		57.53Db	57.67Dab	57.84Da	57.90Da	58.03Da	48.80De	49.40Dd	50.27Dc	51.63Db	53.29Aa
Ether extract	Zero time	20.32Ca	14.52Db	10.48Cc	14.64Cb	10.31Cc	20.94Da	16.97Db	11.91Dd	14.80Dc	11.75Dd
	1	20.66Ba	15.18Cb	10.55Cd	14.91Bc	10.36BCde	21.07Ca	17.01Cb	11.99Cd	14.99Cc	11.81Cd
	2	20.74Ba	15.53Bb	10.78Bd	15.06Ac	10.46ABde	21.19Ba	17.11Bb	12.17Bd	15.05Bc	11.90Be
	3	20.85Aa	15.92Ab	11.14Ad	15.14Ac	10.55Ae	21.94Aa	17.35Ab	12.29Ad	15.21Ac	11.99Ae

*Within the same column and row means with different superscripts a, b, and c are significant at P <0.05. C= control sample &W5= wheat bran 5% & W10= wheat bran 10% & B5= barley grains 5% & B10= barley grains 10%. *Values presented are mean of three replicates*

Table (3): Crude protein and crude fiber content of camel meat burger samples as affected by adding different fat replacers % during frozen storage at -18°C and cooking.

	Storage period (months)	C	W5	W10	B5	B10	C	W5	W10	B5	B10
		Raw					Cooked				
Crud protein	Zero time	14.29Dc	15.45Ab	15.04Cb	15.84Ab	16.23Ca	18.78Dc	19.85Db	19.96Db	19.99Cb	20.69Ba
	1	14.59Cc	15.50Bb	15.11Cbc	15.90Bb	16.32Ba	18.98Cd	19.96Cc	20.08Cb	20.02Cb	20.71Ba
	2	14.84Bc	15.55Cb	15.27Bbc	15.95Bb	16.40Bab	19.25Bc	20.07Bb	20.24Bb	20.70Bb	20.77Aa
	3	15.23Ac	15.60Db	15.40Abc	15.99Cb	16.56Aa	19.53Ac	20.30Ab	20.44Ab	20.83Ab	20.80Aa
Crud fiber	Zero time	0.71Ae9	3.70Cc	5.18Da	3.12Cd	4.68Cb	1.95Ce	4.48Bc	6.01Da	4.21Dd	5.15Bb
	1	0.81Ae	4.03Bc	5.40Ca0	3.68Bd	4.69Cb	2.99BCd	4.51Bc	6.09Ca	4.54Cc	5.23Ab
	2	0.82Ad	4.08Bc	5.56Ba	4.02Ac	5.01Bb	3.01Bd	4.57Ac	6.13Ba	4.70Bc	5.28Ab
	3	0.87Ad	4.19Ac	5.75Aa	4.05Ac	5.26Ab	3.16Ad	4.20Ccd	6.27Aa	4.75Ac	5.32Ab

*Within the same column and row means with different superscripts a, b, and c are significant at P <0.05. C= control sample &W5= wheat bran 5% & W10= wheat bran 10% & B5= barley grains 5% & B10= barley grains 10%. *Values presented are mean of three replicates.*

Table (4): Total carbohydrates, ash content and caloric value of camel meat burger samples as affected by adding different fat replacers % during frozen storage at -18°C and cooking.

	Storage period (months)	C	W5	W10	B5	B10	C	W5	W10	B5	B10
		Raw					Cooked				
Total carbohv	Zero time	3.64Ac	3.79Ac	5.48Da	3.67Cc	5.10Db	4.82B e	4.91Cc	6.21Da	4.00Bd	5.09Cb
	1	3.60Ac	3.49Cc	5.61Ca	3.71Bc	5.30Cb	4.90Ae	4.93Cc	6.31Ca	4.04Bd	5.15Bb
	2	3.79Ac	3.44Cc	5.84Ba	3.92Ac	5.42Bb	4.97Ae	4.97Bc	6.37Ba	4.24Ad	5.17Bb
	3	3.82Ac	3.68Bc	6.08Aa	4.01Ac	5.97Ab	5.08Ce	5.36Ac	6.43Aa	4.24Ad	5.25Ab
Ash	Zero time	1.42Be	2.79Ac	3.79Ca	2.59Cd	3.46Cb	2.85Bd	2.99Cc	4.11Da	2.97Dc	3.19Cb
	1	1.49Bc	2.88Ab	3.67Ba	2.71Bb	3.53BCa	2.96Ac	3.17Bb	4.16Ca	3.04Cb	3.21Cb
	2	1.55Bc	2.90Ab	3.76BCa	2.81ABb	3.58ABa	2.97Ab	3.20Bb	4.20Ba	3.19Bb	3.30Bb
	3	1.70Ac	2.94Ab	3.93Aa	2.91Ab	3.63Aa	2.99Ac	3.39Ab	4.30Aa	3.29Ab	3.35Ab
caloric value	Zero time	254.41Da	207.43Db	175.10Dc	209.64Cb	177.78Dc	269.50Da	251.55Da	211.48Db	229.02Dab	208.63Db
	1	258.52Ca	212.42Cb	177.39Cc	212.35Bb	179.33Cc	272.03Ca	252.41Ca	213.02Cb	231.01Cab	209.49Cb
	2	260.98Ba	215.52Bb	180.96Bc	214.74Ab	181.03Bc	274.47Ba	253.87Ba	215.55Bb	235.09Bab	210.60Bb
	3	263.66Aa	219.98Ab	185.73Ac	215.96Ab	183.31Ac	278.65Aa	258.47Aa	217.64Ab	236.76Aab	211.82Ab

*Within the same column and row means with different superscripts a, b, and c are significant at P <0.05. C= control sample &W5= wheat bran 5% & W10= wheat bran 10% & B5= barley grains 5% & B10= barley grains 10%. *Values presented are mean of three replicates.*

content was recorded for W10 followed by B10, either raw or cooked camel burger during storage periods. This increased may be occurring due to the loss in moisture content (Hamza, 2011).

