Research Journal of Recent Sciences _____ ISSN 2277-2502
Vol. **2(4),** 20-27, April **(2013)** *Res. J. Recent Sci.*

Assessment of the Microbial Growth and Chemical Changes in Beef and Lamb Meat Collected from Supermarket and Shop during Summer and Winter Season

Fahad Mohammed Al-Jasass
King Abdulaziz City for Science & Technology, General Directorate of Research Grants, P.O. Box 6086, Riyadh11442, SAUDI ARABIA

Available online at: www.isca.in
Received 5th November 2012, revised 28th November 2012, accepted 25th December 2012

Abstract

Spoilage of meat has remained a serious challenge in developing countries. The objective of this study was to evaluate the beef and lamb meat quality from supermarkets and shops in summer and winter season. Beef and lamb meat were stored at 4±1°C during 5 days and test for microbiological properties, oxidation stability, and color properties, in beef and lamb meat. Samples were collected from supermarkets and shops during the summer and winter seasons to determine variation in the microbial load, chemical, and color characteristics. On day zero the total viable cell counts, Pseudomonas, Streptococcus fecal, coliform fecal, Staphylococcus, and Staphylococcus aureus in beef and lamb meat samples collected from shops were higher than those found in the samples collected from supermarkets. Viable cell count, Pseudomonas, Streptococcus fecal, coliform fecal Staphylococcus, and Staphylococcus aureus in beef and lamb meat collected in winter season at day 0 were significantly lower than in summer samples. Thiobarbituric acid reactive substances (TBARS) in beef and lamb meat samples collected from supermarket in winter season were lower than those of the samples collected in summer season. TBARS in beef and lamb samples collected from small shop in winter season were lower than those of the samples collected in summer season. Lightness, redness, and yellowness in beef and lamb meat collected in the winter and summer seasons from supermarkets and shop were decreased during storage time. This study proved that the storage temperature, season, sources of meat affect significantly in meat quality.

Keywords: Microbial analysis, meat chemical analysis, color, lamb, beef, seasonal variation.

Introduction

Food spoilage is a metabolic process by enzymes and microorganisms that causes foods to be unpalatable or unfit for human consumption due to growth of spoilage organisms and changes in sensory characteristics. The chemical composition of the beef and lamb meat provides suitable media for the growth of both spoilage and pathogenic microorganisms. Therefore the shelf-life of fresh meat is limited to a few days during storage at refrigeration temperature unless preservation methods are used[1]. Bacteria are dominant at low temperatures and play a significant role in the spoilage of meat and meat products in the refrigerator[2]. The microbial population in meat depends on a number of factors such as the way in which animals are slaughtered and eviscerated, how meat is handled and stored, temperature during transport and chilling, and hygienic conditions[3]. The off odor and sliminess develop in meat when the number of bacteria exceeds 10^7 CFU/g. The organisms which are mainly responsible for the spoilage of meat and meat products are *Pseudomonas* spp.[4]. *Pseudomonas* are gram negative, rod shaped, nonsporeforming bacteria that grow satisfactorily at low temperatures. Normally, *Pseudomonas* spp, *Enterobacteriaceae*, *Brochothrix thermosphacta* and lactic acid bacteria contribute to meat spoilage when oxygen is available in the storage environment[5,6]. Beef and lamb meats are rich sources of protein, fat, and minerals. Meat provides suitable media for growth of both spoilage and pathogenic microorganisms. Therefore, the shelf-life of fresh meat is limited to few days during storage at refrigerator temperature. Low temperature, good handling and transportation as well as hygienic conditions can extend both shelf-life and meat quality. In general microorganisms grow well when they are kept at 5°C and have adequate supply of nutrients. Food stored for prolonged periods at 5°C provides the perfect conditions in which microorganisms can thrive.

Lipid oxidation is a complex process whereby unsaturated fatty acids reacting with molecular oxygen which lead to the degradation of the lipid and the development of oxidative rancidity. Lipid oxidation is the main contributor to flavor deterioration in meat and meat products. Postmortem processes can influence microorganisms increase and lipid oxidation and thus decrease the shelf life and meat quality due to the initiation of per-oxidation[6]. Oxidation of fatty acid starts directly after animal slaughter. Freezing temperatures can delay the oxidation but do not prevent it.

The first impression to consumers of meat is its color which it is an extremely critical component of the appearance of fresh beef sold through retail[7,8]. The color of meat may vary from deep purplish-red of freshly cut beef to the light gray of faded cured meat. However, the color of meat can be controlled by some

factors that influence meat color. When oxygen from the air comes into contact with the exposed meat surfaces, it binds to the iron in meat and hence called oxymyoglobin that gives beef its bright cherry red color. To maintain this meat color, it is required that the meat surface be free from any contamination which would cause a chemical reaction resulting in the formation of the brown pigment metmyoglobin. Vacuum packaged fresh meat has a dark, purplish red color because the oxygen has been removed from the package and reducing enzymes have converted the meat pigment back to the myoglobin. Once the meat is taken out of the vacuum package it will recover its bright red color.

This study was undertaken to determine the variation in microbial, chemical, and sensory characteristics in beef and lamb meats that were collected from a number of supermarkets and shops. Also, determine the quality of meat in the supermarkets and shops and known the current status of these stores.

