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Full Length Research Paper

A comparative study of microbial load, chemical and sensory characteristics of camel meats collected from supermarkets and butcher shops

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This study was set out to identify microbial load, chemical, and sensory characteristics of camel meats collected in the winter and summer seasons from both butchery shops and supermarkets butcheries. On day 0, the viable cell count, *Pseudomonas* count, *Streptococcus* fecal, coliform fecal count, *Staphylococcus* count and *Staphylococcus aureus* were higher in the summer as compared with winter season. Also, the data showed that the numbers of microorganisms were affected by seasoning and storage temperature. On day 0, the total viable count in camel meat sample collected in the winter and summer was 5.6 and 6 log10 CFU/g and increased to 6.7 and 8.4 log10 CFU/g, respectively after 48 h of storage at refrigerator temperature 7±1°C. *Pseudomonas* count in winter and summer samples on day 0 was 4.4 and 7.5 log $_{10}$ CFU/g, respectively. After 48 h of storage, the *Pseudomonas* count increased and reached 6.2 and 7.7 log10 CFU/g. *Streptococcus* fecal count in winter and summer sample was 3 and 4.2, and increased to 3.4 and 5.1 log10 CFU/g during storage at 7±1°C, respectively. Coliform fecal co unt in winter and summer sample was 2.4 and 4.2 but increased to 2.7 in winter sample and decreased to 2 log10 CFU/g in summer sample. The initial *Staphylococcus* count in camel meat collected in winter was 3.2 and 5.5 log10 CFU/g in the summer and reached 3.8 and 5.9 log10 CFU/g after 48 h in the refrigerator temperature. *S. aureus* count in winter sample on day 0 was 2.5 and 5.8 log10 CFU/g in summer sample and reached 3.3 and 5.6 log10 CFU/g after 48 h in the refrigerator temperature. There were no significant differences in thiobarbituric acid reactive substances (TBARS) in camel meat collected in the winter and summer seasons. However, there were significant differences in TBARS in camel meat collected in supermarkets butchery and from butchery shops. There were significant differences of lightness, redness and yellowness P≤0.05 after 48 h in storage. However, there were no significant differences in the meat color of the second and third day of storage. Overall, there were no significant differences between the results obtained during the summer and winter periods, which means that seasons do not have a significant impact on the values of Hunter lab instrument.

Key words: Microbial load, chilling, freezing temperature, camel meat, thiobarbituric acid reactive substances (TBARS).

INTRODUCTION

Camel meat is considered as an excellent source of protein, low fat content and rich in polyunsaturated fatty acid (PUFA) content (Rawdah et al., 1994; Dawood and Al-kanhal, 1995). Also, the camel meat is healthier as it contains less intramuscular fat and cholesterol as well as being relatively richer in PUFAs than beef (Kadim et al., 2006). Camel meat contains 70-77% moisture, 20-23% protein, 10.5% fat for camel between 5 and 8 years, while 4.4% for 1-3 years old, and 1.1-1.5% ash (Kadim et al., 2008; Al-Owaimer, 2000). The chemical composition of camel meat provides suitable media for growth of both spoilage and pathogenic microorganisms. Therefore, the

shelf life of fresh meat is limited to a few days during storage at refrigerator temperature. Suitable storage temperature, good handling and transportation, and hygiene can extend the shelf life and improve the safety and quality of camel meat and meat products. In general, microorganisms grow well at 5°C with a good supply of nutrients. Food that is stored for prolonged periods at 7°C provides the perfect conditions in which microorganisms can thrive.

Lipid peroxidation depends upon the degree of unsaturation of the fatty acids. Increase in the degree of unsaturation of the fatty acids results in decrease in color and oxidative shelf-life. Lipid oxidation is a main contributor to flavor deterioration in meat and meat products. Postmortem can influence lipid oxidation and can decrease both the shelf life and meat quality due to the initiation of peroxidation (Vercellotti et al., 1992). Oxida-tions of fatty acid start after animal's slaughter. Lipid oxidation can be evaluated by the determination of thiobarbituric acid reactive substances (TBARS). Low temperature can delay the oxidation but do not prevent it.