Results in Table (4) showed the ash content of raw and cooked camel meat burger samples during storage period. It could be observed that all treatments which containing additive ingredients as fat-replacers had high ash content when compared to control sample. These results may be occurring due to the high total ash content of these fat-replacers. There were significant differences ($P \leq 0.05$) in total ash content among different studied treatments during storage period. The W10 treatment recorded the highest percentage of ash content while the control camel meat burger recorded the lowest value for raw and cooked camel burger during storage period (Abolgasem,2011) and Hamza,2011).

Results in Table (4) showed the caloric value of different studied treatments during storage period on -18ºC. The caloric values were higher in the control treatment followed by the treatments containing 5% fat-replacers and then treatments containing 10%. These results explain that the control treatment contains the highest fat percentage (20%) compared to the other treatments. During storage period the caloric value increased for all treatments for raw or cooked camel meat burger. This probably occurs due to the losses in moisture content (Hussein, 2015).

Physicochemical properties:

Results in Table (5) appeared the change of pH value of camel meat burger samples storied at –18ºC for 3 months. It could be observed that, treatments which prepared by using fat-replacers (W or B) had higher significantly ($P \leq 0.05$) pH-values than that of control sample during storage. These results may be occurring due to the high pH values of these fat-replacers (Kim *et al*., 2016). Generally, the pH values for all camel burger treatments were decreased significantly ($P \leq 0.05$) during frozen storage time. The percentages of decreasing in pH value for camel meat burgers samples were ranged between 3.19 -6.51 % with the end storage period. These results are in agreements with those obtained by Hamza (2011).

The changes of thiobarbituric acid values of different studied treatments during storage period on -18ºC were graphically illustrated in Table (5). Significant differences ($P \leq 0.05$) were observed in TBA values among different studied treatments at any time of storage. Generally, the TBA values were higher in the control treatment followed by the treatments containing 5% of (W or B) fat-replacer and then treatments containing 10%, this increase in the TBA values is associated with the percentage of fat in the product and during storage. This increase in TBA value during the frozen storage could be indicated continuous oxidation of lipids and consequently the production of oxidative by products (Ali, 2008 and Hamza, 2011).

Results showed that in Table (5) were significant differences ($P \leq 0.05$) in WHC values among different treatments at fresh. It could be observed that, fat replacers (W or B) increased the WHC of low-fat burger samples. This could explain the fact that the addition of fiber increased the WHC due to their ability to bind water molecules and retain fat, Gerardo *et al*., (2015). By advancement of frozen storage time, the WHC was decreased for all studied treatments whether the control or low-fat burger. This is probably due to the protein denaturation, its ability to bind water decreases, the loss of protein solubility and biochemical change associated with freezing meat product (Serdaroğlu and Değirmencioğlu, 2004 and Aktas and Genccelep, 2006).

Plasticity values of camel burger treatments during storage period at - 18^{o}C are presented in Table (5). From these results, there are significant differences ($P \leq 0.05$) in plasticity values among different treatments at any time of frozen storage. An improvement in plasticity was observed as the fat-replacers were added to burger as compared to the control samples. This may be occurring due to bind water and fat (Mansour and Khalil, 1999 and Kerr *et al*., 2005). Moreover, the plasticity values of all camel burger treatments increased during storage time. Similar results were obtained by Mohamed (2005) and Ali (2008).

Results tabulated in Table (5), showed the shrinkage values of different studied treatments during storage period at -18ºC up to 3 months. It could be observed that adding fat replacers to a camel burger improves the shrinkage values as compared to control treatment. By prolongation the frozen storage time, the shrinkage was significantly ($P \leq 0.05$) increased for all studied treatments. This might be due to protein solubility which led to decrease in water holding capacity. This increase in shrinkage value during frozen storage similar with the observation of Mohamed (2005) and Ali (2008).

Results given in Fig. 1 and 2 showed that cooking loss and cooking yield of different studied treatments during storage period at -18°C. It could be observed that, the control burger had higher the cooking loss and lower cooking yield than the other camel burger samples. This could be attributed to the excessive fat separation and water release that occurred from breaking emulsion during cooking. In the

control burger sample, fat content was more easily leaching out during cooking, probably occurring due to a low-density meat protein matrix, along with a high fat instability as reported by Suman and Sharma (2003). On the other hand, the cooking loss decreased, and cooking yield increased significant by increase % level of W or B addition different fat-replacers to camel meat burger. By increasing period of frozen storage, the cooking loss increased, and cooking yield decreased of all studied formulas. during frozen storage period, the percentages of increasing in cooking loss and decreasing cooking yield for camel meat burgers samples were ranged between 11.96 - 31.84% and 3.70 - 5.98 %, respectively.

