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Original Research Article

Determination of collagen content in Algerian camel meat

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Naima Sahraoui*[1], Guy Degand[2], Mohamed Brahim Errahmani[3], Babelhadj Baaissa[4], Djamel Guetarni[5], Antoine Clinquart[2] and Jean Luc Hornick[6]

[1]Veterinary Institute, Blida 1 University, Blida, Algeria
[2]Department of Food Sciences, University of Liège, Belgium
[3]Department of Chemistry, Blida 1 University, Blida, Algeria
[4]Laboratory for the Protection of Ecosystems in Arid and Semi-Arid Zones, Kasdi Merbah University, Ouargla, 30000, Algeria.
[5]Department of Biology, Blida 1 University, Blida, Algeria
[6]Nutrition Unit, Tropical Veterinary Institute, University of Liège, Belgium

*Corresponding Author Email: nasahraoui@gmail.com

Collagen is an important constituent when the physical properties of meat are considered. In view of the fact that factors affecting camel meat toughness are not fully understood and the possibility that they could influence marketing of camel meat. A total of twenty-three camels (age range: 4 months-15 years) from both sexes and belonging to Sahraoui and Targui breeds were slaughtered following the normal abattoir procedures in Ouargla (Algeria). Samples of *Longissimus dorsi* muscle were collected and the collagen content was determined. Mean value was 2.20±0.27 % on fresh matter. A high value of the collagen content was recorded in animals more than 8 years old compared to adults animals from 0 to 4years old (p=0.024). The difference between the breeds was not significant (2.13 vs. 2.39 % in Sahraoui and Targui breeds, respectively). Females meat's had significantly higher values than that of the males (4.77 vs. 1.82%).

Key words: camel, collagen content, meat, gender, breed, *longissimus dorsi*

INTRODUCTION

Dromedary camel is one of the most important domestic animals in arid and semi-arid regions as it is equipped to produce high quality food at low costs under extremely harsh environments compared to other animals (Yagil, 1985; Yousif and Babiker, 1989). It is a good source of meat in areas where climate adversely affects the efficiency of production of other animals (Kadim et al., 2006). Moreover, camel meat has low fat content and is rich in some healthy nutrients (Sahraoui et al., 2014). Few studies performed on camel meat (Babiker and Yousif, 1990; Kadim et al., 2008) suggested that the quality of camel meat is comparable to beef if animals are slaughtered at comparable ages, whereas, physicochemical and textural characteristics of camel meat have not been fully exploited.

Basically, meat can be considered in its simplest form as a myofibrillar structure, a collection of parallel fibers, bound together by a connective network tissue composed of collagen and elastin (Icier et al., 2009). The texture of meat mainly depends on zootechnical parameters such as breed, age and sex (Huff-Lonergan and Lonergan, 2005), and on anatomical characteristics such as type of muscle (Zamora, 1997). Structure of collagen and elastin is a significant factor that affects meat texture (Takagi et al., 1992). Hydroxyproline is a major component of the protein collagen, comprising roughly 13.5% of mammalian collagen. Hydroxyproline and proline play key roles for collagen stability. They permit the sharp twisting of the collagen helix (Szpak, 2011). To our knowledge, the connective tissue composition of meat is unknown in Algeria. The aim of this study was thus to measure the levels of collagen in the meat from camels belonging to Algerian population.