The attractiveness of meat to the consumers is mainly related to the color. The color of meat may vary from the deep purplish-red of freshly cut beef to the light gray of faded cured pork. However, the color of meat can be controlled by some factors that have influence on the color meat. When oxygen from the air comes into contact with the exposed meat surfaces it is absorbed and binds to the iron and called oxymyoglobin, gives beef its bright cherry red color. To maintain this meat color requires 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 myoglobin. Once the meat is taken out of the vacuum package, it will recover its bright red color.

Therefore, the objective of this study was to investigate the effect of storage temperature on microbiological, chemical, and sensory properties of meat collected in winter and summer seasons from supermarket and butchery shops in the Saudi Arabia.

MATERIALS AND METHODS

Microbiological analyses

Aseptically approximately 25 g of camel meat was diluted 10-fold in 225 ml buffered peptone water and homogenized in a stomacher bag for 1 min. Serial decimal dilutions were made and the following analyses were carried out on duplicate agar plates: (1) Total viable count on plate count agar aerobic incubation at 30°C for 48 h, (2) *Pseudomonas* count on Pseudomonas agar media aerobic incubation at 30°C for 24 h, (3) *Streptococcus* count on tryptic soy agar at 35°C for 24 h, (4) Coliform fecal at violet red bile agar aerobic incubation at 30°C for 24 h, (5) *Staphyloccous* and *Staphylococcus* aureus at Staphylococcus medium 110 aerobic incubation at 35°C for 48 h.

Chemical analyses

Lipid oxidation was evaluated by the determination of TBARS using the extraction method described by Witte et al. (1970). 20 g of the minced meat were blended with 50 ml of cold solution containing 20% trichloroacetic acid in 2 M phosphoric acid for 2 min. The resulting slurry was transferred to a 100 mL volumetric flask. It was diluted to 100 ml with double-distilled water, homogenized by shaking and filtered through Whatman no. 1 filter paper. 5 ml of the filtrate was then pipetted into a test tube and 5 ml of fresh chilled 2-thiobarbituric acid (0.005 M in double-distilled water) added. The test tube was shaken well and placed in dark at room temperature (25°C) for 15 h to develop the color reaction. The resu lting color was measured in a spectrophotometer at 530 nm to calculate the TBARS value. The results were expressed as mg malonaldehyde/kg meat.

Meat color analyses

Fresh camel meat color was measured by Hunter values L, a, and b and for each slide at three sites (duplicates) different from the surface of the slide for each store and then calculate the average L, a, b type of scales simulate like: L (lightness) axis—0 is black, 100 is white; a (red-green) axis—positive values are re d; 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 can also 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 was measured by D65 as a source of light and then the device was standardized by the white standard. Color measurement was repeated three times during each period of storage after a piece of meat was exposed to light and air for 45 min and during the offer period, pieces were covered with a flexible membrane with a high permeability for oxygen to prevent drying of the piece.

Statistical analyses

All analyses were performed using three samples (bags) for each separate replicate. Three replicates were done. All the data were statistically analyzed using the one-way analysis of variance of the SPSS software. The differences among means at $P< 0.05$ were compared by Duncan multiple analysis method.

RESULTS AND DISCUSSION

Microbiological analyses

On day 0, the total viable count, *Pseudomonas*, *Streptococcus* fecal, Coliform fecal, *Staphylococcus* count and *S. aureus* in camel meat collected in winter and summer seasons in Saudi Arabia are shown in Table 1. The data also show that the numbers of micro-organisms were affected by both seasons and storage temperature. A high count of total viable count in camel

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Abbreviations: PUFA, Polyunsaturated fatty acid; **TBARS,** thiobarbituric acid reactive substances.

Table 1. Growth of microbial count on camel meat collected in the winter and summer seasons and stored at 7°C f or 48 h.

