Effect of heating on shelf life and sensory characteristics of camel milk

Arab Khan Lund1*, Atta Hussain Shah2, Ahmed Sultan Jatoi3, Gul Bahar Khaskheli2, Mool Chand Malhi4, Asad Ali Khaskheli5, Maha Aslam Khanzada2 and Qudratullah Kalwar6

1. Department of Animal Products Technology, Shaheed Benazir Bhutto University of Veterinary and Animal Science, Sakrand-67210-Pakistan
2. Department of Animal Products Technology, Sindh Agriculture University, Tandojam-Pakistan
3. Department of Poultry Production, Shaheed Benazir Bhutto University of Veterinary and Animal Science, Sakrand-67210-Pakistan
4. Department of Veterinary Physiology and Biochemistry, Sindh Agriculture University, Tandojam-Pakistan
5. Department of Animal Nutrition, Sindh Agriculture University, Tandojam-Pakistan
6. Department of Animal Reproduction, Shaheed Benazir Bhutto University of Veterinary and Animal Science, Sakrand-67210-Pakistan.

*Corresponding author’s email: aarabbaloch@gmail.com

Citation
Arab Khan Lund, Atta Hussain Shah, Ahmed Sultan Jatoi, Gul Bahar Khaskheli, Mool Chand Malhi, Asad Ali Khaskheli, Maha Aslam Khanzada and Qudratullah Kalwar. Effect of heating on shelf life and sensory characteristics of camel milk. Pure and Applied Biology. Vol. 9, Issue 1, pp74-79. http://dx.doi.org/10.19045/bspab.2020.90009

Received: 02/06/2019 Revised: 24/08/2019 Accepted: 02/09/2019 Online First: 20/09/2019

Abstract
This study was aimed to analyze the sensory characteristics and keeping quality of raw and heat treated (63°C for 30 minutes, 72°C for 15 seconds and 100.5°C for 10 minutes) camel milk. The sensory scores for taste (36.3, 34.8 and 33.2), texture (24.4, 24.0 and 22.3) and overall acceptability (7.4, 7.7 and 7.0) in comparison to control (32.2, 21.4 and 6.9) were observed at 63°C for 30 minutes, 100.5°C for 10 minutes and 72°C for 15 seconds, respectively. Statistically, the difference was significant (p<0.05) in between control and heat treated samples, however, the insignificant (p>0.05) among different treatments. The scores for colour were 7.6, 7.5 and 7.3 (72°C/15sec, 100.5°C/10min and 63°C/30min, respectively) than that of control (7.8). Statistically, the variation was non-significant (p>0.05) among different heat treatments and time combinations. The keeping quality of camel milk also enhanced under different heat treatments and storage temperatures. Heat treated (100.5°C/10min, 63°C/30min, 72°C/15sec) and raw camel milk were spoiled on 76, 64, 56 and 24 hrs, respectively at ambient temperature, while at the refrigeration temperature, the shelf life was 42, 39, 27 and 18 days, respectively. Statistical analysis showed the significant difference ((p<0.05) among all heat treatments and time combinations. It was found that the heat treatment (63°C/30min) was the best for sensory characteristics because it received the highest score for taste and texture while the heat treatment (100.5°C/10min) was the best for the shelf life as the highest keeping quality of camel found at that temperature.

Keywords: Camel milk; Heat treatments; Shelf life; Sensory properties

Introduction
Globally, camel milk and its products have been gaining a wide demand due to their versatile health promoting properties. It contains good qualities of lactoperoxidase, lactoferrin, lysozyme, antiviral and antibacterial protective protein, that make it more superior over cow milk [1]. Furthermore, it contains low sugar, low cholesterol, high mineral (copper, sodium, iron, zinc, potassium and magnesium), high vitamin A, B2, C and E, low protein and high concentration of insulin [2]. From way back, it has been utilized by human...
beings due to its health promoting properties. In Pakistan, the camel populations and its milk production were one million and 875 tons, respectively [3]. Sensory characteristics of milk are most important for rating as well as consumer’s preference for milk and milk products. It can be done on the basis of color, consistency, texture and flavor. Moreover, it provides estimated information to the processors and producers regarding the consumers’ preference and acceptance for their products [4]. The taste of camel milk is sweet, sharp and sometimes salty. The physicochemical properties of milk is varied with the species which ultimately change the sensory characteristics of milk [5]. The flavor is considered as the most important attributes for the acceptability and preference to milk [6]. Camel milk’s keeping quality is superior to the milk of other ruminants because of its protein component which inhibits the microbial growth. Farah and Fische [7] reported that raw milk of camel could be a saleable commodity, even though at basic hygiene and high temperature for a short period of time. Currently, the bulk of camel milk is utilized in the fresh state. However, the different heat treatments such pasteurization (63°C for 30 minutes and 72°C for 15 seconds), sterilization and boiling may be applied to milk in order to extend its keeping quality and improve the products’ quality by curtailing the load of microorganisms, hence minimizing the risk of food poisoning [8, 9]. However, these treatments are not always applied to ascertain microbiological safety but also applied to improve the organoleptic properties of its products [10]. The different characteristics of camel milk in comparison to other ruminants’ milk fascinated for the present study. It was aimed to evaluate the sensory characteristics and shelf life of camel milk.