Table (5): Physicochemical properties of camel meat burger samples as affected by adding different fat replacers % during frozen storage at -18°C for 3 months.

	Storage period (months)	C	W5	W10	B5	B10
pH value	Zero time	6.61^{Ad}±0.29	6.68^{Abc}±0.11	6.63^{Acd}±0.22	6.90^{Aa}±0.68	6.77^{Aab}±0.31
	1	6.37^{Bd}±0.24	6.52^{Bc}±0.38	6.45^{Bcd}±0.41	6.82^{Aa}±0.13	6.71^{Ab}±0.25
	2	6.25^{Cd}±0.09	6.46^{Cc}±0.15	6.37^{Ccd}±0.20	6.76^{Ba}±0.12	6.62^{Bb}±0.20
	3	6.18^{Dd}±0.14	6.35^{Db}±0.20	6.29^{Dc}±0.13	6.68^{Ca}±0.31	6.53^{Ca}±0.16
TBA(mg malonaldehyde/ Kg)	Zero time	0.229^{Da}±0.021	0.114^{Db}±0.011	0.095^{Dc}±0.022	0.135^{Db}±0.031	0.067^{Dc}±0.033
	1	0.311^{Ca}±0.011	0.188^{Cc}±0.029	0.115^{Cd}±0.016	0.204^{Cb}±0.017	0.088^{Ce}±0.033
	2	0.606^{Ba}±0.116	0.325^{Bc}±0.112	0.212^{Bd}±0.095	0.421^{Bb}±0.096	0.150^{Be}±0.048
	3	0.965^{Aa}±0.122	0.503^{Ac}±0.107	0.352^{Ad}±0.147	0.665^{Ab}±0.127	0.283^{Ae}±0.079
WHC (%)	Zero time	43.83^{Ae}±0.95	60.75^{Ac}±1.83	64.85^{Ab}±1.68	56.75^{Ad}±1.86	69.80^{Aa}±2.02
	1	41.27^{Bd}±0.83	56.08^{Bc}±1.55	60.22^{Bb}±1.32	54.13^{ABc}±1.77	64.20^{Ba}±2.11
	2	38.81^{Cc}±0.75	53.90^{Bb}±1.41	57.09^{Ba}±1.44	51.56^{Bb}±1.54	59.08^{Ca}±2.42
	3	36.42^{Dc}±0.90	49.39^{Cb}±1.19	51.43^{Ca}±1.50	47.33^{Cb}±1.90	55.82^{Da}±2.20
plasticity(cm^2/0.5g)	Zero time	3.42^{Aa}±0.21	2.62^{Ab}±0.35	2.37^{Ab}±0.31	2.75^{Ab}±0.25	2.43^{Ab}±0.18
	1	2.72^{Ba}±0.26	2.14^{Bb}±0.16	1.37^{Bc}±0.31	2.28^{Aab}±0.24	1.67^{Bc}±0.23
	2	2.42^{Ba}±0.87	1.95^{BCab}±0.09	1.05^{BCc}±0.06	2.08^{Bab}±0.37	1.43^{Cbc}±0.18
	3	2.10^{Ca}±0.12	1.75^{Ca}±0.13	0.97^{Cb}±0.11	1.97^{Cb}±0.53	1.27^{Db}±0.17
Shrinkage (%)	Zero time	32.80^{Ca}±0.27	23.16^{Bc}±0.18	20.03^{Bd}±0.41	28.19^{Cb}±0.21	20.37^{Dd}±0.35
	1	33.10^{BCa}±0.21	25.12^{Bc}±074	21.35^{Bd}±0.65	29.59^{Bb}±0.91	21.83^{Cd}±0.33
	2	34.01^{Ba}±0.60	27.50^{Ac}±0.59	22.03^{Be}±0.41	32.13^{Ab}±0.77	23.08^{Bd}±0.39
	3	35.13^{Aa}±0.71	28.28^{Ac}±0.11	23.33^{Ae}±0.29	33.19^{Ab}±0.21	24.65^{Ad}±0.30

Within the same column and row means with different superscripts a, b, c, d and e are significant at P <0.05. SD, standard deviation of group mean. C= control sample &W5= wheat bran 5% & W10= wheat bran 10% & B5= barley grains 5% & B10= barley grains 10%.