Material and Methods

Sample collection: For this study, beef and lamb meat samples were collected from supermarkets and shops in winter (September, October, November and December) and summer seasons (May, June, July, and August). Samples withdrawn on the first day of their arrival to the places of sale in supermarkets and shops. About 1±0.2 kg of each of the meat samples (longissimus dorsi) packed in polyethylene bag was purchased and kept at low temperature (0-1^{o}C) and transported to the lab within 1 hour. Each replicate consisted of four samples of beef and lamb meats were collected separately from supermarkets and shops under aseptic conditions. When the samples reached the laboratory, microbial, and chemical analyses were carried out and the rest of samples were kept at appropriate temperatures.

Microbiological evaluation: Three replicates from each sample of beef and lamb meats were aseptically taken. then 25 g of each samples were 10-fold diluted in 225 ml buffered peptone water and homogenized in a stomacher bag for 1 min. Serial decimal dilutions were prepared and the following analyses were carried out in duplicates: i. Total viable counts on aerobic count agar plate which was incubated at 30°C for 48 hours, ii. *Pseudomonas* count on aerobic Pseudomonas agar media which incubated at 30°C for 24 hours, iii. *Streptococcus* count on Tryptic Soy Agar was incubated at 35°C for 24 hours, iv. Coliform fecal at Violet Red bile Agar aerobic with incubation at 30°C for 24 hours, v. *Staphyloccous* and *Staphylococcus aureus* at *Staphylococcus* Medium 110 aerobic with incubation at 35°C for 48 hours. The FDA Bacteriological Analytical Manual (BAM) and American Public Health Association were used to enumerate the total viable counts and identify pathogens in meats[9,10].

Chemical Analyses: Thiobarbituric acid reactive substances (TBARS): The TBARS values were measured in duplicate with the method described by Sørensen and Jørgensen[11]. For extraction, 10 g portion of the minced beef and lamb meat was homogenized (15000 rpm, 30 s, 20 °C) with 30 mL of a 7.5% aqueous solution of trichloroacetic acid in a homogenizer. After filtration, 5.0 mL of the filtrate were then pipetted into test tubes and 5 mL 0.02 M aqueous solution of TBA in a stoppered test tube, kept at 100°C for 35 min in a water bath, and cooled for 10 min in cold water. The developed color was measured using spectrophotometer at 530 nm by Ultraspec 3000 against a control containing 5.0 mL distilled water and 5.0 mL TBA reagent. The results were expressed as mg malonaldehyde/kg meat and were measured from the 1,1,3,3-tetraethyoxypropane (TEP) based standard curve.

Meat color analyses: A Hunter Lab instrument was used for measuring the meat color during storage period. L* measuring the white, a* for red and b* for yellow color. The a value (redness) was used to determine the color deterioration during meat storage in the refrigerator 4±1^{o}C. The length of time the meat had been stored postmortem, affects the color stability of the meat or meat products. Increased time from slaughter results in reduced color stability because co-factors necessary for the reduction of met-myoglobin are depleted as postmortem time increases.

Fresh beef and lamb meat color were measured by Hunter lab values, L*, a*, and b* (yellowness), for each slide at three sites (in duplicates) other than the surface of the slide for each location and then the average was calculated L*, a*, b* as: L (lightness) axis—0 is black, 100 is white; a (red-green) axis—positive values are red; negative values are green and 0 is neutral; and b (yellow-blue) axis—positive values are yellow; negative values are blue and 0 is neutral. These scales were used to measure the color difference between a sample and a standard. Measurements of the color of red meat samples were obtained by using a Hunter lab. values of L*, a*, and b* measured by D 65 as a source of light, then the device was standardized by using a white standard. Color measurements were repeated three times during each period of storage after a piece of meat was exposed to light and air for 45 minutes and during this period meat pieces were covered with a flexible membrane with a high permeability of oxygen to prevent drying of the meat piece.

Statistical analyses: All analyses were performed using three replicates. ANOVA for the factorial experiment in the completely randomized design was carried out according to Gomez and Gomez[12]. The treatments means were compared using the least significant difference (LSD) at the 5% level according to Waller and Duncan,[13]. SAS software package was used (SAS),[14].

Results and Discussion

Microbiological analyses: Tables 1 and 2 show the analytical results of microbial growth in beef and lamb meats collected in summer season. On day 1 the total counts in beef meat collected from supermarket and shops were 4.9 and 4.8 $\log_{10}$

CFU/g, respectively, which indicated that meat was loaded with moderate numbers of microorganisms. Moderate counts may be related to contaminated during slaughtering, handling, chilling, and temperature during transportation. The total count were similar to those reported by Esmer et al.[15], for beef as well as lamb and sheep Karabagias et al,[16]. After 5 days of storage at refrigerator temperature ($4 \pm 1^{o}C$), the total count in beef meat from supermarkets and shops increased to 7.6 and 8.1 $\log_{10}$ CFU / g, respectively. Khalafalla et al.[17], found that the aerobic plate count of fresh meat at first day was $8x10^5$ CFU/g while it was reached to $9x10^8$ CFU/g at 5th day during storage at chilling (5ºC). The low temperature in the supermarkets more effectively suppressed the growth of aerobic spoilage bacteria in beef. The initial counts in the lamb meat collected from supermarkets and shops were 3.7 and 4.6 $\log_{10}$ CFU/g, respectively. The results indicated that lamb meat from shops contained higher count than those from supermarkets. After 5 days of storage at refrigerator temperature, the total count in lamb meat from supermarkets and shops increased to 7.2 and 7.8 $\log_{10}$ CFU / g, respectively. ICMSF,[18] identified the maximum of the viable cell count should be less than 10^7 CFU/g in chilled meat.

