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Vacuum packaging as an effective strategy to retard off-odour development, microbial spoilage, protein degradation and retain sensory quality of camel meat

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ABSTRACT

Impact of different packaging conditions [Air (A), Vacuum (V) and Wrapped (W)] on various quality attributes of camel meat during 18 days of refrigerated storage was investigated. The results showed that camel meat packed under vacuum displayed lower lipid oxidation and microbial load as depicted by lower thiobarbituric acid reactive substances (TBARS) and lower counts for different microorganisms, respectively, compared to samples packed under air and those which were wrapped. Redness (a*) values for the samples packed under vacuum were higher compared to other samples. Sensory evaluation of camel meat revealed that the vacuum packed samples received superior scores on odor, color and overall acceptability compared to other samples. Interestingly, the vacuum packed samples after day 14 of storage displayed lower degradation for all detected protein bands compared to other samples. Moreover, vacuum packed sample retained the hardness values (1070.05 g) while samples packed under air (597.0 g) and wrapped sample (567.02 g) showed lower hardness on day 14 of storage. Therefore, vacuum packaging was very effective in retarding lipid oxidation, microbial growth and protein degradation, as well as maintaining the sensory quality for the fresh camel meat.

1. Introduction

Camel meat is an important source of high quality protein for people living in arid and semi-arid regions. The world consumption of camel meat has shown an increase during the recent years and the main “camel meat eaters” with more than 2 kg/habitant/year are in Somalia, Mauritania, Western Sahara, Oman, Emirates and Mongolia (Faye and Bonnet, 2012). Moreover, the demand of camel meat as a healthy red meat is increasing in the middle eastern as well as Asian countries. Camel carcass is known to produce good amount of meat with certain parts of carcass considered as a delicacy and favored among the consumers. Many researchers suggested that camel meat is healthy and nutritious due to its low fat and cholesterol content, relatively high polyunsaturated fatty acid content and it is considered as a good source of minerals (Babiker & Yousif, 1990; Kadim et al., 2006; Kadim, Mahgoub, & Purchas, 2008; Kurtu, 2004). However, camel meat is known to contain higher amounts of haem protein like myoglobin and high iron content, which can act as a pro-oxidant to cause lipid oxidation (Maqsood, Abushelaibi, Manheem, & Kadim, 2015). Therefore, camel meat is expected to be more susceptible to lipid oxidation and off-odour development. Lipid deterioration takes place easily and can limit the shelf-life of meat during refrigerated storage (Maqsood & Benjakul, 2010a). Lipid oxidation, color change coupled with microbial spoilage are the critical factor limiting the shelf-life and consumer acceptability of the camel meat displayed on refrigerated shelves (Maqsood, Abushelaibi, Manheem, Al Rashedi, & Kadim, 2015). Therefore, there is a need to identify a preservative strategy which can retard the spoilage process and retain the quality of camel meat during refrigerated display.

Using an appropriate packaging and storage conditions can play a major role in color enhancement and preservation of meat during storage (Lavieri & Williams, 2014). Recent strategies of industries and researchers are directed towards the use of packaging system without the use of any synthetic additives which can minimize lipid oxidation and off-odour development with significant retardation of microbial growth. Vacuum packaging (VP) provides anaerobic conditions which extend both the microbiological and the oxidative shelf life of meat (Sahoo & Kumar, 2005; Strydom & Hope-Jones,

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2014). Although camels are reared in many countries of the world, camel meat is the least researched meat among other red meats. No sound scientific study has been conducted on exploring the use of vacuum packaging in quality retention and preservation of camel meat. Therefore, objective of this study was to evaluate efficacy of vacuum packaging in prevention of lipid oxidation, microbial and sensorial quality deterioration of fresh camel meat during refrigerated storage.

2. Material and methods

2.1. Chemicals and reagents

Chloroform, ethanol, and methanol were obtained from BDH Prolabo (Briare, France). Sodium chloride and hydrochloric acid were obtained from Scharlau Chemicals (Barcelona, Spain). 1,1,3,3-tetramethoxypropane (MDA) (99% purity), cumene hydroperoxide, wide range molecular weight marker and bovine serum albumin (BSA) (>98% purity), were procured from Sigma–Aldrich Chemical Co. (St. Louis, MO, USA). All other chemicals used were of analytical grade. All the microbiological media were obtained from Hi–media Laboratories (India, Mumbai).