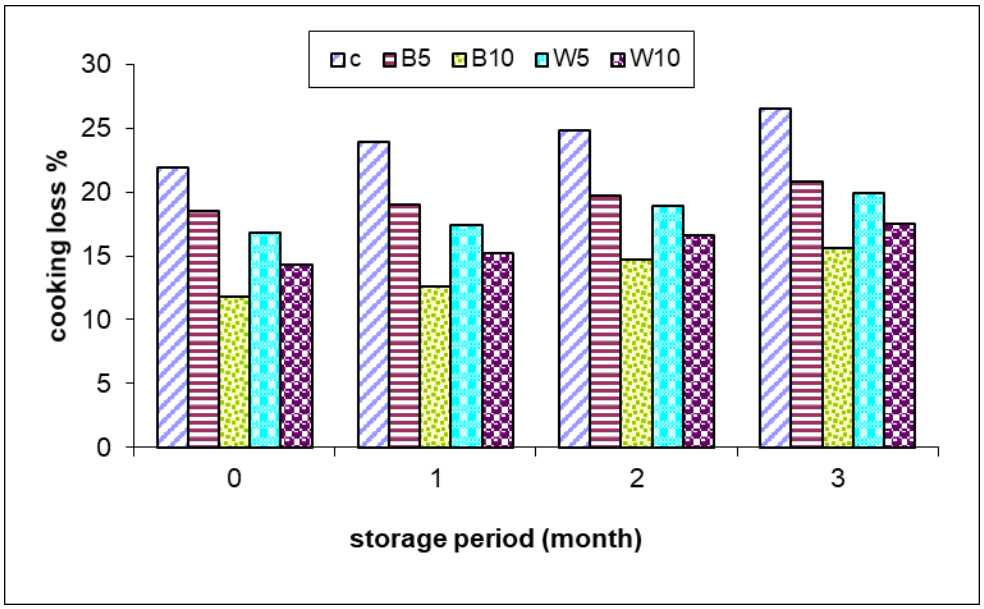

Figure (1): Cooking loss % of camel meat burger samples as affected by % adding different fat replacers during frozen storage at -18°C for 3 months.
C= control sample &W5= wheat bran 5% & W10= wheat bran 10% & B5= barley grains 5% & B10= barley grains 10%.

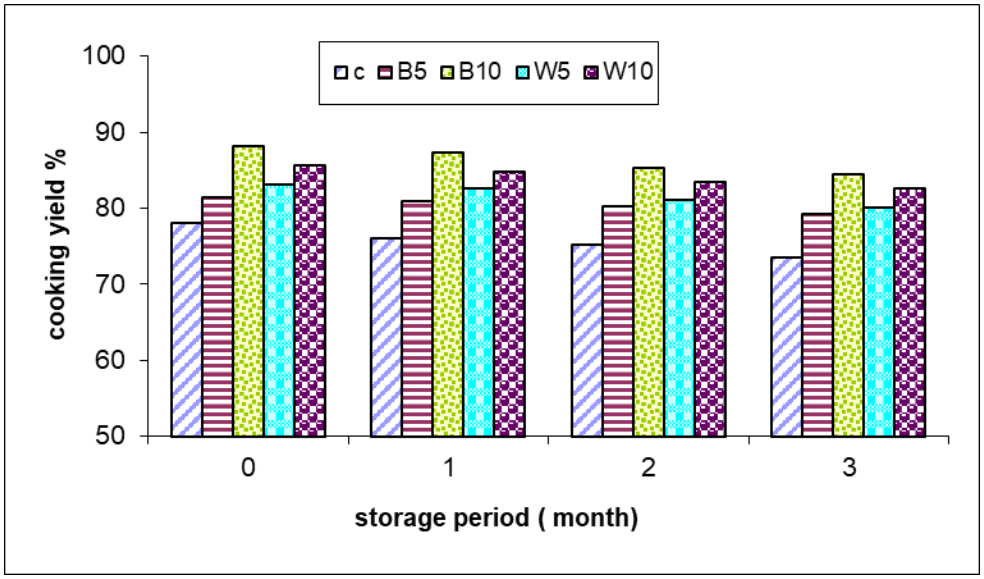

Figure (2): Cooking yield % of camel meat burger samples as affected by % adding different fat replacers during frozen storage at -18°C for 3 months.
C= control sample &W5= wheat bran 5% & W10= wheat bran 10% & B5= barley grains 5% & B10= barley grains 10%.

Microbiological evaluation:

Total bacterial count (CFU/g) of raw different studied treatments and during storage period at -18ºC indicated that low-fat camel burger treated with fat-replacers had higher counts of total bacteria than control sample during frozen storage period, as shown in Fig 3. In addition, when compared to the other treatments, the treatment containing B10% had the greatest total bacteria counts. The addition of fat replacers may be causing these results. On the other hand, by advancement of frozen storage time, the total bacterial counts were increased ($P \leq 0.05$) for all treatments 2months and the decreased at the end of storage period may be occurring due to the damage of bacterial cells caused by ice crystals. Moreover, the mean values of total bacterial count for camel burger samples were still in the limits permitted by the Egyptian standard for frozen burger (10^5) (Egyptian Standards, 2005).

