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The Influence of Frozen Storage on Physical and Organoleptic Properties of Beef and Low-Fat Beef Burgers

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Abstract:

This investigation was carried out in an attempt to clarify the effect of freezing storage on the physical and organoleptic properties of beef and low-fat beef burger. Fresh lean beef (top round) muscle of old cows (3 years age) was obtained from Assiut slaughter house during March 2010. Meanwhile, goat meat (chevon) was obtained from healthy 1-year old goat (leg and shoulder cuts) purchased from Assiut local market. Fat replacers namely: carrageenan, carboxymethyl cellulose (CMC), and soy flour were obtained at due time. Low-fat beef burger was prepared by mixing well minced meat with carageenan, soy flour, CMC, and goat meat (chevon) with different ratios and other ingredients, different burger formulae were formed using burger form and were packed in polyethelene bags and stored immediately at -20°C for 3 months. The low-fat beef burger samples at zero time and during storage were grilled on an electrical grill. Physical properties namely: water holding capacity (W.H.C), pH, cooking loss, cooking yield, and shrinkage were assessed. Likewise, the organoleptic properties of grilled beef burger samples were evaluated after grilling (zero time) and after 1, 2, and 3 months of frozen storage at -20°C. Sensory quality attributes included color, chewiness, taste, flavor, appearance, and overall acceptability. The data revealed that samples having soy flour by different ratios had the highest pH with a significant difference in comparison between control and other treatments. Moreover, the data indicated that treatments containing fat replacers (carrageenan, CMC, and soy flour) and treatment which had goat meat (chevon) + beef resulted in increasing of W.H.C of low-fat beef burger. Besides, all used fat replacers improved the shrinkage value of low-fat beef burger as compared to that of control sample. While, the cooking losses of the samples decreased with more fat replacers addition. Meanwhile, the cooking yield increased which occurred in accordance with the changes of cooking loss and W.H.C during 3 months storage of beef burger, the more W.H.C the more

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cooking yield and less of cooking loss was found. Furthermore, when fat replacers increased the color of beef burger sample decreased as storage time increased. While, the chewiness of the grilled beef burger samples showed that control sample had higher score than that of low-fat beef burger at zero time storage and during frozen storage. Meanwhile, taste score the lowest score recorded for sample containing 100% goat meat (chevon). However, the best taste scores wasobtained for control sample. On the other hand the highest flavor value was recorded in control sample having the more amount of fat content. Besides, the appearance scores of the investigated samples revealed that the control sample recorded the lowest value. While, the texture was increased as fat replacers addition increased. Last but not least, the data revealed that control sample and samples containing carrageenan at level 0.3%, CMC at level 1.5%, soy flour at level 5%, and samples containing 25% goat meat (chevon) + 75% beef had the highest overall acceptability values.

Keywords: low-fat; beef burgers; goat meat, fat replacers.

Introduction:

Consumer acceptance of food products depends largely on taste, the most important sensory attribute. Although many consumers want foods with lower fat and energy, they also want foods to taste good. Because foods formulated with fat replacers do not compare favorably with the flavor of full-fat counterparts, it may be difficult for some people to maintain a reduced-fat dietary regimen (Akoh, 1998). Some of the problems arising from the reduction of animal fat in beef products can be minimized through the use of leaner raw material, physical handling of the meat, and the inclusion of various ingredients in the formulation (Keeton, 1994). Such ingredients include water (Sylvia *et al.*, 1994); carbohydrates (Giese, 1992); proteins and vegetable oils (Paneras and Bloukas, 1994); and oat bran (Chang and Carpenter, 1997).

Fat contributes key sensory benefits to foods and is perceived through mouthfeel, taste, and aroma/odor. When fat levels are lowered the products become firmer, more rubbery, less juicy, darker in color, more costly and less acceptable in terms of skin formation, mouth feel, processing yield and increased purge in vacuum package (Keeton, 1994).

Reduction or removal of fat from meat products requires a fat replacers and various ingredients e.g. flavoring and seasoning that can provide mouth feel, texture and flavor of fat in the finish products, fat replacers may be protein- based, carbohydrate-based or fat- based constituents. One of the most interesting hydrocolloids gums, which could be used in meat industries, is carrageenan. Carrageenan are sulphated polysaccharides extracted from seaweed. It is widely used in food industry for a broad range of applications because of its water binding, thickening and gelling properties. (Bater *et al.*, 1993) found that carrageenan caused an increase in yield, sliceability and rigidity and a decrease in expressible juice in roasted turkey breast. In breakfast sausages, carrageenan was also found to increase the hardness of meat batters when replacing fat by water-gum solution, whereas carrageenan importantly improved the water holding ability (Barbut and Mittal, 1992).

Carboxy methyl cellulose like water soluble celluloses can be used as bulking agents because of their high water binding capacity (Sester & Racette 1992). Methylated cellulose derivatives have reversible thermal gelation property and even though not true fat mimetics, but are useful as fat barriers in fried foods as they reduce oil absorption into batter. Gums are also hydro colloids that provide viscosity or thickening and in some cases gel formation. These gums contribute no calories and have potential health benefits. In the food industry CMC is widely used because it is tasteless, odorless, and forms clear solutions without cloudiness or opacity, it dissolves rapidly in both hot and cold aqueous systems, acts as moisture binder, emulsion stabilizer, thickener and improves the texture of a wide range of food products. Because it is physiologically inert and non caloric, cellulose gum is particularly useful in dietetic foods (Zhang, 2001).

Soy protein is one of the most widely used vegetable proteins in meat industry due to its various technological benefits, whereas it plays a significant role in the modification of the functional characteristics of the meat products. It can also be used to replace part of the animal fat. With its hydrating capacity, soy protein can considerably decrease the final cost of the meat products. Despite the many advantages of soybean, its use had been limited because of the characteristic beany flavor (Mizutani and Hashimoto, 2004). Martinez (1979) reported that soy proteins were utilized in meat products because of their availability, price and functionality. Moreover, other vegetable proteins were found to posses a potential to provide functional properties.

Chevon (goat meat) is one of the most widely eaten red meats in the world and enjoys great popularity in many developing countries, especially in Asia, Africa, and the Far East (Devendra, 1990). The lean of chevon has a fat content of less than 3.5% (James *et al.*, 1991) and may be an excellent resource in the preparation of low-fat diets. Therefore, this study was carried out in an attempt to clarify the effects on physical, and organoleptic properties of beef and low-fat beef burger made with add carrageenan, carboxymethyl cellulose, soy flour and goat meat (chevon) during frozen storage period at -20°C up to 3 months.