2.2. Preparation of camel meat samples

Meat was obtained from three female camels (Arabian dromedary one-humped camel, *Camelus dromedarius*), which have been reared in a semi-intensive management system and fed ad libitum on a Rhodes grass (*Chlorisgayana*) hay diet mixed with date seed powder. Camels were slaughtered at an age of 4–5 years and possessing body weigh of 430 ± 25 kg at Al Ain slaughterhouse in the United Arab Emirates (UAE) following UAE-Standard No. 993/2000 concerning animal slaughtering requirements. Semitendinosus (ST) muscle was carefully removed with a sterile sharp knife from the carcass of the camels within 24 h of slaughter. Separated meat portions were carefully packed in polyethylene bags and stored in insulated box filled with ice during transportation to laboratory of Department of Food Science, UAE University. Upon arrival, the meat was washed with chilled sterilized and deionised water, cut into slices (3 cm × 3 cm × 3 cm), and the connective tissue and visible fat were removed manually. Meat samples obtained from the carcass of three female camels were divided into three batches (or replicates) and packed under 3 different packaging conditions [vacuum (V), air (A) and wrapped (W)] and stored at 4 °C for 18 days. Vacuum sample were packed using a Vac-Star vacuum packaging machine (Ch-1786, Sugiez, Switzerland). Samples packed under air were placed on the thermoform trays and kept without any cover during the storage, while as the wrapped samples were covered or wrapped with a cling film after being place on a thermoform tray. Each replicates for each packaging condition contained 8 meat slices. As a general practice, camel meat is displayed on the refrigerated shelves either without any package (air) or it is wrapped with a plastic film, which limits the shelf life of camel meat. Therefore, it is expected that vacuum packaging might retard the quality changes and thus extend the shelf-life of camel meat under refrigeration. During storage, the samples were evaluated on day 0, 4, 9 and 14 for peroxide value (PV), thiobarbituric acid reactive substances (TBARS), total haem pigments and color values and microbiological counts were monitored until 18 days. Sensory evaluation was carried out on day 12, while protein degradation and hardness values were determined out on day 0 day 14.

2.3. Analysis

2.3.1. Peroxide value (PV)

Peroxide value (PV) was determined following the method of Richards and Hultin (2000) with a slight modification as described by Maqsood, Abushelaibi, Manheem, and Kadim (2015). A standard curve was prepared using cumene hydroperoxide with the concentration range of 0.5–2 ppm.

2.3.2. Thiobarbituric acid-reactive substances (TBARS)

Thiobarbituric acid-reactive substances (TBARS) were determined by the method of Buege and Aust (1978) as described by Maqsood, Abushelaibi, Manheem, and Kadim (2015). A standard curve was prepared using 1,1,3,3-tetramethoxypropane (MAD) at the concentration ranging from 0 to 10 ppm and TBARS were expressed as mg of MAD equivalents/kg sample.

2.3.3. Determination of total haem pigment

Total haem pigment in the camel meat was determined according to the method of Hornsey (1956) with some modifications as described by Maqsood, Abushelaibi, Manheem, and Kadim (2015).

2.3.4. Color analysis

Color of the meat samples was measured using a colorimeter (Hunter Lab, Model color Flex, Reston, VIRG, USA) with the port size of 0.50 inch. The determination of color was done on three different samples. Standardization of the instrument was done using a black and white Minolta calibration plate. The values were reported in the CIE color profile system as L* (lightness), a* (redness), and b* (yellowness/blueness).

2.3.5. Hardness values of camel meat

Hardness values were determined on day 0 and 14 by using a TA-XT2i texture analyser (Brookfield, CA, USA) with cylindrical aluminum probe (50 mm diameter). Detailed procedures mentioned by Maqsood, Abushelaibi, Manheem, and Kadim (2015) were followed to determine hardness values of camel meat.

2.3.6. Sensory evaluation of camel meat packaged under different packaging conditions

Sensory evaluation of camel meat was conducted for color, odor and overall acceptability on day 12 of storage, as after day 12 air and wrapped samples were almost spoiled. 30 female untrained panelists aged between 20 and 25 years and familiar with camel meat consumption were recruited to conduct the sensory test. Assessment of raw samples for sensory attributes was conducted using a 9-point hedonic scale (Mailgaad, Civille, & Carr, 1999): 1, dislike extremely to 9, like extremely. Panelists evaluated 3 randomly selected samples taken from three different replicates of each package for all the sensory attributes. All raw camel meat samples from different packaging conditions were coded with 3-digit random codes and offered to the panelist in the random order. Samples were presented to panelist to score odor first followed by color and overall acceptability.

2.3.7. Protein degradation as analyzed by SDS- polyacrylamide gel electrophoresis (SDS-PAGE).

Fresh camel meat obtained at day 0 and samples packed under different condition and stored for 14 days were subjected to SDS-PAGE according to the method of Laemmli (1970) as described by Maqsood and Benjakul (2010b). 5% SDS was used to solubilize the meat proteins. The samples (15 μg protein) were loaded onto the polyacrylamide gel made of 10% separating gel and 4% stacking gel. Protein identification was done based on the molecular weight of