MATERIALS AND METHODS

Animals and muscle sampling

Twenty-three Algerian camels, aged between 4 months and 15 years, fattened by local camel herders in Ouargla

Table 1. Effect of age on collagen content in Algerian camel's meat (mean±SE). Means with different uppercase letters are significantly different at $p < 0.05$

	0-4 years	4-8 years	>8 years	p
n	10	8	5	
Collagen %	1.67±0.19[a]	2.05±0.20[a]	3.51±0.97[b]	0.021

Table 2. Effect of gender on collagen content (mean±SE) in Algerian camel's meat

	Male	**Female**	p
n	20	3	
Collagen %	1.82±0.13	4.77±1.08	<0.001

Table 3. Effect of breed on collagen content (mean±SE) in Algerian camel's meat

	Sahraoui	Tergui	P
n	17	6	
Collagen %	2.13±0.36	2.39±0.21	0.68

(Algeria), were selected and slaughtered following the normal abattoir procedures. The samples of *Longissimus dorsi* muscle were removed from each carcass within 1 h post-slaughter. Muscle samples were cut cylindrically (5 cm diameter and 10 cm length). Samples were sealed in plastic bags and transported to the Faculty of Veterinary Medicine, University of Liege, in an insulated box filled with ice, where samples were packed and stored at −18°C until analysis in the Laboratory of Food Science.

Chemical analysis

Hydroxyproline estimation

The hydroxyproline (OH proline) content in meat was determined according to ISO 3496 method performed by ISO 3496 (1994). Briefly, 6-7 grams of fresh meat sample was hydrolysed with 8, 4 N sulfuric acid for 16 h at 105 °C. Hydrolysate was filtered, and solution was diluted to volume with distilled water. One millilitre of hydrolysate was pipetted into a 100 mL volumetric flask and filled to mark with H_2O. Two milliliters of colour reagent was added and mixed. Tube was then placed in a water bath at 60°C for 20 min, then cooled to room temperature and absorbance measured.

A standard calibration curve was carried out from OH proline proanalyzer at concentrations ranging from 0.25 to 3.2 µg / mL. The calibration line related optical density to concentration of OH proline expressed in µg /mL. The OH proline content in the collagen being considered as 12.5%. The collagen content was calculated from hydroxyproline content using the coefficient 8

Statistical analysis

The analysis was performed on Statistica 10, Statsoft, USA. The collagen concentrations were compared by age groups, gender and breed using the Student t-test or ANOVA procedure**.** Differences were considered significant at $p<0.05$. The data were expressed as % ±SE (SE : standard error on %) in fresh meat.

RESULTS

Our results showed that the mean collagen content in meat was 2.20±0.27 %, with maxima value of 6.27% and minima value of 0.86%.

Regarding to age, the results showed that higher collagen content was recorded in animals over than 8 years, when compared to animals between the age of 0-4 and 4-8 years age groups ($p=0.021$; Table 1). A strong gender effect was observed on collagen content. Significantly higher collagen content was measured in females compared to males (Table 2). By contrast, no significant difference in total collagen content in meat was observed between Sahraoui and Tergui breeds(Table 3).

DISCUSSION

Collagen is the most abundant mammalian and avian protein and is found in all tissues, particularly skin, tendon, and bone (Piez, 1966; McCormick, 1999) but there is little data on camel's collagen content as reported by Kadim et al. (2013) and very few studies have explored the collagen content in camel meat (Babiker and Yousif, 1990; Siddiqi et al., 2000).

Our results showed that the mean collagen content in meat camel was 2.20±0.27%. Hadi Eskandari et al. (2012) reported largely lower total collagen content in camel meat, with values ranging from 1.67 to 2.03 mg/g of meat for

Longissimus dorsi and *Psoas major* muscles from one-humped male camels. Kamoun (1995) indicated that the total collagen content was 3.3 to 7.5 mg/g in six major muscles. Nevertheless, Babiker and Yousif (1990) indicated that the total collagen content is greater in camel *Longissimus dorsi* than in *Semitendinosus* or *Triceps brachii*, possibly due to the morphological requirement for stabilizing the hump attached to the *Longissimus dorsi*.