Materials and Methods

I. Materials

1. Meat

36.706 kg of fresh lean beef (top round) muscle of old cows (3 years age) was obtained from Assiut slaughter house during March 2010. External fat and connective tissue were manually trimmed. The lean beef samples were minced using meat mincer and used for processing of low-fat beef burger.

2. Goat meat (Chevon)

6.289 kg of fresh meat of goat was obtained from healthy 1-yr-old goat (leg and shoulder cuts) purchased from Assiut local market during March 2010. The goat meat samples were minced using meat mincer and used for processing of low fat-beef burger.

3. Fat replacers

3.1 Carrageenan

GENUVISCO carrageenan type CSM-2 was obtained from Technogen Company at Dokii, Cairo, Egypt during March, 2010. It is a hydrocolloid consisting mainly of calcium, magnesium, potassium, and sodium sulphate ester of glactose and 3,6 anhydrogalactose co-polymers. It is soluble in cold water exhibiting a viscosity effect almost instantaneously after dispersion. The suspension was prepared by stirring 0.3, 0.5 and 1.0g of carrageenan in 100 ml iced water, then it was added to meat.(Ali, 2008).

3.2 Soy flour

Soy flour was purchased from the Food Technology Institute Agriculture Research Center- Giza, Egypt during March, 2010.It was finally powderd by using a mill. Powdered soy flour was rehydrated (by mixing one part of powdered soy flour with two parts of tap water) before addition to the meat. (El-Naggar, 1999).

3.3 Carboxy Methyl Cellulose Sodium Salt (CMC)

Carboxy methyl cellulose (CMC) product No: 0385 was purchased from EL- Badry company at Assuit, Egypt during March, 2010. The suspensions were prepared by stirring 1.5, 3.0, 4.5 gm of CMC in 100 ml iced water, then it added to meat. (Gomez-Díaz & Navaza, 2003; Gomez-Díaz *et al*., 2008).

4. Spices

Spices mixture was prepared using equal weights of clove, black pepper, Chinese cubeb, paprika and nutmeg that were obtained from Assiut local market during March, 2010.

5.Salt, onion, garlic and parsely

Salt, fresh onion, garlic and parsley were obtained from Assiut local market and used for preparation of beef burger during March, 2010.

II. Methods

1.preparation of beef burger samples

Low-fat beef burger formulae Table (1) were prepared by mixing well minced meat with carrageenan, soy flour, carboxy methyl cellulose and goat meat (chevon) with different ratios and other ingredients. The burger formulae were formed using a patty marker (stainless steel model "Form") to obtained round discs 10 cm diameter and 0.5 cm thickness. After preparation of each formulae, the beef burger samples (each sample was 50 g) were packed in polyethelene bags and were stored immediately in a deep freezer at -20°C. for up to three months where samples required at zero time and monthly for analyses after and before cooking.

Table (1): Basal low-fat beef burger formulae (1Kg) using different fat replacers.

Ingredients (g)	Control	Carrageenan			Soy flour			Carboxymethyl cellulose			Chevon+ beef		
		0.3%	0.5%	1%	5%	10%	15%	1.5%	3%	4.5%	100% Chevon	50 % Chevon+ 50% beef	25 % Chevon+ 75% beef
Minced meat	857.5	854.5	852.5	847.5	807.5	757.5	707.5	842.5	827.5	821.5	—	428.75	643.125
Chevon meat	—	—	—	—	—	—	—	—	—	—	857.5	428.75	214.375
Soy flour	—	—	—	—	50	100	150	—	—	—	—	—	—
Carrageenan	—	3	5	10	—	—	—	—	—	—	—	—	—
CMC	—	—	—	—	—	—	—	15	30	45	—	—	—
Salt	10	10	10	10	10	10	10	10	10	10	10	10	10
Onion	5	5	5	5	5	5	5	5	5	5	5	5	5
Garlic	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Parsley	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Mixed spices	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Iced water	120	120	120	120	120	120	120.	120	120	120	120	120	120

2-Cooking of beef burger

The low-fat beef burger samples under investigation at zero time and during storage were grilled on an electrical grill for a total 10 min, 6 min one side and 4 min the other side according to Turhan *et al.*, (2005).

Physical Properties:

a- Water holding capacity (W.H.C):

Water holding capacity (WHC) was measured using the method of Wierbicki and Deatherage (1958).

b- pH value:

The pH value of low-fat beef burger was measured using ICM 41150 pH meter according to Turhan *et al.*, (2005).

c- Cooking loss:

Cooking loss of the prepared beef burger was determined according to **A.M.S.A (1995).** This was carried out after grilling of low-fat beef burger samples. Cooking loss was calculated as follows:

$$\%\ \text{Cooking loss} = \frac{\text{Raw sample weight - cooked sample weight}}{\text{Raw sample weight}} \times 100$$

d- Cooking yield:

Cooking yield were calculated as given by El- Nemr (1979).

% Cooking yield = 100 - % Cooking loss

e- Shrinkage:

The shrinkage percentage was calculated as described by A.M.S.A (1995) as follows:

$$\%\ \text{Shrinkage} = \frac{\text{(Raw thickness-Cooked thickness) + (Raw diameter-Cooked diameter)}}{\text{(Raw thickness-Cooked thickness)}} \text{X } 100$$

Organoleptic evalution:

Grilled beef burger samples were evaluated organoleptically immediately after grilling (zero time analysis) and after 1, 2 and 3 months of frozen storage at -20°C. Sensory quality attributes included color, chewiness, taste, flavor, appearance, texture and overall acceptability.

Grilled burger samples were presented to 10 staff members in the Food Science and Technology Department, Faculty of agriculture, Assuit University and Assuit Agricultural Research Center. After grilling. A 10- point hedonic scale (1 being dislike very much to 10 being like very much) for color, chewiness, taste and flavor. while 20 point hedonic scale for appearance, texture and overall acceptability was used to evaluate the sensory attributes of burger sample according to Gelman and Benjamin (1989).

Statistical analysis:

The data were analyzed by ANOVA using the SPSS statistical package program, and differences among the means were compared using the Duncan's Multiple Range test (SPSS, 1998). A significance level of 0.05 was chosen.

Results and Discussion

pH value:

Measurement of pH value is one of the important characteristics, including shelf life, color, water holding capacity, thiobarbituric acid values and cooking yield of meat and meat products (Clarke *et al*., 1988).