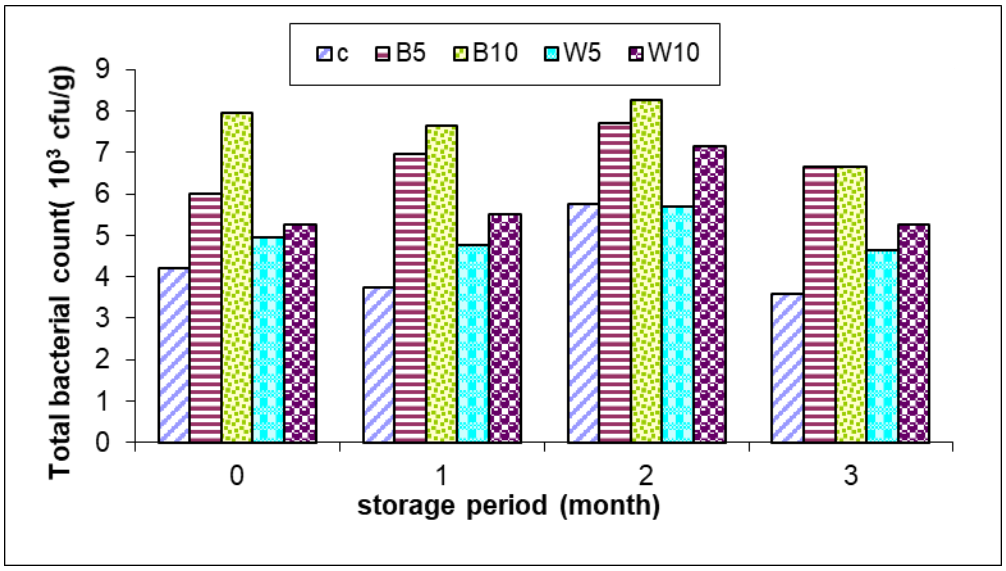

Figure (3): Total bacterial count of camel meat burger samples as affected by adding different fat replacers % during frozen storage at -18°C for 3months.

Psychrophilic bacterial counts (cfu/g) of the various treatments examined during storage at -18ºC in Fig 4. At zero time and during the frozen storage period, low-fat camel burgers treated with fat-replacers had greater numbers of psychrophilic bacteria than the control sample. In addition, when compared to the other treatments, the treatment containing B10% had the greatest total bacteria counts. The addition of fat replacers may have caused these effects. On the other hand, increasing the frozen storage time increased the psychrophilic bacterial counts (P≤0.05) for all treatments until 2 months, and the reduction at the ending of the storage period could be attributed to ice crystal damage to bacterial cells. Furthermore, the Egyptian standard for frozen burgers set the limitations for the mean values of psychrophilic bacterial count for camel burger samples (Egyptian Standards, 2005). These findings are consistent with those of Osheba (2003), and Hamza (2011).

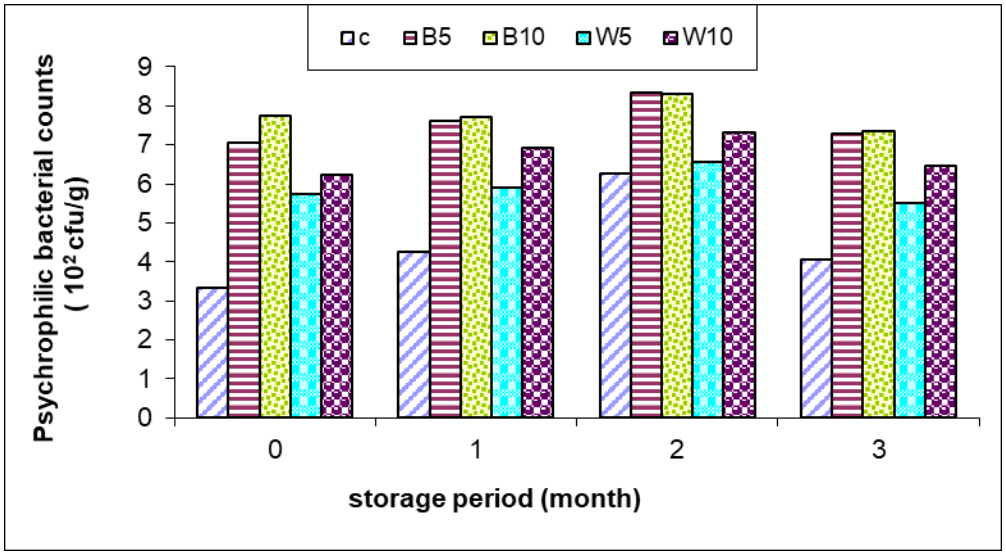

Figure (4): Psychrophilic bacterial count of raw camel meat burger samples as affected by adding different fat replacers % during frozen storage at -18°C for 3 months.

Sensory evaluation:

Sensory evaluation was conducted to evaluate the taste, odor, color, texture, and overall acceptability of camel burgers because of fat replacer percentages during a 3-month frozen storage period at -18°C showed in Table (6). Throughout the storage period, there were significant differences (P≤0.05) in taste scores across different camel burger samples. B10 received the greatest taste rating (7.63), followed by control treatment (5.50), and W5 received the lowest rating (5.00). Taste score values were dramatically

reduced in all treatments when storage time was extended. The percentages of decreasing taste score values for camels at the end of the frozen storage period were ranged between 27.92 - 37.40 %.

Table (6) shows the odor scores of camel burger treatments after 3 months of storage at -18^{o}C. Throughout the frozen storage period in all treatments, the odor score values were considerably (P≤0.05) reduced. Panelists gave B10 the highest odor score, followed by control treatment during storage durations. The percentages of decreasing odor score values for camel meat burgers samples ranged from 37.74 to 28.77 percent at the ending of the frozen storage period.

The texture scores of the different tested treatments during a 3-month storage period at -18^{o}C are shown in table 6. During all storage periods, there were significant differences (P≤0.05) decline in texture scores among different camel burger treatments. Panelists gave B10 the highest texture score (7.00), followed by control treatment (6.13) at zero time, and the same result was observed over all storage durations.