Numerous investigations have determined total and insoluble collagen contents in bovine meat (Torrescano et al. 2003). However, Torrescano et al. (2003) reported that total collagen content of bovine muscles showed a wide range of values (0.31 to 1.15%). Mamani-Linares and Gallo (2013) indicated that soluble collagen was only 1.28 mg/g (20.28% of total collagen content) in llama *Longissimus lumborum* muscle. Other studies have reported that texture of meat fibers, aggregation and gel formation in bovine meat mainly depend on myofibrillar and sarcoplasmic proteins, on characteristics of animal such as breed, age and sex (Huff-Lonergan and Lonergan, 2005), on anatomical characteristics such as type of muscle, and on collagen solubility (Zamora, 1997).

Tenderness of meat is rated as the most important quality attributed by the average consumer and appears to be sought at the expense of flavor or color (Lawrie, 1979). The most marked difference in meat quality characteristics between camel and other livestock is believed to be tenderness. Camels are usually slaughtered at the end of their productive life (>10 years) which is the reason that camel meat is classified as a low quality meat. In Kenya, the average age for camels slaughtered was 14.5 years (Mukasa-Mugerwa, 1981).

General consumers' view is that camel meat is unacceptably tough, but in fact meat from young camels has been reported to be comparable in taste and texture to beef (Kurtu, 2004).

For age, we observed that higher collagen content was recorded in animals over than 8 years, when compared to animals aged between 0-4 and 4-8 years. The same observation was made by Kadim et al. (2006) who suggested that male camels should be slaughtered between one to three years of age. Kadim et al. (2008) reported that Warner-Bartzler shear force (WBSF) values in 5–8 years old camels were significantly higher than 1–5 years old ones. Increase in toughness due to age may be related to changes in muscle structure and nature and quantity of connective tissue in the meat (Kadim et al., 2014). The collagen content of muscle increased from 18 to 20% between 9 and 13 months of age; above 13 months, muscles had lower variations in content. The gradual decrease in solubility of collagen would explain the decrease in meat tenderness with age of animal. However, Duarte et al. (2011), reported that total collagen content in muscle does not increase significantly with physiological maturity in cattle; however, collagen solubility is correlated with dental maturity since meat from animals with 2 and 4 permanent incisors has greater collagen solubility compared to that of animals with 8 permanent incisors. Intermolecular cross-links present in collagen found in muscle of young animals are unstable to heat but these links are converted into complex structures as the animal ages, becoming thermostable (Robins et al., 1973), tending to make the meat less tender.

Nevertheless, the total collagen level was found to be higher in females (Table 2). Abdelhadi et al. (2015) indicated that OH proline contents did not differ between male and female camel. Total collagen values decreased in the strong male lambs, while soluble collagen did not vary significantly.

The influence of gender on connective tissue is reported and refers to content and solubility of collagen. Collagen content is observed to be higher among males than in females. The collagen content of females is close to that of castrated males. Collagen solubility is similar in castrated males and females; It was low in all males (Monin, 1991). These differences are corresponding with the animal's age, since they are relatively poor in young animals and then increase with age (Kopp, 1982).

Collagen content also decreases with muscle development, it is linked with physiological period among genotypes, which can also contribute to differences in tenderness (Boccard and Bordes, 1986; Renand, 1988). When reported to the breeds, no significant difference was observed between total collagen content in meat. Al-Owaimer et al. (2014) reported that cross sectional area of muscle fibers did not differ between the animal's breeds. Though, in the literature, many authors have reported the effect of breeds on beef tenderness. In semi-tropical region of Argentina, breeds effect on tenderness was observed between Criollo Argentino and Brasford steers raised on forage (Orellana et al., 2009). Breeds specialized for meat production (Limousin and blonde of Aquitaine) have a lower value of shear force than other breeds (Holstein and Old Brown Swis) (Monsón and Sañudo Sierra, 2004). In indigenous African cattle breeds, meat of Santa Gertrudis is less tender than those of Sanga, Afrikaner, Nguni, Brown Swiss, Pinzgauer and Bonsmara (Strydom et al., 2000). According to this author, in the arid subtropics of South Africa, breeds effect on tenderness and shear force were not significant, and as a rule, meat quality characteristics from young camels are comparable with those of beef.