Data given in Table (2) indicated that samples having soy flour by different ratios had the highest pH with a significant difference in comparison between control and other treatments (a). These results might be due to the high pH values found in the soy extenders products as reported by Brewer *et al*., (1992). On the contrary, the pH values of samples containing carrageenan and carboxymethyl cellulose approximately were rather similar and were lower than that of the control sample probably due to the acidic nature of carrageenan (Shand *et al*., 1993). Similar findings were reported by (El-Naggar, 1999 and Koutsopoulos *et al*., 2008) who found that the pH of sausages produced with 0% to 2% carrageenan ranged from 5.21 to 5.25 and were reduced ($P < 0.05$) to 5.13 in the treatment with 3% carrageenan. Likewise, there were a significant difference in comparison within each treatment in most of cases except in the treatment which had soy flour by different ratios (b).

Table (2): Changes in pH values of raw high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	6.84	5.52^{ab}	4.8^{ab}	5.3^{ab}	5.59^{ab}	5.95^{ab}	5.93^{ab}	7.14^{a}	7.14^{a}	7.12^{a}	6.5^{ab}	6.78^{b}	6.65^{b}
1	6.87	5.58^{ab}	5.2^{ab}	5.36^{ab}	5.6^{ab}	5.98^{ab}	5.96^{ab}	7.16^{a}	7.17^{a}	7.14^{a}	6.53^{ab}	6.81^{b}	6.68^{b}
2	6.89	5.59^{ab}	5.25^{ab}	5.4^{ab}	5.63^{ab}	6^{ab}	5.97^{ab}	7.2^{a}	7.21^{a}	7.22^{a}	6.57^{ab}	6.85^{b}	6.71^{b}
3	7	5.62^{ab}	5.29^{ab}	5.44^{ab}	5.66^{ab}	6.03^{ab}	6^{ab}	7.23	7.25	7.26	6.61^{a}	6.88	6.74
Sig	NS	*	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Not significant difference

***= significant difference between treatment and time**

a = significant difference between control and other treatment b =significant difference within treatments

During storage, the pH values gradually increased with no significant statistical difference in comparison between each treatment and time of storage (NS) except in the treatment which had carragenan at 0.3%, 0.5%(*). pH values increased for all samples till the end of storage period. Such increase in pH values during storage might be attributed to the breakdown of protein macromolecule to smaller fractions and to formation of basic volatile nitrogenous substances. Likewise, it is known that during storage period, denaturation of protein occurred which decrease total soluble protein nitrogen (T.S.N), moisture content, while increase the pH value and lipid oxidation , as previously reported by Dessouki (1976). The increase of pH might be due to partial proteolysis leading to an increase of free alkaline groups (Bala *et al*., 1979).

Water holding capacity (W.H.C):

Water holding capacity (W.H.C) means the ability of meat to hold fast to its own or added water during application of any force it is considered as one of the very important technological properties of meat as it affects the tenderness, juiciness, thawing drip and cooking yield of meat and meat products (Labuza and Busk, 1979).

From the data obtained in Table (3) it could be observed that treatments containing fat replacers (carrageenan, carboxymethyl cellulose and soy flour) and treatment which had goat meat (chevon) + beef resulted in an increasing of water holding capacity of low-fat beef burger. On the other hand, the control of high-fat beef burger which had no fat replacers, had low water holding capacity (6.00 cm^2) with a significant difference and had less moisture content, as it was 56.82%. Water holding capacity is the ratio of moisture retained in the sample to the initial moisture content, so the higher percentage indicates release of less moisture (Pietrasik and Duda, 2000). (Tornberg *et al.*, 1989) reported that all low fat systems had a significantly higher ($P < 0.05$) WHC values than the full-fat control (16.4%). This low value was probably due to the fact that the high-fat control, being high in fat and low in protein, was unable to retain the 8% added water. The fact there was a lower moisture content and a high fat content (23%), which is more easily removed during cooking. Demos and Mandigo (1996) also found low-fat (10%) treatment to have higher ($P < 0.05$) WHC values than those made with 20% fat.

Furthermore, the highest water holding capacity of samples which containing soy flour at different levels was highly significant compared with that of control and other treatments (a). These results were probably due to the ability of soy products to bind water as reported by Wolf (1970). This could be ascribed to the higher adsorption capacity of soy products to water which might suggest that soy protein products could be more hydrophilic in nature, a suggestion previously reported by Lin *et al.* (1974). Hegazy (2004) found that replacement of 10 and 20% hens meat with soy flour found to improved W.H.C of the prepared sausage more than control. On the contrary, the samples which had carrageenan and carboxymethyl cellulose had low water holding capacity than samples which containing soy flour by different ratios and had higher W.H.C than control , also increasing the carrageenan and carboxymethyl cellulose concentration caused an increase in W.H.C values. This might be due to carrageenan and carboxymethyl cellulose were less effective in preventing water loss. Verbeken *et al.* (2005) showed that increasing the carrageenan concentration from 0 to 2% causes an increase in W.H.C of about 5%. Meanwhile, Tory *et al.* (1999) found that burgers containing blends of tapioca starch/ oat fiber/ whey protein, tapioca starch/ oat fiber and the carrageenan + locast bean gum mixture/ pectin/ why protein had the highest W.H.C values of 42.07%, 40.28% and 40.21%, respectively, with the majority of burgers having a W.H.C value between 36 – 40%. This W.H.C improving effect of carrageenan is attributed to gum-water interaction or gum : protein : water molecules, concentration and other compounds environment (Foeding and Ramsey,1986).

Table (3): Changes in water holding capacity (W.H.C) of high and low – fat beef burgers as affected by using different ratios of fat replacers during frozen storage at -20°C. (cm^2)

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	6.00	5.82^{ab}	5.76^{ab}	5.27^{ab}	5.2^{ab}	4.99^{ab}	4.77^{ab}	4.2^{ab}	4^{ab}	3.76^{b}	5.99	5.89^{a}	5.78^{a}
1	5.87	5.76^{ab}	5.55^{ab}	5.1^{ab}	5^{ab}	4.82^{ab}	4.67^{ab}	4.13^{ab}	3.92^{ab}	3.66^{b}	5.86	5.72^{a}	5.68^{a}
2	5.78	5.45^{ab}	5.32^{ab}	4.83^{ab}	4.9^{b}	4.68^{ab}	4.3^{ab}	3.99^{ab}	3.78^{ab}	3.42^{b}	5.57^{ab}	5.38^{ab}	5.25^{ab}
3	5.65	4.93^{ab}	4.8^{ab}	4.67^{ab}	4.53^{ab}	4.53^{ab}	4.19^{ab}	3.84^{ab}	3.51^{ab}	3.2^{ab}	4.98^{a}	4.88^{a}	4.75^{a}
Sig	*	*	*	*	*	*	*	*	*	*	*	*	*

NS= Not significant difference
***= significant difference between treatment and time**
a = significant difference between control and other treatments
b =significant difference within treatments.