**Materials and methods**

**Study Area**

Samples (n=20) of camel milk were collected from the nearby areas of Hyderabad and transported (4±1°C) to the Department of Animal Products Technology, Laboratory of Milk and Meat Chemistry, Sindh Agriculture University, Tandojam, Sindh Pakistan for the analysis of sensory properties and shelf life of camel milk.

**Heat treatments**

Each milk sample was distributed into four equal parts and coddled as A, B, C and D. One part (A) was kept as the control without any treatment while remaining three parts of samples (A, B, and C) were thermally treated at 63°C/30 minutes, 72°C/15 seconds and 100.5°C/10 minutes, respectively. For heat treatments, each sample was transferred to the flask, had a long neck closed tightly with a stopper. The flask was placed in a container filled with hot water and heated for specified time and temperature. During heating, milk was stirred continuously and finally cooled after specified time using running tap water.

**Sensory analysis**

Milk samples were analysed for sensory characteristics by a panel of judges. A total of 30 panelists (of different age and sex) were selected from the Master of Philosophy students. They were familiarized with the questionnaires for sensory characteristics and following vocabulary was used for the sensory characteristics, maximum scores 10 for appearance/color, 45 for flavor/taste and 30 for texture/body [11]. The samples were also served among the judges for overall acceptability (maximum 10 score) that was evaluated with Hedonic Scale [12]. Biscuits were used to neutralize the tastes in between samples.

**Shelf life evaluation**

All the treated and control samples were further divided into two parts, one was kept at ambient temperature while other was placed at refrigeration (4±1°C) for the shelf life evaluation. The former (ambient temperature) was evaluated first at the interval of 24hrs and then at the interval of 4 hours and the second part (refrigerated)
was analysed at the interval of 3 days. The shelf life of camel milk was analysed by using titratable acidity and clot on boiling (COB) tests.

**Titrable acidity (%)**
The developed acidity (%) of camel milk was observed by titration with sodium hydroxide. Camel milk (10 ml) was transferred in a conical flask and 3-4 drops of phenolphthalein were added and titrated against N/10 NaOH (sodium hydroxide) till the change of colour. Finally, the reading of burette was used in formula for the determination of titrable acidity [13].

**Clot on boiling test**
Clot on boiling test in addition to titrable acidity was used for the analysis of shelf life of camel milk. Camel milk (5 ml) was added in screw cap test tubes and heated for boiling. Once the milk starts boiling, it was heated further for 5 minutes. The time was noted by using stopwatch. The precipitation of milk showed that the milk expired which cannot be used for the manufacturing of any products or for consumption [14].

**Statistical analysis of data**
The collected data was interpreted by the Student Edition of Statistix (SXW), a computer program version 8.1 (Analytical software-USA, Copyright 2005). The LSD (least significant difference) and Analysis of variance were also used for the observation of variation in between different heat treatments [15].

### Results and discussion

**Effect of heat treatments on sensory characteristics of camel milk**
The effect of thermal treatments on sensory characteristics is shown in (Table 1). The sensory properties of camel milk significantly (p<0.05) improved when heated at different temperatures and time combinations such as the score for taste, texture and overall acceptability (36.3, 24.4 and 7.4, respectively) was noted at 63°C for 30 minutes followed by 100.5°C for 10 minutes (34.8, 24.0 and 7.7, respectively) and 72°C for 15 seconds (33.2, 22.3 and 7.0, respectively) in comparison to the control (32.2, 21.4 and 6.9). The significant difference (p<0.05) was found between control and heat treated camel milk. On the other hand, the scores for colour were decreased with heat treatments and time combinations. However, the analysis of variance showed non-significant (P>0.05) difference among different heat treatments and time combinations. The flavor imparted by heating is the cause of this significant variation in the sensory characteristics. Present findings are well supported by the results of Gandy et al. [16] who stated that the heat treatments altered the consumers’ preference. They further reported that the consumer preferred the pasteurized milk at 79°C in comparison to pasteurization at 77, 82 and 85°C. A similar type of research on skim milk was conducted by ul Ha et al. [14] who reported that the heat treated skim milk was preferred by the panel judges in comparison to the raw skim milk.