Table (6): Sensory evaluation of camel meat burger samples as affected by adding different fat replacers % during frozen storage at -18°C for 3 months.

score	Storage period (months)	C	W5	W10	B5	B10
Taste	Zero time	5.50^{Ab}±2.45	5.00^{Ab}±2.27	5.38^{Ab}±2.26	5.25^{Ab}±3.11	7.63^{Aa}±0.52
	1	5.25^{Ab}±2.47	4.89^{Bb}±2.25	5.13^{Bb}±2.95	5.02^{Bb}±2.28	6.50^{Ba}±2.05
	2	4.50^{Bb}±2.49	4.00^{Cb}+2.28	4.38^{Cb}±2.92	4.22^{Cb}±2.20	6.25^{Ba}±0.76
	3	3.75^{Cb}±2.05	3.13^{Db}±2.10	3.63^{Db}±2.62	3.50^{Db}±2.07	5.50^{Ca}±0.88
Odor	Zero time	6.50^{Ab}±2.51	5.25^{Ac}±2.34	5.83^{Ac}±2.83	5.50^{Ac}±2.20	7.38^{Aa}±0.74
	1	5.38^{Bb}±2.00	5.19^{Ab}±2.11	5.25^{Ab}±2.31	5.20^{Ab}±2.33	6.25^{Ba}±0.91
	2	5.05^{Bb}±2.53	4.20^{Bc}±2.31	4.50^{Bc}±2.62	4.25^{Bc}±2.26	6.13^{Ba}±0.83
	3	4.63^{Cb}±2.26	3.43^{Cc}±2.06	3.63^{Cc}±2.45	3.50^{Cc}±1.93	5.25^{aC}±0.71
Texture	Zero time	6.13^{Ab}±2.42	5.75^{Ac}±2.92	5.63^{Ac}±2.39	5.75^{Ac}±3.06	7.00^{Aa}±0.53
	1	6.03^{Ab}±2.39	5.25^{Ac}±2.20	5.50^{Ac}±2.78	5.38^{Ac}±2.62	6.25^{Ba}±0.71
	2	5.25^{Bb}±2.12	4.70^{Bc}±2.07	4.88^{Bc}±2.85	4.75^{Bc}±2.92	5.63^{Ca}±0.74
	3	4.38^{Cb}±1.85	3.73^{Cd}±1.89	4.00^{Cc}±2.67	3.88^{Cd}±2.75	5.00^{Da}±0.53
Color	Zero time	6.75^{Aa}±1.39	5.75^{Ab}±1.83	6.25^{Aa}±2.20	6.13^{Aa}±2.10	6.88^{Aa}±0.64
	1	6.55^{Aa}±1.32	5.35^{Bb}±1.77	6.18^{Aa}±2.26	6.00^{Aa}±1.93	6.25^{Ba}±0.89
	2	5.63^{Ba}±0.74	4.75^{Cb}±1.83	5.38^{Ba}±1.92	5.13^{Ba}±2.10	5.75^{Ca}±1.39
	3	4.75^{Ca}±1.42	3.88^{Db}±1.55	4.50^{Ca}±1.60	4.25^{Ca}±1.83	4.88^{Da}±0.64
Overall acceptability	Zero time	5.25^{Ac}±2.60	6.13^{Ab}±1.96	6.50^{Ab}±2.51	6.25^{Ab}±2.49	7.13^{Aa}±0.64
	1	5.13^{Ad}±2.42	6.03^{Ab}±1.88	6.13^{Ab}±2.36	5.13^{Bc}±2.10	6.50^{Ba}±0.76
	2	4.25^{Bc}±2.58	5.13^{Bb}±1.96	5.50^{Bb}±2.51	5.03^{Bb}±2.20	5.88^{Ca}±0.83
	3	3.50^{Cc}±2.27	4.25^{Cb}±1.67	4.63^{Cb}±2.26	4.50^{Cb}±1.93	5.13^{CDa}±0.64

Within the same column and row means with different superscripts a,b,c,d and e are significant at P <0.05. C= control sample, W5= wheat bran 5%, W10= wheat bran 10%, B5= barley grains 5% , B10= barley grains 10%.

The percentages of declining texture score values for camel meat burgers at the conclusion of the frozen storage period were ranged between 28.55 - 35.13%.

The average color scores of the different treatments examined during the frozen storage at -18^{o}C are shown in table 6. Throughout all storage periods, there were significant changes ($P \leq 0.05$) reduced in color scores among different camel burger treatments. Panelists gave B10 the highest color score (6.88), followed by W10 with a score (6.25). The percentages of decreasing color score values for camel meat burgers samples ranged from 28.00 to 32.52 % at the conclusion of the frozen storage period. The similar trend was discovered in all types of storage.

The results in Table (6) demonstrate the overall acceptance scores of the various treatments evaluated throughout a 3-month storage period at -18^{o}C. Throughout the storage period, there were significant changes ($P \leq 0.05$) reduced in overall acceptance scores between different camel burger treatments. Panelists gave B10 the greatest overall acceptability score (7.13) at zero time, followed by W10 with a score of (6.50). The percentages of declining score values of overall acceptability for camel meat burger at the conclusion of the frozen storage time were ranged between 28.00 - 33.33%.

CONCLUSION

The sensory and physical qualities of camel meat burgers were improved by using fat-replacers. Using fat- replacers during manufacturing of low-fat camel burger have considerable importance in the industrial, nutritional applications, useful for human weight control, and some other diseases require low – calories diets. Based on the chemical, physical, microbiological, and sensory qualities of camel meat burgers, the optimal treatment was discovered to be a camel burger manufactured with 10% barley grain + 10% fat content.