Pseudomonas counts in beef meat collected in summer from supermarket and shops were 3.8 and 4.3 $\log_{10}$ CFU/g, respectively. Lorenzo and Gómez,[2] found that the initial *Pseudomonas* spp. count were 4.24 $\log_{10}$ CFU. The results showed that the beef meat sample from shops contained high microbial count. After 5 days of storage, the *Pseudomonas* counts in beef meat collected from supermarket and shops increased and reached to 6.1 and 7.2 $\log_{10}$ CFU/g, respectively. According to Pennacchia et al.,[19], the initial count of *Pseudomonas* spp. in minced beef sample was in the range of 3.7 and 5.6 $\log_{10}$ CFU/g which increased to 7.5 $\log_{10}$ CFU/ g when it was stored under aerobic conditions at $4^{o}C$ for 7 days. *Pseudomonas* grow at low temperatures and are thus responsible for meat spoilage. Beef meat was close to index of spoilage defined as 6 $\log_{10}$ CFU/g[20]. This study showed that refrigeration alone does not interact with microbial populations on beef. *Pseudomonas* counts in lamb meat from supermarkets and shops were 3.0 and 4.5 $\log_{10}$ CFU/g, respectively. Perez Chabela et al,[21], found that the psychrothrophs in beef and sheep were 4.27 and 3.71 $\log_{10}$ CFU, respectively. Perez Chabela[21], found that the microbial populations in sheep and beef were above 3 $\log_{10}$ CFU g. According to Lorenzo and Gómez[2],, the initial psychrotrohic aerobic bacteria in beef meat were 4.44 $\log_{10}$ CFU/g. Psychrotropic count in fresh meat at day 0 was $2x10^4$ CFU/g as well as it was reached to 9×10^5 at 5th day during storage at chilling (5ºC)[17]. Also, mesophiles in beef and sheep samples were recorded at 4.7 and 5.03 $\log_{10}$ CFU/g, respectively. After 5 days at refrigerator temperature storage the *Pseudomonas* counts in the lamb meat collected from supermarkets and shops increased and reached 6.8 and 7.2 $\log_{10}$ CFU/g, respectively. The results indicated that the initial counts in the lamb meat from shop contained high count. In the final day in the refrigerator, there was significant difference between lamb meat collected from supermarkets and shops.

Table-1
Growth of microbial load in beef meat samples collected in summer season from supermarkets butcheries and butcher shops and stored at $4\pm1^{o}C$ for 5 days

Time (Day)	Supermarket butcheries				Butcher shops			
	1	2	3	5	1	2	3	5
	Log_{10} CFU/gram				Log_{10} CFU/gram			
Total viable cell count	4.9^{a}	5.3^{b}	6.5^{b}	7.6^{c}	4.8^{a}	5.5^{b}	6.8^{c}	8.1^{d}
Pseudomonas	3.8^{a}	4.5^{b}	5.5^{c}	6.1^{d}	4.3^{a}	4.9^{b}	5.8^{c}	7.2^{d}
Streptococcus fecal	2.4^{a}	3.5^{b}	3.9^{c}	4.2^{d}	3.4^{a}	4.3^{b}	5.5^{c}	6.0^{d}
Coliform fecal	2.9^{a}	3.2^{b}	3.5^{c}	3.8^{d}	3.2^{a}	3.8^{b}	4.3^{c}	4.8^{d}
Staphylococcus	3.6^{a}	4.0^{b}	4.5^{c}	4.8^{d}	4.4^{a}	4.4^{b}	5.7^{c}	6.1^{d}
Staphylococcus aureus	2.2^{a}	2.6^{b}	3.5^{c}	4.2^{d}	3.7^{a}	4.9^{b}	5.5^{c}	5.8^{d}

Each number is mean of three replicates. Means with different letters in the same row are significantly different at ($p < 0.05$).

Table-2
Growth of microbial load in lamb meat samples collected in summer season from supermarkets butcheries and butcher shops and stored at $4\pm1^{o}C$ for 5 days

Time (Day)	Supermarket butcheries				Butcher shops			
	1	2	3	5	1	2	3	5
	Log_{10} CFU/gram				Log_{10} CFU/gram			
Total viable cell count	3.7^{a}	4.8^{b}	5.7^{c}	7.2^{d}	4.6^{a}	5.8^{b}	6.7^{c}	7.8^{d}
Pseudomonas	3.0^{a}	4.2^{b}	5.0^{c}	6.8^{d}	4.5^{a}	5.2^{a}	6.3^{b}	7.2^{c}
Streptococcus fecal	1.3^{a}	2.2^{b}	2.3^{b}	2.5^{c}	1.9^{a}	2.8^{b}	3.1^{c}	3.5^{d}
Coliform fecal	2.0^{a}	2.6^{b}	3.1^{c}	3.6^{d}	2.0^{a}	2.5^{b}	3.0^{c}	3.9^{d}
Staphylococcus	2.2^{a}	2.5^{b}	2.8^{c}	3.4^{d}	2.6^{a}	3.5^{b}	3.9^{c}	4.7^{d}
Staphylococcus aureus	2.0^{a}	2.6^{b}	3.1^{c}	3.5^{d}	2.5^{a}	2.9^{b}	3.8^{c}	4.2^{d}

Each number is mean of three replicates. Means with different letters in the same row are significantly different at ($p < 0.05$).