CONCLUSION

This study evaluated the content of collagen in Algerian camel meat. Results showed low mean levels but higher collagen content was recorded in the elderly. In addition, female camel meat had significantly higher collagen values but probably owing to an age effect. The values remained similar for Sahraoui and Tergui breed.

REFERENCES

Abdelhadi OMA, Babiker SA, Bauchart D, Listrat A, Remond

D, Hocquette JF, Faye B (2015). Effect of gender on quality and nutritive value of dromedary camel (Camelus dromedarius) longissimus lumborum muscle. Journal of the Saudi Society of Agricultural Sciences. King Saud University.

Al-Owaimer AN, Suliman GM, Sami AS, Picard B, Hocquette JF,(2014).Chemical composition and structural characteristics of Arabian camel (*Camelus dromedarius*) m. longissimus thoracis. Meat Sci.;96(3):1233-41.

Babiker SA, Yousif OK (1990). Chemical composition and quality of camel meat. Meat Sci.,(27): 283–287.

Boccard R, Bordes P, (1986). Caractéristiques qualitatives et technologiques des viandes bovines: influence des facteurs de production. In Production de viande bovine. Ed D. Micol, INRA Publ, Paris, pp 61-84.

Duarte MS , Paulino PVR, Fonseca MA, Diniz LL, Cavali J, Serão NVL, Gomide LAM, Reis SF, Cox RB (2011). Influence of dental carcass maturity on carcass traits and meat quality of Nellore bulls. Meat Sci., 88(3): 441–446.

Hadi Eskandari M, Majlesi M, Gheisari MR, Farahnaky A, Khakzar Z (2013). Comparison of some physicochemical properties and toughness of camel meat and beef . J. Appl. Ani. Res., 41(4): 442-447.

Huff-Lonergan E, Lonergan SM (2005). Mechanisms of water holding capacity of meat: The role of post mortem biochemical and structural change. Meat Sci., 71: 194-204.

Icier F, Engin M, Bozkurt H (2009). Investigation of Applications of Ohmic Thawing and Ohmic , Cooking in Meat Processing. Project Report. TUBITAK TOVAG 107O898, pp: 171 (in Turkish). J. Cam. Pract. Res. 22(1): 27-32.

ISO 3496:1994(E) Meat and meat products – determination of hydroxyproline content http://www.iso.org/ISO/catalogue

Kadim IT, Al-Karousi A, Mahgoub O, Al-Marzooqi W, Khalaf SK, Al-Maqbali RS, Al-Sinani SSH, Raiymbek G (2013). Chemical composition, quality and histochemical characteristics of individual dromedary camel (*Camelus dromedarius*) muscles. Meat Science, 93(3) : 564–571

Kadim IT, Mahgoub O, Al-Marzooqi W (2008). Meat Quality and Composition of *Longissimus thoracis* from Arabian Camel (*Camelus dromedaries*) and Omani Beef: A Comparative Study. J. Camelid Sci., 1: 37-47.

Kadim IT, Mahgoub O, Al-Marzooqi W, Al-Zadgali S, Annamali K, Mansour MH (2006). Effects of age on composition and quality of muscle Longissimus thoracis of the Omani Arabian camel (*Camelus dromedaries*). Meat Sci., 73 : 619–625.

Kadim IT, Mahgoub O, Mbaga M (2014). Potential of camel meat as a non-traditional high quality source of protein for human consumption. 4 (4):13-17

Kamoun M (1995). Evolution de la qualite de la carcasse et de la viande des dromadaires En function de la conduit zootechnique des animaux. Rapport final relative à la bourse de recherché FIS no. 1372-2.

Kopp J, (1982). Qualité des viandes de taurillons: évolution avec l'âge des caractéristiques physicochimiques des muscles. Bull. Techn. CRZV Theix INRA, (48): 27-46.