Types of microorganism	Winter season			Summer season		
	0	24 h	48 h	0	24 h	48 h
Total viable cell count	5.6[a]	6.7[b]	6.6[b]	6.0[a]	7.8[b]	8.4[c]
Pseudomonas	4.4[a]	5.8[b]	6.2[c]	7.5[a]	7.5[a]	7.7[a]
Streptococcus fecal	3[a]	3.3[b]	3.4[b]	4.2[a]	5.0[b]	5.1[b]
Coliform fecal	2.4[a]	2.6[b]	2.7[b]	4.2[a]	3.6[b]	2.0[c]
Staphylococcus	3.2[a]	3.5[a]	3.8[b]	5.5[a]	5.9[b]	5.9[b]
Staphylococcus *aureus*	2.5[a]	3.0[b]	3.3[c]	5. 8[a]	5.8[a]	5.6[a]

Each number is average for three replicates. Numbers that carry different letters for the same values of one sample in the same row are significantly different ($p<0.05$).

meat indicated that meat is of low quality. High count may be related to factors such as slaughtering, handling, delay in chilling and elevated temperature during trans-portation. High microbial load can reduce both shelf life and quality of meat. Also, it can cause economic losses and health problems. The initial total viable counts in camel meat samples collected in the winter was 5.6 and 6 log10 CFU/g in summer and increased to 6.7 and 8.4 log10 CFU/g after 48 h of storage at refrigerator temperature of 7±1°C. High microbial load in camel meat indicates that the meat was heavily contaminated during slaughtering, handling and processing operations or alternatively, the meat had been stored for an unknown length of time before it was purchased for the study. According to Al-Bachir and Zeinou (2009), the total plate count and total coliforms on camel meat on day 0 were 10^6 and 10^3 CFU/g, respectively. After 48 h of storage at refrigerator temperature 7±1°C, the total count inc reased to 6.6 and 8.4 log10 CFU/g in samples collected in winter and summer, respectively. During storage, total viable count increased significantly ($p<0:05$) in all the samples and reached a level of 6.6–8.4 log CFU/g after 2 days of storage at 7°C. This study confirmed that refrigera tor temperature alone did not interact with microbial popula-tions on camel meat. The low temperature effectively suppressed the growth of aerobic spoilage bacteria on camel meat and prolonged the shelf-life by 48 h. The temperature 7°C is not suitable to prolong shelf li fe of meat and should be lower than 7°C. Most meats have a short shelf life that varies between 3–5 days when kept at 4°C (Kanatt et al., 2010). Short shelf life of fre sh meat is due to the microbial growth, *Pseudomonas*, Enterobacteriaceae and lactic acid bacteria being mainly responsible for meat spoilage. According to Chinen et al. (2001), meat may be contaminated by pathogens such as *S. aureus, Salmonella* Typhimurium, *Escherichia coli* O157:H7 and *Yersinia enterolitica*. There are many ways to save and prolong the shelf life period of meat; these methods include refrigeration, freezing, drying, irradiation and high pressure treatment.

Pseudomonas count in samples was 4.4 and 7.5 log10 CFU/g in winter and summer seasons. After 48 h of storage *Pseudomonas* count increased and reached 6.2 and 7.7 log10 CFU/g. On day 0, the total count of *Pseudomonas* in winter samples indicated medium count of microorganisms; however, in the summer, *Pseudomonas* count was higher. Al-Sheddy et al. (1999) found that the initial psychrotrophic count on the surface of camel meat was of 3.3 log10 CFU/cm^2 which indicate that meat contain low count of microorganisms. *Pseudomonas* can grow at low temperature are rarely responsible for meat spoilage.

The initial *Staphylococcus* counts in camel meat collected in winter was 3.2 and 5.5 in summer log10 CFU/g and reached 3.8 log10 CFU/g after 48 h in the refrigerator temperature. *S. aureus* counts in winter samples at day 0 was 2.5 and 5.9 in the summer log10 CFU/g and reached 3.3 and 5.6 log10 CFU/g after 48 h in the refrigerator temperature.