Moreover, data presented in Table (3) revealed that treatment containing goat meat (chevon) + beef at different levels had higher W.H.C values than that of the control sample . Babiker *et al.* (1990) reported that chevon meat had significantly higher water holding capacity and lower cooking loss. Meanwhile there was a significant difference in comparison within each treatment in most cases (b).

As the time of storage increased, there were a significant statistical decrease in the W.H.C values of all treatments in comparison between each treatment and time of storage (*). This decrease of all samples, possibly was due to protein denaturation and losses in protein solubility. These findings were in agreement with the results of El- Naggar (1999) and Hegazy (2004) who showed that as protein was denaturated, its ability to bind water decrease. Besides the moisture content of these treatments decreased during frozen storage as previously reported by the same authors.

Shrinkage:

The shrinkage was measured by difference between two diameters of burger before and after cooking. It can be considered as one of important quality attributes measurements of meat and meat products.

Data presented in Table (4) indicated that all used fat replacers improved the shrinkage values of low-fat beef burger as compared to that of the control sample with a significantly lower values in comparison between control and other treatments (a). This probably because of the higher fat content of control batch compared with the batches with added fat replacers. This shrinkage agreed with observation of El- Magoli *et al.* (1995), who showed that reduction in the fat level from 22 to 11% improved all the cooking parameters such as reducing the shrinkage. Troy *et al.* (1999) found that all treatments had a reduction in diameter with the full-fat control shrinkage due to the high loss in fat and moisture during cooking.

Meanwhile, the best treatment was low-fat beef burger which had carrageenan by different levels. This probably was due to a gum – water interaction or a gum – protein – water interaction as described by Foeding and Ramsey (1986) and by El- Naggar (1999). However, was followed by the treatment which had soy flour at different levels. This might be due to increasing of fat and water holding capacity of soy or to the higher pH values of soy extended products as reported by Brewer *et al.* (1992) and El- Naggar (1999).

Table (4): Changes in shrinkage percentages of high and low–fat beef burgers as affected by using different ratios of fat replacers during 3 months of frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethy celluloe			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	30.53	13.7^{ab}	12.5^{ab}	10.52^{ab}	18.5^{ab}	17.62^{ab}	15.3^{ab}	14.74^{ab}	13.72^{ab}	11.3^{ab}	15.25^{ab}	18.2^{ab}	18.1^{ab}
1	31.4	13.96^{ab}	12.83^{ab}	10.95^{ab}	19.1^{ab}	18.87^{ab}	15.96^{ab}	15.5^{ab}	14.37^{ab}	12.52^{ab}	16.8^{ab}	18.5^{ab}	18.5^{ab}
2	32.7	14.3^{ab}	13.1^{ab}	11.4^{ab}	20.2^{ab}	19.86^{ab}	16.5^{ab}	16.14^{ab}	14.9^{ab}	12.96^{ab}	17.5^{ab}	19.46^{ab}	19.94^{ab}
3	33.3	14.68^{ab}	13.62^{ab}	11.99^{ab}	21.23^{ab}	20.56^{ab}	17.3^{ab}	16.7^{ab}	15.7^{ab}	13.72^{ab}	18.1^{ab}	20.35^{ab}	20.12^{ab}
Sig	*	*	*	*	*	*	*	*	*	*	*	*	*

NS= Not significant difference.
***= significant difference between treatment and time.**
a = significant difference between control and other treatments.
b =significant difference within treatments.

From the data outlined in Table (4) it could be noticed that formulae containing goat meat (chevon) + beef had low shrinkage values when compared to the control treatment. This might be due to the less amount of fat in theses treatment. Meanwhile, there were a significant difference in comparison within each treatment in all of cases that as the ratio of additives increased the shrinkage also decreased (b).

As frozen storage time increased the shrinkage values increased for all treatments with a significant statistical difference in comparison between each treatment and time of storage (*), these results were on line with Abd El-Qader (2003) who found that, the shrinkage values were progressively increased by extending storage time (at -18°C for 6 months) this might be due to excessive fat separation and water released which occurred during cooking and decreasing in water holding capacity. Likewise, Mohamed (2005) found that, shrinkage of beef patties changed from 25.13 to 27.5% after 3 months of storage at -18°C. Similar findings were reported by El- Naggar (1999) and Ali (2008).

Cooking loss:

Results in Table (5) indicated that the highest cooking loss was recorded for the control beef burger, due to the high loss of fat and moisture during cooking. While, the cooking losses of the samples decreased with more fat replacers addition. Similar results were obtained by Mansour and Khalil (1997) who used hydrated wheat fiber as fat substitute in ground meat products. Anderson and Berry (2001) indicated that inner pea fiber had the potential useful ingredient in the development of food products required to retain the maximal amount of fat during high temperature heating.

The data given in Table (5) indicated the formulae of beef burger with high water holding capacity had low cooking loss. So, the control beef burger had the lowest water holding capacity as shown in Table (4). Hence, the highest cooking loss was 32.67%. in contrast, the beef burger formulae which contained soy flour at different levels had lowest cooking loss. These results are probably due to its ability to bind water and fat as reported by Wolf (1970). Williams and Zabik (1975) noticed a significant decrease in total cooking losses in both beef and pork loaves when 30% soy substitution was considered. This might be due to the important functional properties of soy protein and their ability to bind fat and retain moisture as found and reported by Wolf (1970).

similarely, it could be observed that samples containing carrageenan and carboxymethyl cellulose had low cooking loss when compared to control sample. Overall, the cooking loss was lowest with a significant difference when the ratio of carrageenan , carboxymethyl cellulose and soy flour increased within each treatment. Egbert *et al.* (1991) reported that beef burger containing carrageenan had significantly lower total cooking losses than 20% fat beef burger. Also, He and Sebranek (1996) studied the addition of either κ-carrageenan (0.5%) or isolated soy protein (2%) to turkey bologna and frankfurters with lean finely textured tissue and they reported decreases in cooking loss during cooking with increasing soy protein or carrageenan levels.