Kurtu MY (2004). An assessment of the productivity for meat and carcass yield of camel (*Camelus dromedarious*) and the consumption of camel meat in the eastern region of Ethiopia. Trop. Anim. Health Prod.,(36):65–76.

Lawrie RA (1979). Meat science (3rd ed.). Pergamon Press.

Mamani Linares W, Gallo C (2013). Meat quality attributes of the Longissimus lumborum muscle of the Kh'ara genotype of llama (Lama glama) reared extensively in northern Chile. Meat Science 94(1):89-94

McCormick RJ (1999). Extracellular modifications to muscle collagen: Implications for meat quality. Poult. Sci. 78:785.

Monin G (1991). Facteurs biologiques des qualités de la viande bovine. INRA Prod. Anim., 4 (2): 151-160.

Monsón FC, Sañudo Sierra I (2004). Influence of cattle breed and ageing time on textural meat quality. Meat Sci., 68(4): 595-602.

Mukasa-Mugerwa, E. 1981.The camel (Camelus dromedaries): A biographical review (pp. 147). Addis Ababa, Ethiopia: International Livestock Centre for Africa.

Orellana C, Peña F, García A, Perea J, Martos J, Domenech V, Acero R (2009). Carcass characteristics, fatty acid composition and meat quality of Criollo Argentino and Braford steers raised on forage in a semi-tropical region of Argentina. Meat Sci., 81: 57-64.

Piez KA (1966). Collagen. In The Physiology and Biochemistry of Muscle as a Food. P 315. Univ. Wisconsin Press, Madison, WI.

Renand G (1988). Genetic determinism of carcass and meat quality in cattle. Proceedings of 3rd World Congress on sheep and beef cattle breeding. 19-23 June 1988, Paris. Volume 1, INRA Publ., Paris, 381- 395.

Robins SP, Shimokomaki M, Bailey AJ (1973). The chemistry of the collagen cross-links. Age-related changes in the reducible components of intact bovine collagen fibres.Biochemstry journal, 131 (4) : 771–780

Sahraoui , Dotreppe O, Brahim Errahmani M, Boudjenah S, Babelhadj B, Guetarni D. Hornick JL (2014). Caractérisation des acides gras de la viande cameline en Algérie. Cahiers de Nutrition et de Dietitique

Siddiqi NJ, Al-jafari AA, Alhomida AS (2000). Investigation of total, free, peptide-bound, protein-bound, soluble and insoluble collagen hydroxyproline content in tissues from the Arabian camel (*Camelus dromedarius*). Cell Biochem Funct. 18:243–248.

Strydom PE, Naede RT Smith MF, Scholtz MM, van Wyk JB (2000). Characterization of indigenous African cattle breeds in relation to meat quality traits. Meat Sci., 55: 79-88.

Szpak P (2011). "Fish bone chemistry and ultrastructure: implications for taphonomy and stable isotope analysis". J. Archaeological Sci. 38 (12): 3358–3372.

Takagi H, Kondou M, Tomoaki H, Nakamori S, Tsai YCH, Yamasaki M (1992). Effects of an alkaline elastase from an alkalophilic Bacillus strain on the tenderization of beef meat.

Torrescano G, Sanchez-Escalante A, Gimenez B, Roncales P, Beltran JA (2003). Shear values of raw samples of 14

bovine muscles and their relation to muscle collagen characteristics. Meat Sci. 64:85–91

Yagil R (1985). The desert camel comparative physiological adaptation (vol. 5). Munchen, London: Verlag Karger Basal.

Yousif OK, Babiker SA (1989). The desert camel as a meat animal. Meat Sci. 26(4): 245-254.

Zamora F (1997). Variabilité biologique de l'attendrissage de laviande bovine. - Pre´diction en fonction du facteur animal et du facteur type de muscle [Biological variation of bovine meat tenderisation. Prediction depending on animal or muscle-type factors].