Coliform fecal counts in beef collected in summer from supermarket at day 1 was 2.9 $\log_{10}$ CFU/ g while it was reached to 3.8 $\log_{10}$ CFU/g at the 5th day during storage at 4±1ºC. Coliform fecal counts in beef collected from small shop in summer at day 1 was 3.2 $\log_{10}$ CFU/ g while it was reached to $\log_{10}$ 4.8 CFU/g at the 5th day during storage at 4±1ºC. The results show that the meat from supermarket were lower than those collected from shops. Lamb meat collected in summer from supermarket load lower count of coliform fecal at day 0 the count was 2.0 $\log_{10}$ CFU/ g while it was reached to 3.6 $\log_{10}$ CFU/g at the 5th day during storage at 5±1ºC. Coliform fecal counts in lamb collected from small shop at day 1 was 2.0 CFU/ g while it was reached to 3.9 $\log_{10}$ CFU/g at the 5th day during storage at 4±1ºC. Khalafalla et al.,[17], reported that the most probable number of coliforms was 6.7 x 10 CFU/g at the first day while it was reached to 3 $\log_{10}$ CFU/g at the 5th day during storage at chilling (5ºC). Also, fecal coliforms was 2.8 x 10 CFU/g at first day while it was reached to 10^3 ±3x10^2 CFU/g at 5th day.

Staphylococcus aureus count in beef meat collected in summer from supermarket was 2.2 $\log_{10}$ CFU/g at day 1 while it was reached to 4.2 $\log_{10}$ CFU /g at 5th day. There are a significant differences between *Staphylococcus aureus* counts starting from day 1 to the 5th day. Beef meat from small shop contained high a count of *Staphylococcus aureus* at day 1 the count was 3.7 $\log_{10}$ CFU/g at day 1 while it was reached to 5.8 $\log_{10}$ CFU /g at 5th day. *Staphylococcus aureus* count in lamb collected in summer meat from supermarket shop at day 1, 2, 3, and 5 days was 2.0, 2.6, 3.1, 3.5 $\log_{10}$ CFU/g, respectively. Also, the count of *Staphylococcus aureus* in lamb meat from small shop at day 1, 2, 3, and 5 days was 2.5, 2.9, 3.8, and 4.2, $\log_{10}$ CFU/g, respectively. *Staphylococcus aureus* count was 5x10^2 CFU/g at 1st day while it was reached to 2x10^4 CFU/g at 5th day during storage at chilling (5ºC)[17].

The high count of microorganism in beef and lamb meat may be derived from exterior and the gut of animal, knives, other utensils; butchery tables. Therefore, the variations in counts in meat from supermarket and shop often reflect to the hygienic conditions under which those meats produce. The number of microorganisms in fresh meat may enhanced by the abuse temperature, time of storage, the way of handling and transportation because meat contains on rich of nutrient elements and suitable pH required for multiplication of microorganisms.

Coliform fecal, *Staphylococcus*, and *Staphylococcus aureus*, and *Streptococcus* fecal counts in beef and lamb meat samples collected in summer from supermarket were lower than those collected from shops. The high count in shop samples may be due to poor hygienic conditions and possible faecal contamination[22]. The lower count in samples from supermarket was probably due to good hygienic conditions in handling, storage and display. Beef meat samples from supermarket had moderate counts after 2 days storage at 5^{o}C.

Tables 3 and 4 summarizes the total viable cell count, *Pseudomonas*, *Streptococcus* fecal, coliform fecal *Staphylococcus*, and *Staphylococcus aureus* in beef and lamb meat collected from supermarket and shop in winter season. The microbial load in beef and lamb meat collected from supermarket and shop were lower than the results in summer sample. The microflora present in meat depends on the environment, hygiene and temperature in slaughterhouse, chilling, and handling conditions during storage. Results showed that viable cell count at day 1 in beef meat collected in winter season were significantly lower than in beef collected in summer by 1 $\log_{10}$ CFU/g and 0.5 $\log_{10}$ CFU/g for lamb meat. The differences in the results due to microorganisms grow faster in the warm summer months and most of foodborne bacteria grow fastest at temperatures from 32 to 43°C. In general, bacteria need moisture to grow quickly, the summer season is often hot and humid and this favorable environment for microorganisms to grow and multiple. *Pseudomonas*, *Streptococcus* fecal, coliform fecal, *Staphylococcus*, and *Staphylococcus aureus* in beef and lamb meat collected in winter at day 1 were significantly lower than in summer samples. An increase in viable cell count, *Pseudomonas*, *Streptococcus* fecal, coliform fecal *Staphylococcus*, *Staphylococcus aureus* in beef and lamb meat was observed at 1, 2, 3 and 5 days during the storage period at 4±1°C in all two sampling seasons.

Table-3
Growth of microbial load in beef meat samples collected in winter season from supermarkets butcheries and butcher shops and stored at 4±1^{o}C for 5 days

Time (Day)	Supermarket butcheries				Butcher shops			
	1	2	3	5	1	2	3	5
	$\log_{10}$ CFU/gram				$\log_{10}$ CFU/gram			
Total viable cell count	3.9^a	4.8^b	6.1^b	7.1^c	4.5^a	5.4^b	6.4^c	7.7^d
Pseudomonas	3.4^a	4.1^b	5.2^c	6.0^d	3.8^a	4.6^b	5.8^c	6.9^d
Streptococcus fecal	2.2^a	3.0^b	3.6^c	4.0^d	3.1^a	3.8^b	4.6^c	5.7^d
Coliform fecal	2.4^a	3.2^b	3.4^c	3.7^d	2.9^a	3.6^b	4.1^c	4.5^d
Staphylococcus	3.2^a	3.9^b	4.2^c	4.3^d	3.8^a	4.3^b	5.4^c	5.8^d
Staphylococcus aureus	2.0^a	2.8^b	3.3^c	4.0^d	3.2^a	3.9^b	4.8^c	5.1^d

- Each number is mean of three replicates. Means with different letters in the same row are significantly different at ($p < 0.05$).