Table (5): Changes in cooking loss percentage of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	32.67	22.29^{ab}	15.38^{ab}	10.46^{ab}	29.58^{ab}	27.39^{ab}	23.51^{ab}	22.11^{ab}	14.12^{ab}	10.81^{ab}	27.26^{ab}	28.48^{ab}	25.87^{ab}
1	33.76	25.09^{ab}	20.19^{ab}	13.89^{ab}	30.07^{ab}	28.62^{ab}	25.06^{ab}	23.49^{ab}	14.86^{ab}	13.35^{ab}	28.83^{ab}	28.67^{ab}	26.50^{ab}
2	34.51	27.16^{ab}	21.71^{ab}	14.46^{ab}	30.52^{ab}	28.9^{ab}	26.14^{ab}	24.81^{ab}	15.7^{ab}	15.12^{ab}	28.97^{ab}	29.42^{ab}	28.55^{ab}
3	36.28	28.5^{ab}	23.22^{ab}	15.51^{ab}	31.81^{ab}	30.45^{ab}	27.8^{ab}	25.68^{ab}	16.32^{ab}	16.45^{ab}	31.21^{ab}	30.88^{ab}	30.33^{ab}
Sig	*	*	*	*	*	*	*	*	*	*	*	*	*

NS= Not significant difference.

***= significant difference between treatment and time.**

a = significant difference between control and other treatments.
b =significant difference within treatments.

Besides, it could be concluded that treatments containing goat meat (chevon) + beef had low cooking loss than control sample, which might be due to the less amount of fat in chevon meat. So, there was a significant difference in comparison between control and other treatments (a). Gadiyaram and Kannan (2004) found that cooking loss was the lowest (P< 0.5) for chevon sausages compared to other types of sausages. The outhors stated that superior water holding capacity of chevon was responsible for its lower cooking loss. Babiker *et al.* (1990) reported that chevon had lower cooking loss than lambs.

By advancement of frozen storage the cooking loss of all formulae was increased with a significantly statistical increased in comparison between each treatment and time of storage (*). This increase might be due to decreasing in the water holding capacity of these treatments and probably due to the excessive fat separation and water released. Salama *et al.*, (1994) found that, the cooking loss of sausage increased as the period of storage increased up to 90 days at -18°C. Furthermore, Trius *et al.*, (1994) reported that increasing of cooking loss during frozen storage is probably due to excessive fat separation and water released which occurred during cooking. Moawad (1995) found that, cooking loss of beef at zero time storage was 33.39% and increased after 3 months of storage at -18°C to 38.52%. Similar trend was reported by El- Naggar (1999) and Hegazy (2004).

Cooking yield:

From the data presented in Table (6) it could be observed that cooking yield occurred in accordance with the changes of cooking loss and water holding capacity during 3 months

storage of beef burger, the more W.H.C, the more cooking yield and less of cooking loss was found. Control had low cooking yield with a significantly higher in comparison between control and other treatments (a). Similar trend was reported by Mohamed (2005). Likewise, it could be noticed that samples containing soy flour by different ratios had the highest cooking yield followed by samples with added carrageenan and then, the samples containing carboxymethyl cellulose. Increasing the cooking yield for these samples indicating the blend of non-meat ingredients, capacity of binding and retention moisture during cooking process. Bater *et al.* (1993) reported that addition of 0.5 κ- carrageenan to a restructured turkey meat significantly increased product yield. While, Foeding and Ramsey (1986) had shown that in sausage batters (2.35% NaCl), carboxymethyl cellulose addition resulted in lower yields.

Table (6): Changes in cooking yield percentage of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	67.33	77.71^{ab}	84.61^{ab}	89.53^{ab}	70.42^{ab}	72.61^{ab}	76.49^{ab}	77.88^{ab}	85.87^{ab}	89.18^{ab}	72.74^{ab}	71.52^{ab}	74.03^{ab}
1	66.24	74.9^{ab}	79.81^{ab}	86.1^{ab}	69.92^{ab}	71.38^{ab}	74.94^{ab}	76.5^{ab}	85.14^{ab}	86.64^{ab}	71.17^{ab}	71.33^{ab}	72.8^{ab}
2	65.49	72.84^{ab}	78.29^{ab}	85.54^{ab}	69.48^{ab}	71.1^{ab}	73.86^{ab}	75.19^{ab}	84.3^{ab}	84.87^{ab}	71.03^{ab}	70.58^{ab}	71.45^{ab}
3	63.72	71.5^{ab}	76.78^{ab}	84.49^{ab}	68.19^{ab}	69.55^{ab}	72.2^{ab}	74.32^{ab}	83.68^{ab}	83.55^{ab}	68.79^{ab}	69.12^{ab}	69.67^{ab}
Sig	*	*	*	*	*	*	*	*	*	*	*	*	*

NS= Not significant difference.
***= significant difference between treatment and time.**
a = significant difference between control and other treatments.
b =significant difference within treatments.

The obtained results also showed that samples which had goat meat (chevon) + beef at different levels had higher cooking yield when compared with control samples. James and Berry (1997) found that 100% chevon patties had a significantly higher cooking yield than those of 100% beef and that the optimal yield was obtained with 80/20 chevon-beef patties. However, it must be pointed out that fat level of 100% beef patties was higher than that of 100% chevon patties. Cooking yields of chevon-beef patties were not significantly different after the patties had more than 40% of beef. Likewise, there was a significant difference in comparison within each treatment in all of cases that the cooking yield increased when the ratio of additives increased (b).

During advancement of the storage time, cooking loss progressively increased , while cooking yield decreased with a significant statistical difference in comparison between each treatment and time of storage that by advancement of the storage time the cooking yield decreased (*). This agrees with Mohamed (2005).

Oragnoleptic evaluation of the grilled low-fat beef burger:

Organoleptic evaluation was carried out to assess the color, chewing, taste, flavor, appearance, texture and overall acceptability of low-fat beef burger samples during frozen storage at -20°C for 3 months.

Table (7): Changes in color of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	9.4	9.1^{ab}	8.5^{ab}	8.1^{ab}	9.2^{b}	8.4^{ab}	7.6^{ab}	9.7^{ab}	8.6^{ab}	8.1^{ab}	7.2^{ab}	8.7^{ab}	9.4^{b}
1	9.4	9.1^{ab}	8.4^{ab}	8.1^{ab}	9.2^{b}	8.3^{ab}	7.6^{ab}	9.6^{b}	8.6^{ab}	8^{ab}	7.2^{ab}	8.6^{ab}	9.4^{b}
2	9.3	9^{ab}	8.4^{ab}	8^{ab}	9.1^{b}	8.2^{ab}	7.6^{ab}	9.6^{ab}	8.4^{ab}	8^{ab}	7^{ab}	8.5^{ab}	9.3^{b}
3	9.2	8.8^{ab}	8.3^{ab}	7.8^{ab}	9^{b}	8^{ab}	7.4^{ab}	9.5^{ab}	8.3^{ab}	7.7^{ab}	6.7^{ab}	8.5^{ab}	9.1^{b}
Sig	NS	*	NS	*	NS	NS	*	NS	*	*	NS	*	*

NS= Not significant difference .
***= significant difference between treatment and time.**
a = significant difference between control and other treatments.
b =significant difference within treatments.