Streptococcus fecal count in winter was 3 and 4.2 in summer and increased to 3.4 and 5.1 log $_{10}$ CFU/g during storage at 7±1°C. Coliform fecal count in winter an d summer sample was 2.4 and 4.2 log10 CFU/ g, res-pectively. After 48 h in refrigerator temperature, coliform fecal count in winter sample increased to 2.7 log10 CFU/ g and decreased in summer sample to 2.0 log10 CFU/ g.

Oxidative rancidity analyses

Chemical deterioration especially lipid oxidation is the main factor limiting the shelf life of foods. Lipid peroxidation or oxidative rancidity was measured in terms of TBARS and results are shown in Table 2. All meat samples from supermarkets and butchery shops induced an increase in TBARS values. Accelerated TBARS formation during storage of irradiated meat and meat products has also been reported (Galvin et al., 1998; Lefebvre et al., 1994). The results show that the highest values of the reactants with the TBARS were reached on the fifth day but the unwanted odors began to appear on the third day of the storage. According to Chang and Peterson (1977), the judges' trainers were able to detect the undesired odors and flavors when the values of the

Table 2. Average values of the reactants with thiobarbituric acid reactive substances (TBARS) meat samples collected in the summer and winter from the supermarkets and small butchery shop (mg malonaldehyde/kg meat).

Type of meat	Time (days)	Supermarkets butchery		shop butchery	
		Winter season	Summer season	Winter season	Summer season
		mg malonaldehyde/kg		mg malonaldehyde/kg	
Camel meat	1	0.37[a]	0.32[a]	0.40[a]	0.37[a]
	2	0.41[a]	0.34[a]	0.53[b]	0.49[b]
	3	0.44[a]	0.49[b]	0.65[c]	0.61[c]
	5	0.71[b]	0.83[c]	0.76[a]	0.88[a]

Each number is average for all three replicates. Numbers that carry different letters for the same value in the same row are significantly different ($p<0.05$).

TBARS in meat range between 0.5 and 1.0 ppm. The values of TBARS in camel meat samples collected from supermarkets butchery was 0.32 and 0.37 mg malonaldehyde/kg in the meat collected from butchery shops, indicating a low degree of lipid oxidation. After 2 days of storage at 4°C, camel meat collected from butchery shop had significantly ($P<0.05$) higher TBARS than day 1 and the levels of TBARS were positively correlated with the storage time. At day 5, the levels of TBARS increased and reached 0.83 in the meat from supermarket butchery and 0.88 mg malonaldehyde/kg in the meat from butchery shop positively. The results indicated that the meat from butchery shop had a higher level of rancidity than meat from supermarket. The lower value of TBARS in meat collected from supermarket may be due to low storage temperature covering way of meat and light. The low level of TBARS in meat indicates that the meat was of good quality.

The results show that the value of TBARS in meat collected in summer season was higher than the meat collected in winter season. Further interpretation of data indicated that TBARS levels were lowest during winter and highest during the summer. Almroth et al. (2005) indicated the presence of a seasonal cycle with TBARS levels lowest during colder winter months and highest during the summer.

Table 2 shows the changes that occur in the values of TBARS in the camel meat obtained from supermarkets and butchery shops. These values have been increasing significantly different ($p<0.05$) during storage in the refrigerator and reached the highest values on the fifth day. The odors began to appear on the third day. In this study, all the meat had become unacceptable in terms of odor. The differences in values of TBARS between the meat collected from supermarkets and butchery shops may be due to condition of transport, storage and distribution especially temperature.

Data show that there are significant differences during storage periods. After 5 days, there was a significant rise in the value of TBARS. These results are in consistent with results from many others studies concerning the effect of temperature on TBARS values. During periods of storage, Keller and Kinella (1973) noted that the value of thiobarbituric acid in uncooked hamburger meat had increased during the period of the freeze. In frozen chicken meat, the value of the TBARS had increased during storage at -10°C for 3 months (Pikul et al, 1984). Also, TBARS in frozen meat and cattle fat stored at temperature -10°C for a period of 35-70 and 60-175 days had increased (Table 2).