Table-4
Growth of microbial load in lamb meat samples collected in winter season from supermarkets butcheries and butcher shops and stored at 4±1°C for 5 days

Time (Day)	Supermarket butcheries				Butcher shops			
	1	2	3	5	1	2	3	5
	Log_{10} CFU/gram				Log_{10} CFU/gram			
Total viable cell count	3.4^{a}	4.3^{b}	5.5^{c}	6.7^{d}	4.1^{a}	5.3^{b}	6.4^{c}	7.5^{d}
Pseudomonas	3.0^{a}	4.0^{b}	4.9^{c}	5.5^{d}	3.6^{a}	4.4^{a}	5.4^{b}	6.5^{c}
Streptococcus fecal	1.3^{a}	1.8^{b}	2.1^{b}	2.3^{c}	1.6^{a}	2.3^{b}	3.0^{c}	3.4^{d}
Coliform fecal	2.0^{a}	2.4^{b}	3.2^{c}	3.5^{d}	2.0^{a}	2.6^{b}	3.5^{c}	3.8^{d}
Staphylococcus	2.2^{a}	2.6^{b}	3.3^{c}	3.9^{d}	2.5^{a}	3.4^{b}	3.8^{c}	4.2^{d}
Staphylococcus aureus	2.0^{a}	2.4^{b}	3.0^{c}	3.3^{d}	2.4^{a}	3.1^{b}	3.7^{c}	4.0^{d}

Each number is mean of three replicates. Means with different letters in the same row are significantly different at ($p < 0.05$).

Oxidative rancidity analyses: Oxidative stability of meat derived from two different places (supermarket and small shop) and two species (beef and lamb) was studied in raw chill stored at 4±1°C for 1, 2, 3 and 5 days. Development of lipid oxidation in beef and lamb meat during storage was evaluated by TBARS. Lipid oxidation increased during storage time in all samples, but the highest increase in TBARS values over time were observed in the lamb meat. Lipid oxidation or oxidative rancidity as TBARS mg malondialdehyde/kg of meat increased in beef meat during storage at 4±1°C. The results are presented in table 5. Beef meat samples collected from supermarket butcheries in the winter season had the lowest oxidative rancidity. They were significantly different from beef meat samples collected in the summer season. The value of TBARS in the beef meat samples collected in the winter season was 0.22 mg malonaldehyde/kg and increased during storage. At the end of the 5th day of storage, the value of TBARS was 0.59 mg malonaldehyde/kg. The TBARS in the beef meat samples collected in the summer season was 0.29 mg malonaldehyde/kg. It increased to 0.82 mg/kg after 5 days of storage. Oxidative rancidity in beef meat samples collected from shops in the winter and the summer season at day 1 was 0.35 and 0.39 mg malonaldehyde/kg, respectively. On day 5, the rancidity in beef meat samples collected from shops in the winter and the summer season increased and reached 0.74 and 0.94 mg malonaldehyde/kg, respectively. Almroth, et al.,[23] indicated the presence of a seasonal cycle, with TBARS levels lowest during the colder winter months and highest during the hot summer months. The results indicated that the beef meat samples from supermarket contain low amount of oxidative rancidity both in winter and summer seasons as compared to meat collected from shops. According to Chang et al.,[24], the judges were able to detect the undesirable odors and flavors when the values of the TBARS in meat sample were between 0.5-1.0 ppm. Keller and Kinella,[25] noted that the value of TBARS in uncooked hamburger meat increased during the freezing period. In frozen chicken meat the value of the TBARS had increased during storage at -10°C for 3 months[26]. Also, frozen meat and cattle fat stored at temperature -10°C for a period of 35-70 and 60-175 days showed increased values of TBARS. The lower value of TBARS in meat collected from supermarket may be due to low temperatures during storage environment, the way of meat was covered, and the light. The low level of TBARS in meat indicates that the meat is of good quality. TBARS increased significantly ($P < 0.05$) for the beef and lamb samples in the winter and summer season either from supermarket or shop.

Oxidative rancidity in lamb meat collected from supermarket in winter and summer seasons was 0.32 and 0.40 mg malonaldehyde/kg, respectively. On day 5, the rancidity increased and reached 0.85 and 1.1 mg malonaldehyde/kg for the samples collected in the winter and summer seasons, respectively. The amount of rancidity in lamb meat collected from shops in winter and summer season were 0.34 and 0.38 mg malonaldehyde/kg, respectively. On day 5 of the storage, the rancidity in meat collected from shops in winter and summer samples increased to 0.87 and 0.91 mg malonaldehyde/kg, respectively. Similar results were reported by O'Gradya et al.,[27], who found the initial TBARS in beef meat were 0.41±0.22 at day 1 well as it was reached to 0.84±0.41 mg malonaldehyde/kg after 4 day in storage at chilling (5ºC). The results indicated that there was no significant difference between lamb meat samples collected from supermarket and shops during the winter and summer seasons. Ponnampalam et al.,[28] found that the values of TBARS in beef meat stored for 1, 3, and 5 days were 0.77, 0.84, and 0.92 mg malonaldehyde/kg, respectively. Accelerated TBARS formation during storage of irradiated meat and meat products has also been reported by Galvin et al.,1998 and Lefebvre et al.,[29, 30]. The results showed that the highest values of the TBARS were reached on the fifth day, but the unwanted odors started to appear on the third day of storage.