Results shown in Table (7) indicated that color was evaluated for all samples, hence, the best samples which gained high scores (i.e. mean values) were 9.4 for control sample. 9.1 for sample containing carrageenan at level 0.3%, 9.2 for sample containing carboxymethyl cellulose at level 1.5%, 9.7 for sample containing soy flour at level 5% and 9.4 for sample containing 25% goat meat (chevon) + 75% beef. Hence, there was a significant difference in comparison between control and other treatments in most cases (a). However, it could be noticed that when fat replacers increased the color decreased with a significant difference in comparison within each treatment in most of cases (b). , and color scores decreased as storage time increased with a significant statistical difference in comparison between each treatment and time of storage (*) except in control and samples which had carrageenan 0.5%, carboxymethyl cellulose 1.5% and 3% ; soy flour 5% and goat meat (chevon) 100% (NS). Ho *et al.* (1995) reported that color scores decreased as storage time increased with a change from reddish pink to prayish-brown. Likewise, they reported that high-fat patties had less desirable color over the storage period than reduced fat patties.

Table (8): Changes in chewiness of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	10	9.8	9.9	9.9	9^{ab}	9^{ab}	10^{b}	10	10	10	7^{ab}	9.8^{b}	9.8^{b}
1	10	9.8	9.8	9.9	8.8^{ab}	9^{ab}	10^{b}	10	9.9	10	6.8^{ab}	9.7^{ab}	9.8^{b}
2	9.8	9.6	9.8	9.6	8.8^{ab}	9^{ab}	10^{b}	10	9.9	9.8	6.5^{ab}	9.7^{b}	9.8^{b}
3	9.8	9.5^{a}	9.7	9.7	8.5^{ab}	8.8^{ab}	9.8^{b}	10	9.8	9.8	6.3^{ab}	9.5^{ab}	9.6^{b}
Sig	NS	*	NS	*	*	NS	*	NS	NS	NS	*	*	NS

NS= Not significant difference.
***= significant difference between treatment and time.**
a = significant difference between control and other treatments. b =significant difference within treatments.

With respect to chewiness of the investigated grilled beef burger samples, results given in Table (8) showed that scores of control samples were higher than that of low-fat beef burger at zero time storage and during frozen storage with a significant difference in comparison between control and other treatments in all cases (a) except treatments which had carrageenan, soy flour at different levels and samples which had 50% and 25%chevon. Moreover, when fat replacers increased the chewinesss increased with a significant difference in comparison within each treatment in all of cases except treatments which had carrageenan and soy flour at different levels (b). This might be because the fat replacers carrageenan, carboxymethyl cellulose and soy flour had the property of viscosity. Cierach *et al.* (2009) found that carrageenan and water addition to sausages containing 10% fat caused a significant increase in gumminess and chewiness. Kirzner (1995) suggested that higher fat (> 20%) ground beef patties had improved juiciness and tenderness compared to lower fat (5 to 10%) patties. On the other hand, sample which containing 100% goat meat (chevon) had lowest score but both 50% goat meat (chevon) + 50% beef meat and 25% goat meat (chevon) + beef meat had similar score for chewiness, as it recorded 9.8. James and Berry (1997) showed that 100% chevon patty formulation was the toughest. The patties with more than 80% beef were the most tender. This texture trend paralleted that of initial fat content, and thus it might be concluded that higher fat content produced more tender patties, as predicted by Berry and Leddy (1984). However, this increase in fat content as result of adding more beef to the formulae also probably contributed to lower cooking yield. Lecomte *et al*. (1993) showed that utilization of soya proteins resulted in finished products with improved sensory characteristics and enhanced functional properties. Generally, by advancement of frozen storage time, chewiness scores for all samples decreased recording a significant statistical difference in comparison between each treatment and time of storage (*) except in control and treatments containing carrageenan at level 0.5% , carboxymethyl cellulose at level 3% and all samples containing soy flour.

Results presented in Table (9) showed that taste scores were 9.9 for control sample. 9.00 for sample containing carrageenan at level 0.3%, 9.3 for sample containing carboxymethyl cellulose at level 1.5%, 9.4 for sample containing soy flour at level 5% and 9.6 for sample containing 25% goat meat (chevon) + 75% beef . While the lowest score was 7.5 for sample containing 100% goat meat (chevon), so, there was a significant difference in comparison between control and other treatments in all cases (a) and also there was a significant difference in comparison within each treatment in most of cases (b). James and Berry (1997) showed that consumer panelists found that the most tender patties contained both chevon and beef and that 100% chevon or beef patties were the toughest. From the same table one can noticed that taste decreased when time of storage increased with a significant statistical difference in comparison between each treatment and time of storage (*) except in control and samples which had carrageenan at 0.3%, 1% and soy flour at 15%.

Table (9): Changes in taste of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	9.9	9^{ab}	8.4^{ab}	8^{ab}	9.3^{ab}	8.4^{ab}	7.9^{ab}	9.4^{ab}	8.6^{ab}	8.1^{ab}	7.5^{ab}	8.4^{ab}	9.6^{ab}
1	9.9	9^{ab}	8.3^{ab}	8^{ab}	9.2^{ab}	8.4^{ab}	7.8^{ab}	9.3^{ab}	8.5^{ab}	8.1^{ab}	7.4^{ab}	8.3^{ab}	9.4^{ab}
2	9.7	9^{ab}	8.2^{ab}	7.9^{ab}	9.1^{ab}	8.2^{ab}	7.8^{ab}	9.1^{ab}	8.5^{ab}	8^{ab}	7.2^{ab}	8.3^{ab}	9.2^{ab}
3	9.7	8.8^{ab}	8^{ab}	7.8^{ab}	9^{ab}	8^{ab}	7.5^{ab}	9^{ab}	8.3^{ab}	8^{ab}	7^{ab}	8^{ab}	9^{ab}
Sig	NS	NS	*	NS	*	*	*	*	*	NS	*	*	*

NS= Not significant difference.

***= significant difference between treatment and time.**

a = significant difference between control and other treatments.
b =significant difference within treatments.