REFERENCES

AMSA (1995). Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh beef. American Meat Science Assoc., Chicago, IL, USA, 240pp.

Abolgasem, F. S. (2011). Effect of Oat Flakes as a Fat Replacer on Chemical, Physical and Sensory Properties of Low-Fat Beef Burgers. M.Sc. Thesis, Food Sci. Dep., Fac. Agric., Cairo Univ., Giza, Egypt, 122p.

Aktas, N. and H. Genccelep (2006). Effect of starch type and its modifications on physicochemical properties of bologna-type sausage produced with sheep tail fat. Meat Sci., 74: 404-408.

Ali, M. A. (2008). Effect of Processing and Cooking Methods on Chemical, Biological and Microbiological Properties of Low-fat Meat Products. Ph.D. Thesis, Food Technol. Dep., Fac. Agric., Cairo Univ., Egypt, 109p.

Ali, R. F.; A. M. El-Anany and A. M. Gaafar (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.

Allen, P.; Dreeling N.; E. Desmond; E. Hughes ; A. M. Mullen and D.Troy (1999). New technologies in the manufacture of low-fat meat products. Research Report No. 10. The National Food Center, Irish Agric. and Food Development Authority.

AOAC (2005). Association of Official Analytical Chemist Official Methods of Analysis, 18th Ed.,. Washington, USA.

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

Benkerroum, N.; M. Mekkaoui ; N. Bennani and K. Hidane (2004). Antimicrobial activity of camel's milk against pathogenic strains of Escherichia coli and Listeria monocytogen. International Journal of Dairy Technology, 57: 39-43.

Egbert, W. R.; D. L. Huffman; C. M. Chen and D. P. Dylewski (1991). Development of low-fat ground beef. Food Technol., 45(6): 64–73.

Egyptian Standards (2005). Frozen beef burgers. Egyptian Organization for Standardization and Quality Control, Ministry of Industry and Technological Development, Arab Republic of Egypt (E. S. No. 1688).

El-Gasim, E. A. and M. A. AlKanhal (1992). Proximate composition, amino acids and inorganic mineral content of Arabian camel meat: comparative study. Food Chem., 45:1-4.

Farouk, M. M. and A. E. Bekhit (2013). Processed Camel Meats. In: I.T. Kadim et al (ED.), Camel Meat and Meat Products, chap., 12: pp, 186-204.

FAOSTATE (2011). Production yearbook. Food and Agriculture Organization of the United Nations, Rome. Cited in http://www.FAO.org Camel Search.

Gerardo, M. – Z.; J. A. Garcla – Maclasi; E. Santellano – Estrada (2015). Fat reduction in the formulation of frankfurter sausages using inulin and pectin. Food Technol, Campinas, 35 (1): 25 – 31.

Giese, J. (1996). Fats, oils and fat replacers. Food Technol., 50: 78–83.

Grundy, S. M. (1994). Lipids and cardiovascular disease In Nutrition and Disease Update. Heart Disease, Kritchersky D. and Carroll K. K., (Ed), AOCS Press, Champaign, Illinois, pp. 211.

Hamza, R. A. T. (2011). Effect of Some Spices and Type of Frying Oil on Quality Attributes of Semi-Fried Chicken Fingers During Frozen Storage. M.Sc. Thesis, Fac. Agric., Cairo Univ., 204p.

Huang, S. C.; Y. F. Tsai and C. M. Chen (2011). Effects of wheat fiber, oat fiber, and inulin on sensory and physico-chemical properties of chinese-style sausages. Asian-Aust. J.Anim. Sci., 24(6): 875-880.

Hussein, S. A. (2015). Effect of wheat bran and barley as fat replacers on quality characteristics beef sausage during frozen storage. Middle East J. of Appl. Sci., 5 (2): 618-629.

Jiménez Colmenero, F. (2000). Relevant factors in strategies for fat reduction in meat products. Trends in Food Sci. Technol., 11: 56-66.

Kerr, W. L.; X. Wang and S. G. Choi (2005). Physical and sensory characteristics of low-fat Italian sausage prepared with hydrated oat. J. of Food Quality, 28:62-77.

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

Kim, H.W.; K.E. Hwang; D. H. Song; Y. J. Kim Y. J. ; Y. K. Ham; T.J. Jeong; Y. S. Choi and C.J. Kim (2016). Germinated barley as a functional ingredient in chicken sausages: effect on physicochemical and technological properties at different levels. J. Food Sci. Tech., 53(1): 872-879.

Lin, K. W. and J. Y. Chao (2001). Quality characteristics of reduced-fat Chinese-style sausage as related to chitosan's molecular weight. Meat Sci., 59: 343-351.

Lucca, P. A. and B. J. Tepper (1994). Fat replacers and the functionality of fat in foods. Trends in Food Sci. Tech., 5: 12-19.

Mansour, M. E. and S. M. Ahmed (2000). Advanced technology in camel meat processing. The Camel Newsletter, 17: 20-27.

Mansour, E. H. and A. H. Khalil (1997). Characteristics of low-fat beefburger as influenced by various types of wheat fibers. Food Res. Inter., 30: 199–205.

Mansour, E. H. and A. H. Khalil (1999). Characteristics of low-fat beefburger as influenced by various types of wheat fibers. J. of the Sci. of Food and Agric., 79:493-498.