Meat color analyses: Meat color is most important sensory attribute affecting the consumer's purchasing decision. Results of color analyses carried out on beef meat collected from supermarkets and shops in winter and summer season are presented in table 6. Lightness (L*), redness (a*), and yellowness (b*) showed significant differences ($P < 0.05$) due to storage time, place, and season. Initially, beef samples collected during winter season had higher values for L*, a*, and b* in color from the supermarkets butchery significantly different from butcher shop samples in the direct comparison, *t*-test $P < 0.05$. However, on day 5 in the refrigerator at 4±1°C, beef meat samples from the supermarkets had higher values for

L*, a*, and b* in color which were significantly different from that of the shop samples. The results showed that, there was a consistent effect of storage on a* value in the beef meat samples collected from supermarkets and shops during winter season. The a* value on day 1 was 18.81 which decreased to 12.56 when meat was stored in the refrigerator (5±1°C) for 5 days. Also, the a* values for beef meat samples collected from shops and stored in refrigerator on day 1, 2, 3, and 5 were 17.81, 17.27, 15.65, and 13.36, respectively. The a* value decreased rapidly with time during storage in the refrigerator. Balev et al.,[32], found that the L* values in chilled beef between 33.38 to 45.67. During the first 3 days of chilled storage (0±0.5°C) L* values increased slightly and after 12 days L* values decreased significantly (p>0.05). Also, the red (a*) value and yellow (b*) color decreasing. The color (lightness L*; redness, a*; b*, yellowness) of the beef patties at day 0 were 32.2, 17.0, and 10.6; respectively[33]. Ponnampalam et al.,[28], found that the a* value for longissimus muscle was 11 on day 1 and decreased to 9.8 when stored at 4±1°C for 6 days. There was significant effect on meat color (a* value) due to display of day time and storage temperature. It is clear that the refrigeration temperature in supermarket was more efficient than in butcher shops. The L* value in beef meat collected from supermarket and shops in the winter and summer seasons increased significantly during the period of storage in the refrigerator. The b* value in beef meat collected from supermarket in the winter and the summer seasons increased slightly and there was significant difference between time periods in the refrigerator. The b* value in beef meat collected from shops in the winter and the summer seasons declined significantly during the storage period in the refrigerator. The changes of L*, a*, and b* could be explained with the lipid oxidation development of oxygen-enriched atmosphere packaged raw beef [34] and oxymyoglobin layer formation on the beef cuts surface[7].

Results of color analyses on lamb meat samples, collected from supermarket and shops, are presented in table 7. Lamb meat samples collected from the supermarkets had L^* values in color that are significantly different from that of samples collected from shops in a direct comparison, *t*-test $P < 0.05$ Lamb samples collected from the supermarkets in the winter season had a^* values, in color as compared to butcher shops. The data indicated that there were changes in color values of Redness (a) and Yellowness (b) and Lightness (L) during storage period in the refrigerator. There were significant difference of Lightness (L) Redness (a) and Yellowness (b) $P \leq 0.05$ after 5 days in storage. The color measurement in the lamb meat collected from supermarket in winter season at day 1 for the *L**, a*, and b* value was found 41.59, 13.58, and 17.95, respectively. The L*, a*, and b* values decreased significantly during the storage period at (4±1°C) to 39.01, 10.67,, and 13.19, respectively. Cetin and Topcu,[35] found that the L*, a*, and b* values in fresh goat meat 33.46±1.45, 12.8±0.47, 19.1±0.53, respectively. Color acceptability decreases as storage time increases; however, the length of storage time the color is acceptable is greatly affected by storage temperature. Fresh meat and meat products should be stored at temperatures lower than 4±1°C to give maximum color shelf-life and safety of products. Kropf et al.,[36] reported that the shortage of oxygen can lead to oxidation dye-oxy-myoglobin adverse change in color from bright red to brown. Bhattacharya et al,[37] indicated that the decline in the values with time may be due to inability of myoglobin dye to combine with oxygen.

Table-5

Average values of the TBARS (mg Malonaldehyde / kg meat) in beef and lamb meat samples collected in the summer and winter seasons from the supermarkets and butchery shops stored at 4±1°C for 5 days

Time Day	Beef meet				Lamb meat			
	Super market		Butchery Shop		Super market		Butchery Shop	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
1	0.22[a]	0.29[a]	0.35[a]	0.39[a]	0.32[a]	0.40[a]	0.34[a]	0.38[a]
2	0.26[b]	0.37[b]	0.31[b]	0.43[b]	0.38[b]	0.47[b]	0.45[b]	0.41[b]
3	0.45[c]	0.45[c]	0.38[c]	0.56[c]	0.49[c]	0.64[c]	0.51[c]	0.58[c]
5	0.59[d]	0.82[d]	0.74[d]	0.94[d]	0.85[d]	1.1[d]	0.87[d]	0.91[d]

Each number is mean of three replicates. Means with different letters in the same column are significantly different at (p <0.05).

Table-6

Impact of cold storage on the characteristics of the beef meat samples collected during winter and summer seasons from supermarkets butcheries and shops and stored at 4±1°C for 5 days

	Winter season				Summer season			
	Supermarket Butchery				Supermarket Butchery			
Time Day	1	2	3	5	1	2	3	5
L^* (lightness)	35.12[a]	34.73[a]	33.83[b]	32.80[c]	35.05[b]	35.87[b]	34.2 3[c]	32.59[a]
a^* (redness)	18.81[a]	17.21[b]	16.35[c]	12.56[d]	19.11[a]	19.00[b]	18.35[c]	17.62[d]
b^* (yellowness)	15.66[a]	14.87[b]	13.09[c]	12.45[d]	13.27[a]	12.96[b]	11.43[c]	10.55[d]
	Butchery shops (winter season)				Butchery shops (summer season)			
L^* (lightness)	33.87[a]	33.42[a]	31.93[b]	30.24[c]	33.83[a]	33.62[b]	31.88[b]	32.10[b]
a^* (redness)	17.81[a]	17.27[a]	15.65[b]	13.36[c]	20.07[a]	19.41[b]	18.67[c]	17.82[d]
b^* (yellowness)	15.63[a]	14.62[b]	13.99[c]	12.85[d]	14.56[a]	13.35[b]	12.73[c]	11.90[d]

Each number is mean of three replicates. Means with different letters in the same row are significantly different at (p <0.05).