Results given in Table (10) illustrated that the highest value for flavor with a significant difference in comparison between control and other treatments in most cases (a) as it was 9.8 for control sample which had more amount of fat content. Hughes *et al*. (1997) showed that the results of the sensory analysis indicated that decreasing the fat level from 30% and 5% significantly affected on the flavor characteristics of frankfurters. Likewise, the best values for treatments were 9.5 for sample containing carrageenan at level 0.3%, 9.3 for sample containing carboxymethyl cellulose at level 1.5%, 9.7 for sample containing soy flour at level 5% and 9.0 for sample containing 25% goat meat (chevon) + 75% beef. Meanwhile, the lowest value was 7.00 for sample containing 100% goat meat (chevon), however, flavor value was 8.6 and 9.00 for samples containing 50% goat meat (chevon) + 50% beef and 25% goat meat (chevon) + 75% beef, respectively. James and Berry (1997) showed that the most flavorful patties were the 20/80 chevon-beef patties and that the 100% chevon patties were the least flavorful. The trained panel also found that there was no significant difference in flavor among formulation with 20, 40 or 60% beef and they found that the 100% beef patty was not different in flavor from patties made with 40% beef and 60% chevon. With advancement of frozen storage, the flavor value decreased and control sample had the highest value with a significant statistical difference in comparison between each treatment and time of storage (*) except in control and sample having soy flour at 5%. Berry (1993) found that beef patties containing 20% fat beef had highest flavor and tenderness than patties containing 6% fat during storage at -20°C.While, Ho *et al.* (1995) reported that pork sausage samples containing 40% fat had none off-flavor during 12 week than samples containing 6% fat.

Table (10): Changes in flavor of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef meat		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	9.8	9.5^{ab}	8.8^{ab}	8.3^{ab}	9.3^{ab}	8.4^{ab}	8^{ab}	9.7^{b}	8.9^{ab}	8.4^{ab}	7^{ab}	8.6^{ab}	9^{ab}
1	9.8	9.4^{ab}	8.7^{ab}	8.3^{ab}	9.2^{ab}	8.3^{ab}	8^{ab}	9.6^{b}	8.8^{ab}	8.4^{ab}	7^{ab}	8.5^{ab}	8.9^{ab}
2	9.8	9.4^{ab}	8.5^{ab}	8.1^{ab}	9^{ab}	8.1^{ab}	7.8^{ab}	9.5^{ab}	8.8^{ab}	8.1^{ab}	6.8^{ab}	8.5^{ab}	8.9^{ab}
3	9.6	9.2^{ab}	8.5^{ab}	8^{ab}	9^{ab}	8^{ab}	7.5^{ab}	9.5^{b}	8.5^{ab}	8^{ab}	6.5^{ab}	8.3^{ab}	8.6^{ab}
Sig	NS	*	*	*	*	*	*	NS	*	*	*	*	*

NS= Not significant difference.
***= significant difference between treatment and time.**
a = significant difference between control and other treatments.
b =significant difference within treatments.

Data outlined in Table (11) showed appearance scores of the investigated grilled beef burger, hence, the lowest value was 18.7 for control sample with a significant difference in comparison between control and other treatments in most cases (a). This might be due to that control had high amount of fat, so when these samples were grilled recorded most shrinkage when compared to other samples. From the same table it could be noticed that when fat replacers concentration increased appearance scores increased with a significant difference in comparison within each treatment in most of cases (b). This probably was due to that fat replacers acted as binder, extenders and emulsifiers. Besides, the lowest score was 17 for sample containing soy flour at level 15%. Meanwhile, the treatments containing goat meat (chevon) + beef had rather similar value for appearance. James and Berry (1997) demonstrated that creating a product using a mixture of chevon and beef should not have a serious effect on the appearance of the product providing that the product had at least 20% chevon or beef. Furthermore, appearance scores decreased as time of storage increased with a significant statistical difference in comparison between each treatment and time of storage (*) except in treatments containing carboxymethyl cellulose in 3% and soy flour in 5% and 10%.

Table (11): Changes in appearance of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef meat		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	18.7	19^{ab}	19.5^{ab}	19.8^{ab}	19.6^{ab}	19.8^{ab}	20^{ab}	20^{ab}	20^{ab}	17^{ab}	19^{ab}	19.5^{ab}	19.7^{ab}
1	18.5	19^{ab}	19.5^{ab}	19.8^{ab}	19.5^{ab}	19.7^{ab}	20^{ab}	20^{ab}	20^{ab}	16.9^{ab}	19^{ab}	19.3^{ab}	19.7^{ab}
2	18.5	18.7^{b}	19.3^{ab}	19.6^{ab}	19.5^{a}	19.7^{a}	19.7^{a}	20^{ab}	20^{ab}	16.9^{ab}	18.7^{b}	19^{ab}	19.5^{ab}
3	18.1	18.5^{ab}	19^{ab}	19.5^{ab}	19.3^{ab}	19.6^{ab}	19.6^{ab}	20^{ab}	20^{ab}	16.7^{ab}	18.7^{ab}	19^{ab}	19.4^{ab}
Sig	*	*	*	*	*	NS	*	NS	NS	*	*	*	*

NS= Not significant difference.
***= significant difference between treatment and time.**
a = significant difference between control and other treatments.
b =significant difference within treatments.

Results presented in Table (12) showed that texture was increased as fat replacers addition increased except sample containing soy flour at level 15% with a significant difference in comparison within each treatment in some of cases that there was no significant difference in some treatments in some months of storage period (b). Furthermore, there were a significant differences in comparison between control and other treatments in some cases that there was no significant difference in carrageenan at levels 0.5% and 1%, carboxymethyl cellulose by different levels at zero time of storage and soy flour at different levels in some months of storage (a). Candogan and Kolsarici (2003) noted only slight improvements in texture of low-fat frankfurters caused by carrageenan addition. Desmond and Troy (1998) found that carrageenan improved overall texture of low-fat beef burger. With advancement of frozen storage, texture scores decreased recording a significant statistical difference in comparison between each treatment and time of storage (*) except in control and samples having carrageenan in 0.5% , soy flour in 5%, 10% and chevon in 100%. Hand *et al.* (1987) found that when fat of meat products was reduced below 15%, the quality of product changed considerably, especially the texture.

Table (12): Changes in texture of high and low – fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef meat		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	19.8	19.5^{a}	19.7	19.7	19.6	19.6	19.8	20	20	19.8	19^{ab}	19.3^{ab}	19.1^{ab}
1	19.7	19.3^{ab}	19.6^{b}	19.6^{b}	19.6^{b}	19.5^{b}	19.8^{b}	20^{a}	20^{a}	19.8	19^{a}	19.2^{a}	19^{a}
2	19.6	19.3^{ab}	19.5^{b}	19.6^{b}	19.3^{ab}	19.2^{ab}	19.5^{b}	20^{ab}	20^{ab}	19.7^{b}	18.8^{a}	19^{a}	18.9^{a}
3	19.6	19.1^{ab}	19.5^{b}	19.4^{b}	19.3^{ab}	19.2^{ab}	19.5^{b}	20^{ab}	20^{ab}	19.5^{b}	18.8^{a}	19^{a}	18.8^{a}
Sig	NS	*	NS	*	*	*	*	NS	NS	*	NS	*	*

NS= Not significant difference.