Meat color analyses

Results of color analyses carried out on camel meat collected from supermarket and butchery shop in the winter and summer seasons are presented in Table 3. A Hunter lab instrument was used for measuring the meat color during storage time. L measuring the white, a for red and b for yellow color. The length of time of the meat has been stored. Postmortem affects the color stability of the meat or meat product. 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. Table 3 shows the value of Hunter lab (L, a, b) for the rib eye muscle (Longissimus dorsi) in the summer and winter seasons. The data indicated that there was change in the color values of redness (a), yellowness (b) and lightness (L). There were significant differences of lightness (L), redness (a) and yellowness (b) $P\leq0.05$ after 48 h of storage. However, there were no significant differences of redness (a), yellowness (b) and lightness (L) $P\leq0.05$ during the second and third day of the storage. Swan and Boles (2002) found that the freezing does not affect the color in frozen cooked meat. Sakate et al. (1995), found that the freezing temperature -20°C for a mon th had increased the value of redness (a) of meat. There were no significant differences in the results obtained during the summer and winter periods, which means that seasonal factors here did not have a significant impact on the values of Hunter lab instrument. There was no difference in the color of meat that was collected from supermarkets and butcher shops. Both storage time and temperature have a great effect on color stability. Color acceptability decreases as storage time increases;

Table 3. Impact of cold storage on the characteristics of the camel meat collected during summer and winter seasons from the supermarkets and small shops.

Type of meat	Sample place	Hunter value	Day 1		Day 2		Day 3		Day 5	
			Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Camel meat	Supermarkets butchery	L*	38.45^{a}	38.45^{a}	41.31^{b}	41.80^{b}	40.28^{c}	40.21^{b}	39.26^{d}	42.28^{c}
		a*	17.83^{a}	17.23^{a}	19.34^{b}	19.06^{b}	18.67^{b}	18.99^{b}	15.43^{b}	15.29^{c}
		b*	18.16^{a}	18.17^{a}	20.14^{b}	21.74^{b}	19.71^{b}	20.81^{b}	18.78^{b}	19.18^{c}
	Butcher shops	L*	39.36^{a}	39.14^{a}	40.87^{b}	41.65^{b}	41.30^{b}	41.08^{b}	40.63^{b}	41.42^{b}
		a*	16.95^{a}	17.81^{a}	18.45^{b}	19.51^{b}	18.13^{b}	19.00^{b}	16.23^{c}	16.04^{c}
		b*	18.08^{a}	18.34^{a}	20.42^{b}	21.82^{b}	19.73^{b}	21.03^{b}	19.10^{b}	19.58^{b}

Each number is average for all three replicates. Numbers that carry different letters for the same values for the Hunter value one sample in the same column significantly different ($p<0.05$).

however, the length of time the color is acceptable is greatly affected by storage temperature. Fresh meat and meat products should be stored at temperatures lower than 4°C to give maximum color shelf life and safet y of products.

The values of 'a' starts to increase after the first day of storage, then decreas after the second day in the display, regardless of location and season in which the sample was collected. However, it is clear that there is variation in the speed of increase or decrease between the samples collected in the summer or winter. This is due to oxidation that can occur to meat dye, which weakens their ability to form pigment of oxy-myoglobin. Kropf et al. (1992) explained that the shortage of the amount of oxygen can lead to oxidation of dye oxymyoglobin and adversely results in a change in color from bright red to brown. Bhattacharya et al. (1988) indicates that the decrease in the values with time may be due to the inability of myoglobin dye to combine with oxygen.

Conclusion

From the results, it is clear that the total number of micro-microbes is high in the summer samples compared to the winter samples. Low microbial load in winter samples is due to low temperature. Also note that the TBARS value is high in butcher shops compared to the butcher shops in the supermarket. This gives the impression that the small butcher shops have high temperature inside the store and meat are not covered and are exposed directly to oxygen. Seasons have no effect on color, but conservation in the refrigerator has an effect.

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