| Sensory attributes                  | Treatments                  | SE± | LSD (0.05) |
|------------------------------------|-----------------------------|-----|------------|
|                                    | Control | 63°C/30min | 72°C/15sec | 100.5°C/10min |
| Color/appearance (max 10)          | 7.8<sup>a</sup> | 7.3<sup>a</sup> | 7.6<sup>a</sup> | 7.5<sup>a</sup> | 0.361 | 0.716 |
| Taste/flavor (max 45)              | 32.2<sup>b</sup> | 36.3<sup>a</sup> | 33.2<sup>ab</sup> | 34.8<sup>ab</sup> | 2.009 | 3.979 |
| Body/texture (max 10)              | 21.4<sup>b</sup> | 24.4<sup>a</sup> | 22.3<sup>ab</sup> | 24.0<sup>a</sup> | 1.076 | 2.132 |
| Overall Acceptability (max 10)     | 6.9<sup>b</sup> | 7.4<sup>ab</sup> | 7.0<sup>b</sup> | 7.7<sup>a</sup> | 0.314 | 0.623 |

Scores with different superscripts show significant difference
Effect of heat treatments and time combinations on the shelf life of camel milk

The results regarding the shelf life of raw and heat-treated camel milk are presented in (Figure 1 & Table 2). It was found that the heating for different times enhanced significantly (p<0.05) the keeping quality of camel milk. The maximum shelf life of camel milk was noted at 100.5°C for 10 minutes as both titrable acidity (TA) and clot on boiling (COB) test were performed to found that the camel milk was expired on 76 hrs and 42 days (at ambient and refrigerator temperature, respectively). At the ambient temperature, keeping quality of raw and heat treated came milk was 76, 64, 56 and 24 hrs (100.5°C for 10 minutes, 63°C for 30 minutes, 72°C for 15 seconds and control, respectively). However, when kept under refrigeration temperature, the keeping quality of raw and heat treated camel milk was 42, 39, 27 and 18 days (at 100.5°C for 10 minutes, 63°C for 30 minutes, 72°C for 15 seconds and control, respectively). The keeping duration of camel milk is longer in comparison to the other milk because it contains antibacterial constituents [17, 18]. It was observed that the heat treatments and time combinations enhanced the normal shelf life of camel milk due to killing spoilage microorganisms. These findings are correlated with the results of Said et al. [19] who observed that the keeping quality of pasteurized milk (36 days) is higher compared to the raw milk of camel. The refrigeration temperature further extended the keeping quality of camel milk in comparison to ambient temperature because it inhibits the growth of spoilage micro-organisms in addition to antibacterial constituents.

![Figure 1. Comparison of raw and heat treated camel milk under different storage temperatures](image)

Table 2. Shelf life of raw and heat treat camel milk stored at ambient and refrigerator temperatures

| Treatments          | Shelf life of camel milk |
|---------------------|--------------------------|
|                     | ambient temperature (Hrs) | refrigerator temperature (days) |
| Control/raw         | 24<sup>a</sup>            | 18<sup>a</sup>               |
| 63°C/30min          | 64<sup>b</sup>            | 39<sup>b</sup>               |
| 72°C/15sec          | 56<sup>c</sup>            | 27<sup>c</sup>               |
| 100.5°C/10min       | 76<sup>a</sup>            | 42<sup>a</sup>               |
| S.E ±               | 0.9317                   | 0.8841                      |
| LSD (0.05)          | 1.8557                   | 1.7608                      |

Variables with different superscripts show significant difference
Conclusion
Present findings lead to the conclusion that the heating treatments and time combinations improved the sensory properties of camel milk. These treatments changed the salty taste of camel milk into a sweetish taste that’s why the Panel of judges preferred the heat treated camel milk in comparison to control. The milk of camel treated at 63°C for 30 minutes got the highest score for taste and texture while camel milk treated at 100.5°C for 10 minutes received the highest score for overall acceptability of sensory characteristics. In addition to sensory properties, it was found a major improvement in the keeping quality of camel milk under different temperatures and time combinations. The shelf life of camel milk was found maximum at 100.5°C for 10 minutes. The keeping duration further extended when heat treated camel milk kept under refrigeration temperature.