Table-7
Impact of cold storage on the characteristics of the lamb meat samples collected during winter and summer seasons from supermarkets butcheries and shops and stored at 4±1°C for 5 days

	Winter season				Summer season			
	Supermarket Butchery				Supermarket Butchery			
Time (Day)	1	2	3	5	1	2	3	5
L^* (lightness)	41.59 [a]	40.70 [b]	39.47[c]	39.0[d]	41.5[a]	40.80[b]	39.49[c]	37.83[d]
a^* (redness)	13.58[a]	13.06[a]	11.92[b]	10.67[c]	14.15[a]	13.83[b]	12.74[c]	11.13[d]
b^* (yellowness)	17.45[a]	15.59[b]	14.62[c]	13.19[d]	15.59[a]	15.95 [a]	14.19[db]	13.87 [b]
	Butchery shops (Winter season)				Butchery shops (summer season)			
L^* (lightness)	40.16[a]	39.70[b]	39.53[b]	38.36[c]	40.59[a]	40.47[a]	39.56[b]	38.12[c]
a^* (redness)	15.58[a]	15.32[a]	13.44[b]	11.3 9[c]	14.11[a]	14.09[a]	13.77 [b]	13.22[c]
b^* (yellowness)	17.45[a]	15.95[b]	14.35[c]	13.19[d]	17.15[a]	15.82 [b]	14.32[c]	13.21[d]

Each number is mean of three replicates. Means with different letters in the same row are significantly different at ($p < 0.05$).

Conclusion

In the condition of observations carried out in this experiment the dynamics of microorganisms counts, lipid oxidative process and color changes show influence of storage temperature in both fresh beef and lamb meat. The results of this study shows clearly that the total number of microbes were high in butchers shops as compared to the supermarket butcheries. Low microbial load in supermarket samples may be due to the low storage temperature. It was noted that the TBARS values were higher in shops samples compared to the supermarket. Concerning color of meat it was noticed that the season variation has no effect on color, but conservation in the refrigerator has an effect. It is recommended that the storage period should be decreased.

Acknowledgement

The author would like to thank King Abdulaziz City for Science and Technology, for helping and supporting of this work.

References

1. Olaoye O.A. and Onilude A.A., Investigation on the potential use of biological agents in the extension of fresh beef in Nigeria., *World Journal of Microbiology and Biotechnol*, **26**, 1445–1454 **(2010)**

2. Lorenzo J.M. and Gómez M., Effect of packaging conditions on shelf-life of fresh foal meat, *Meat Sci.*, **91**, 513-520 **(2012)**

3. Gram L., Ravn L., Rasch M., Bruhn J.B., Christensen A.B., and Givskov M., Food spoilage- interaction between food spoilage bacteria, *International Journal of Food Microbiology*, **78**, 79-97 **(2002)**

4. Anzai Y., Kim H., Park J. and Wakabayashi H., Phylogenetic affiliation of the Pseudomonads based on 16S rRNA sequence, *International Journal of System Evolution Microbiology*, **50**, 1563–89 **(2000)**

5. Vercellotti J.R., Angelo A.J. St., and Spanier A.M., Lipid oxidation in foods: An overview, Lipid Oxidation in Food, American Chemical Society, Washington **(1992)**

6. Koutsoumanis K.P., Stamatiou A.P., Drosing E.H. and Nychas C.J.E., Control of spoilage microorganisms in minced pork by a self-developed modified atmosphere induced by the respiratory activity of meat micro flora, Food microbiology, **25**, 915-921 **(2008)**

7. Mancine K.A. and Hunt M.C., Current research in meat color, *Meat Science*, **71**, 100-121 **(2005)**

8. Morrissey P.A., Sheehy P.J.A., Galvin K., Kerry J.P. and Buckley D.J., Lipid stability in meat and meat products, *Meat Sci*., **49**, 73–86 **(1998)**

9. FDA's, Bacteriological Analytical Manual (BAM) presents the agency's preferred laboratory procedures for microbiological analyses of foods and cosmetics, http://www.cfsan.fda.gov/~ebam/bam-toc.html. **(2012)**

10. American Public Health Association, Compendium of Methods for the Microbiological Examination of Foods, 3rd ed. APHA, Washington, D.C. **(1992)**

11. SØRENSEN G., and JØRGENSEN S.S., A critical examination of some experimental variables in the 2-thiobarbituric acid (TBA) test for lipid oxidation in meat products, Zeitschrift für LebensmittelUntersuchung und – Forschung 202: 205-210, **(1996)**

12. Gomezand K.A. and Gomez A.A., Statistical Procedures for Agricultural Research, (2nd Ed.), John Wally & Sons, **(1984)**

13. Waller R.A. and Duncan D.B., A Bayes Rule for the Symmetric Multiple Comparison Problem, *Journal of the American Statistical Association*, **64**, 1484–1499, and (1972) "Corrigenda," 67, 253–255, **(1969)**