***= significant difference between treatment and time.**

a = significant difference between control and other treatments.

b =significant difference within treatments.

Data presented in Table (13) indicated that control sample and samples containing carrageenan at level 0.3%, samples containing carboxymethyl cellulose at level 1.5%, samples containing soy flour at level 5%, samples containing 25% goat meat (chevon) + 75% beef meat had the highest overall acceptability values. Meanwhile, the lowest value was 14 for samples containing 100% goat meat (chevon).

Table (13): Changes in overall acceptability of high and low–fat beef burgers as affected by using different ratios of fat replacers during 3 months frozen storage at -20°C.

Time of storage (months)	control	Carrageenan			Carboxymethyl cellulose			Soy flour			Chevon + Beef		
		0.3%	0.5%	1%	1.5%	3%	4.5%	5%	10%	15%	100% chevon	50% chevon + 50% beef	25% chevon +75% beef
0	20	19^{ab}	18^{ab}	18^{ab}	20^{b}	17^{ab}	16^{ab}	20^{b}	19^{ab}	15^{ab}	14^{ab}	16^{ab}	20^{b}
1	20	19^{ab}	18^{ab}	17.8^{ab}	20^{b}	16.8^{ab}	16^{ab}	20^{b}	18.7^{ab}	15^{ab}	13.8^{ab}	15.8^{ab}	20^{b}
2	19	18^{a}	17.8^{a}	17.8^{a}	19.8^{ab}	16.5^{ab}	15.8^{ab}	20^{ab}	18.5^{ab}	14.8^{ab}	13.5^{ab}	15.5^{ab}	20^{ab}
3	19	18^{ab}	17.5^{ab}	17.4^{ab}	19.8^{ab}	16^{ab}	15.5^{ab}	20^{ab}	18.5^{ab}	14.5^{ab}	13^{ab}	15.5^{ab}	20^{ab}
Sig	*	*	*	*	NS	*	*	NS	*	*	*	*	NS

NS= Not significant difference.

***= significant difference between treatment and time.**

a = significant difference between control and other treatments.

b =significant difference within treatments.

Statistical analysis indicated that there were a significant statistical difference in comparison between each treatment and time of storage (*) except in carboxymethyl cellulose in 1.5% and soy flour in 5%, also there was a significant difference in comparison between control and other treatments in most cases that there was no significant difference in overall acceptability in sample having carboxymethyl cellulose in 1.5%, sample having soy flour in 5% and sample having 25% chevon + 75% beef meat (a) and also there were a significant differences in comparison within each treatment in most of cases (b).

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تأثير التخزين بالتجميد على الخصائص الفيزيائية والحسيه للحم البقرى والبيف برجر المنخفض الدهن

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أجريت هذه الدراسة في محاولة لتوضيح تأثير التخزين بالتجميد على الخصائص الفيزيائيه والحسيه للبيف برجر المنخفض الدهن حيث أخذ اللحم البقرى الطازج من أبقار في عمر ثلاث سنوات من عضلة (top round) من المذبح الالي بأسيوط بينما اخذ لحم الماعز من قطعية الفخذ والكتف والمتحصل عليه من السوق المحلى لمدينة أسيوط، وأما عن بدائل الدهون المستخدمة فهي: الكاراجينان بنسبة (0.3، 0.5، 1%)، الكاربوكسي ميثيل سيليللوز بنسبة (1.5، 3، 4.5%)، دقيق الصويا بنسبة (5، 10، 15%) ولحم الماعز (25، 50، 100%) . وقد تم اعداد البيف برجر المنخفض الدهن بالخلط الجيد للحم المفروم مع الكاراجينان،الكاربوكسي ميثيل سيليللوز، دقيق الصويا ولحم الماعز بالنسب المختلفه وتشكيله باستخدام اداة تشكيل البرجر وتغليفه في أكياس من البولى ايثيلين ثم تخزينه بالتجميد على درجة -20°م لمدة ثلاثة شهور مع اخذ عينات للتحليل في بداية التخزين وبعد كل شهر من التجميد. وقد تم تقدير الصفات الطبيعيه وهي: رقم الاس الهيدروجيني، قوة الارتباط بالماء، الانكماش، الفقد في الطبخ والعائد من الطبخ وذلك بجانب تقدير الصفات الحسيه والتي شملت اللون، المضغ، الطعم، النكهه، المظهر، القوام والقابليه العامة وذلك بعد الشي(Grilling) باستخدام الشواية الكهربائيه لمدة 10ق في بداية وخلال أشهر التخزين. وقد اثبتت نتائج التحليلات ان العينات المحتويه على دقيق الصويا النسب المختلفه كانت اعلى في رقم الاس الهيدروجيني مع وجود فرق معنوى عند المقارنة بين الكنترول بباقي العينات. كما اوضحت النتائج ان مقدرة البرجر المنخفض الدهن والمحتوى على بدائل الدهون (الكاراجينان، الكاربوكسي ميثيل سيليللوز، دقيق الصويا، لحم الماعز) على الارتباط بالماء كانت اكبر من تلك الخاليه من هذه البدائل كما ادت هذه البدائل الى تحسين قيمة الانكماش في العينات المحتويه عليها مقارنة بالكنترول بينما قل الفقد في الطبخ بزيادة اضافة بدائل الدهون كما ازداد العائد من الشي والذى يحدث طبقا للتغير في الفقد في الشي وقوة الارتباط بالماء خلال اشهر التخزين حيث ان الزياده في قوة الارتباط بالماء قابلها زياده في العائد مع انخفاض الفقد اثناء الشي. كما ادى التخزين الى زيادة الفقد في اللون بزيادة مدة التخزين وقد سجل الكنترول اعلى القيم بالنسبه لخاصية المضغ، الطعم، النكهه واقل القيم في المظهر وقد تسببت زيادة اضافة بدائل الدهون الى زيادة القوام واخيرا وليس اخرا فقد اشارت النتائج ان اعلى قيم القابليه العامه كانت لكل من الكنترول والعينات المحتويه على الكاراجينان بنسبة 0.3%، الكاربوكسي ميثيل سيليللوز بنسبة 1.5%، دقيق الصويا بنسبة 5%، ولحم الماعز بنسبة 25%.