Authors’ contributions
Conceived and designed the experiments: AK Lund, AH Shah, MC Malhi & GB Khaskheli, Performed the experiments: AK Lund & MA Khanzada, Analyzed the data: Q Kalwar & AA Khaskheli, Contributed materials/ analysis/ tools: AH Shah & GB Khaskheli, Wrote the paper: AK Lund & AS Jatoi.

References
1. Yadav AK, Kumar R, Priyadarshini L & Singh J (2015). Composition and medicinal properties of camel milk: A Review. Asian J of Dairy and Food Res 34(2): 83-91.
2. Alkaladi A, Afifi M, Kamal R & Afifi M (2014). Application of microwave as an alternative home pasteurization method for camel milk; microbiological, physiochemical and biochemical study.
3. Economic Survey of Pakistan (2015-16). Page 40. Ministry of Finance and National Food Security & Research Economic Adviser’s Wing, Finance Division.
4. Saba A, Moneta E, Nardo N & Sinesio F (1998). Attitudes, habit, sensory and liking expectation as determinants of the consumption of milk. Food Quality and Prefer 9(1-2): 31-41.
5. Wolf IV, Bergamini CV, Perotti MC & Hynes ER (2013). Sensory and flavor characteristics of milk. Milk and dairy products in human nutrition: Production, Composition and Health, pp 310-337.
6. Kim YD & Morr CV (1996). Dynamic headspace analysis of light activated flavor in milk. Intl Dairy J 6(2): 185-193.
7. Farah Z & Fischer A (2004). An introduction to the camel. Milk and Meat from the Camel Handbook on Products and Processing, pp 15-22.
8. McKinnon IR, Yap SE, Augustin MA, & Hemar Y (2009). Diffusing-wave spectroscopy investigation of heated reconstituted skim milks containing calcium chloride. Food Hydrocolloids 23(4): 1127-1133.
9. Felfoul I, Jardin J, Gaucheron F, Attia H & Ayadi MA (2017). Proteomic profiling of camel and cow milk proteins under heat treatment. Food Chem 216:161-169.
10. Del Angel CR & Dalgleish DG (2006). Structures and some properties of soluble protein complexes formed by the heating of reconstituted skim milk powder. Food Res Intl 39(4): 472-479.
11. Nelson JA & Trout GM (1981). Judging Dairy Products. Avi. Publishing company, Inc. Westport, Connecticut, pp 60.
12. Hui YH (1993). Dairy science and technology hand book. I principles and properties. VCH publisher, Inc. New York, USA, pp 168-69.
13. Association of official analytical chemistry-AOAC (2000). Dairy products. In: official Methods of Analysis. Association of Official Analytical Chemists, Inc. Gaithersburg, USA.
14. Ul Haq I, Khaskheli M, Salman M, Marri MY, Marri MA, Lochi GM & Habib F (2014). Effect of heat treatments on sensory characteristics and shelf-life of skimmed milk. *African J of Food Sci* 8(2): 75-79.

15. Gomez KA, Gomez KA & Gomez AA (1984). Statistical procedures for agricultural research. John Wiley & Sons.

16. Gandy AL, Schilling MW, Coggins PC, White CH, Yoon Y & Kamadia VV (2008). The effect of pasteurization temperature on consumer acceptability, sensory characteristics, volatile compound composition, and shelf-life of fluid milk. *J of Dairy Sci* 91(5): 1769-1777.

17. Wernery U, Johnson B & Abrahm A (2005). The effect of short-term heat treatment on vitamin C concentrations in camel milk. *Milchwissenschaft* 60(3): 266-267.

18. Benkerroum N (2008). Antimicrobial activity of lysozyme with special relevance to milk. *African J of Biotechnol* 7(25).

19. Said OG, Mofeda KG & Manal SE (2013). Microbial Quality and Shelf Life of Pasteurized Camel Milk. International Scientific Conference of Camel Research and Production (ISCCRP), Khartoum-Sudan 17th–18th April 2013, pp 54-58.