14. SAS Institute, SAS for Windows, SAS user's guide: Statistics, Version 8.0 e. SAS Inst., Inc., Cary, North Carolina **(2001)**

15. Esmer O.K., Irkin R., Degirmentcioglu N. and Degirmencioglu A., The effects of modified atmosphere gas composition on microbial criteria, color and oxidation values of minced beef meat, *Meat Science*, **88**, 221-226 **(2011)**

16. Karabagias I., Badeka A. and Kontominas M.G., Shelf life extension of lamb meat using thyme or oregano essential oils and modified atmosphere packaging, *Meat Science*, **88**, 109-116 **(2011)**

17. Khalafalla F.A., Nagwa S.S., Ata, Mona Elshabrauy A.E., Azza S.M., Abu Elnaga Dorgham S.M. and Khairy A.E., Effect of packing on extension of self-life of retail meat, *Journal of American Science*, **6(12)**, 1049-1058 **(2010)**

18. International Commission on Microbiological Specifications for Foods, ICMSF Microorganisms in Foods Characteristics of Microbial Pathogens, Blackie Academic & Professionals **(1986)**

19. Pennacchia C., Ercolini D. and Villani F., Spoilage-related microbiota associated with chilled beef stored in air or vacuum pack, *Food Microbiology*, **28**, 84-93 **(2011)**

20. Bin jasass F.M. and Fung D.Y.C., Catalase activity as index of microbial load and end-point cooking temperature of fish, *Journal of Rapid Methods and Automation in Microbiology*, **(6)**, 159-197 **(1998)**

21. Perez Chabela M.L., Rodríguez Serrano G.M., Lara Calderon P. and Guerrero I., Microbial spoilage of meats offered for retail sale in Mexico City*, Meat Science*, **51**, 279-282 **(1999)**

22. Brown M.H. and Baird-Parker A.C., The microbial examination of meat, In M. H. Brown (Ed.), Meat Microbiology, 423-520, London: Applied Science **(1982)**

23. Almroth B.C., Sturve J., Berglund A., Förlin L., Oxidative damage in eelpout (Zoarces viviparus), measured as protein carbonyls and TBARS, as biomarkers, *Aquatic Toxicology*, **73**, 171–180 **(2005)**

24. Chang P.Y., Younathan M.T. and Watts B.M., Lipid oxidation in precooked beef preserved by refrigeration, freezing, and irradiation, *Food Technology*, **15**, 1681-1687 **(1961)**

25. Keller J.D. and Kinsella J.E., Phospholipid changes and lipid oxidation during cooking and frozen storage of raw ground beef, *Journal of Food Science*, **38**, 1200–1204 **(1973)**

26. Pikul J., D Leszczynski F. and Kummerow F.A., Effects of frozen storage and cooking on lipids oxidation in chicken meat, *Journal of Food Science*, **49**, 838-843 **(1984)**

27. O'Grady M.N., Monahan F.J., Burke R.M. and Allen P., Comparison of the color stability and lipid oxidative stability of fresh and vacuum packaged lamb muscle containing elevated omega-3 and omega-6 fatty acid levels from dietary manipulation, *Meat Science*, **58**, 151-161 **(2000)**

28. Ponnampalam E.N., Trout G.R., Sinclair A.J., Egan A.R., Leury B.J., O'Gradya M.N., Monahana F.J., BurkeaAllen R. M.P., The effect of oxygen level and exogenous α-tocopherol on the oxidative stability of minced beef in modified atmosphere packs, *Meat Science*, **55**, 39–45 **(2001)**

29. Galvin K.P., Morrissey A., Buckley D.J., Effect of dietary α-tocopherol supplementation and gamma-irradiation on α-tocopherol retention and lipid oxidation in cooked minced chicken, *Food Chemistry,* **62**, 185–190 **(1998)**

30. Lefebvre C., Thibault R.C. and Piette J.P.G., Improvement of shelf-life and wholesomeness of ground beef by irradiation-2, Chemical analysis and sensory evaluation, *Meat Science,* **36**, 371–380 **(1994)**

31. Chang S.S. and Peterson R.J., Recent developments in the flavor of meat, *Journal of Food Science*, **42**, 298-305 **(1977)**

32. Balev D.K., Staykov A.S., Ivanov G.Y., Dragoev St. G. and Filizov E.H., Color Stability Improvement of Chilled Beef by Natural Antioxidant Treatment and Modified Atmosphere Packaging, *American Journal of Food Technology*, **6**, 117-128 **(2011)**

33. Moiseev I.V. and Cornforth D.P., Treatments for Prevention of Persistent Pinking in Dark-Cutting Beef Patties, *Journal of Food Science*, **64,** 738-743 **(1999)**

34. Ferioli F., Caboni M. F., and P Dutta. C., Evaluation of cholesterol and lipid oxidation in raw and cooked minced beef stored under oxygen-enriched atmosphere, *Meat Sci*., **80**, 681-685 **(2008)**

35. Ömer Cetin and Tuna Topcu, Effects of electrical stimulation on meat quality in goat carcasses*, Journal of Food Agriculture & Environment,* **7(3&4),** 101-105 **(2009)**

36. Kropf D.H., Hunt M.C. and Kastner C.L., Appearance Characteristics of Fresh Beef as Affected by Display Lighting for Two Packaging Systems, Research Project Final Report to Nat'l. Livestock and Meat Board, Chicago, I **(1992)**

37. Bhattacharya M., Hanna M.A., Mandigo R.W., Effect of frozen storage conditions on yields, shear strength and color of ground beef patties, *Journal of Food Science,* **53**, 696–700 **(1988)**