Mohamed, H. A. (2005). Low-fat Meat products as Prepared from Ostrich and Other Reduced Fat Beef. Ph.D. Thesis, Fac. of Home Economics, Menofiya Univ., Egypt, 173pp.

Osheba, A. S. (2003). Studies on the Preparation of Some Healthy Foods. Ph.D. Thesis, Food Sci. and Technol. Dep., Fac. Agric., Menofia Univ., Shebin El-Kom, Egypt, 125p.

Petersson, K. (2012). Cereal Dietary Fiber - Physicochemical Properties and Suitability for Addition to Low-Fat Meat Products. Ph.D. Thesis. Department of Food Technology, Engineering and Nutrition. Fac. of Eng., Lund Univ., Sweden, 62 pp.

Rossum, S. T. M. van; H. van de Mheen; J. C. M. Witteman; E. Grobbee; J. P. Mackenbach; C.T.M. Rossum van and H. van de Mheen (2000). Education and nutrient intake in Dutch elderly people. The Rotterdam Study. Eur. J. Clinic. Nutr, 54: 159-165.

Serdaroğlu, M. and Ö. Değirmencioğlu (2004). Effect of fat level (5%, 10%, and 20%) and corn flour (0%, 2%, and 4%) on some properties of Turkish type meatballs (Koefte). Meat Sci., 68: 291-296.

Slattery, M. L.; S. L. Edwards; K. M. Boucher; K. Anderson and B. J. Caan (1999). Lifestyle and colon cancer: an assessment of factors associated with risk. Am. J. Epidemiol., Oct. 15, 150: 869-877.

Suman, S. and B. Sharma (2003). Effect of grind size and fat levels on the physicochemical and sensory characteristics of low-fat ground buffalo meat patties. Meat Sci., 65:973-976.

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

Tungland, B. C. and D. Meyer (2002). Non-digestible oligo and polysaccharides (Dietary Fiber): Their physiology and role in human health and food. Com. Rev. in Food Sci. and Food Safe., 1(3): 90-109.

Vyncke, W. (1970). Direct determination of Thiobarbituric acide value in trichlroacetic acid extracts of fish as measure of oxidative rancidity. Fette Seifen Anstichmittel, 72 (12): 1084-1087.

تحسين جودة برجر لحم الابل المصنوع باستخدام بدائل الدهون أثناء التخزين بالتجميد

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الهدف من هذه الدراسة هو تحسين جودة برجر لحم الإبل من خلال استبدال دهون الإبل بمستويات مختلفة (5 و 10٪) من حبوب الشعير ونخالة القمح كبديل للدهون. سجلت النتائج التي تم الحصول عليها من المعاملات التي تم استبدالها بالدهون محتوى أعلى من الرطوبة ، والبروتين الخام ، والرماد الكلي ، والألياف الخام ، ومحتوى أقل من الدهون ، مقارنة بتلك الموجودة في العينة الكنترول. كما بلغت قيمة الطاقة الكلية 254.49 كيلو كالوري للطازجة ، بينما كانت المستويات منخفضة الدهن للعينات المعاملة 175.10 كيلو كالوري (10٪ دهون) و 207.43 كيلو كالوري (15٪ دهون) قبل الطهي على التوالي. كانت قيم الأس الهيدروجيني لجميع المعاملات أعلى معنويًا ($P\geq0.05$)من تلك الخاصة بالكنترول. كما كانت قيم حمض الثيوباربيتوريك (TBA) لعينات البرجر المعامل أقل معنويا ($P\geq0.05$) من تلك الخاصة بعينة الكنترول. علاوة على ذلك ، كان تأثير التخزين على صفات جودة برجر لحم الإبل كما يلي: لوحظ انخفاض طفيف في قيم الأس الهيدروجيني في جميع المعاملات ، زيادة في قيم TBA في جميع المعاملات. انخفضت المقدرةعلى الاحتفاظ بالماء (WHC) للمعاملات باستخدام بدائل الدهون والتي كانت أعلى معنويا ($P\geq0.05$) من نظيرتها الكنترول أثناء التخزين بالتجميد لجميع المعاملات. كانت نسبة الفقد بالطهى والانكماش في معاملات استبدال الدهون أقل بكثير من الكنترول ، و كما لوحظ خلال فترة التخزين بالتجميد ، زيادة في كل من نسبة الفقد بالطهى و الانكماش ، وفي الوقت نفسه ، انخفاض الناتج بالطهي. كان العدد الإجمالي للبكتيريا وكذلك الأعداد المحبة للبرودة أعلى بشكل ملحوظ في معاملات استبدال الدهون مقارنة بمجموعة الكنترول. حيث زاد عدد البكتيريا مع انخفاض مستوى الدهون لمدة 45 يومًا من فترات التخزين ثم انخفض عدد البكتيريا حتى نهاية وقت التخزين بالتجميد. فيما يتعلق بالتقييم الحسي ، كان القبول العام أعلى فى عينات استبدال الدهون. وخلصت الدراسة إلى أن استخدام حبوب الشعير و نخالة القمح لإنتاج برجر لحم الإبل أدى إلى تحسين خصائص الجودة وتحسن القبول العام للمعاملات. كانت أفضل معاملة هى برجر الإبل الذي تم تحضيره بنسبة 10٪ حبوب شعير + 10٪ محتوى دهني.