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Research Article

Effects of Parity Orders and System Managements on Vitamins A and E in Camel Milk

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ABSTRACT

Introduction: Camel milk provides high nutrient content for people living in harsh environments. The current study evaluates levels of vitamins A and E in camel milk in different production systems.

Materials and methods: The camel milk samples were gathered from a total of 42 lactating she-camels that were in varying phases of the nursing process at the second and third parties in the state of Khartoum, Sudan. Semi-closed and closed farms, as well as grazing ranges, were used for the rearing of she-camels (14 milk samples were collected from each production system).

Results: The findings revealed that a high level of vitamin A was observed in the camel milk samples obtained from the she-camels at third parties in the grazing range. Second parties in the confined farm recorded highly significant amounts of vitamin E. The results demonstrated that the vitamin A content of camel milk was strongly impacted by both the types of production methods and parity orders. In contrast, vitamin E was only significantly affected by parity orders.

Conclusion: In conclusion, the production system and parity orders significantly impact camel milk levels of vitamins A and E. However, further studies are needed to correlate all the contributing factors to the levels of camel milk vitamins.

1. Introduction

Camel milk, in addition to its medicinal benefits, is regarded as one of the most important components of the human diet in many regions of the world[1-5]. Camel milk is drunk fresh or fermented in Sudan and is mostly prepared under traditional circumstances[6,7].

Despite the harsh weather, camels produce milk, which is considered a complete diet for humans since it includes vital nutrients[8]. Because the camel udder has a powerful antibacterial system, the camel milk conservation time at room temperature is extended by a few days[9].

Camel milk has a unique composition that differs from other ruminants' milk. It contains lower fat, cholesterol, and lactose than cow milk, higher minerals (iron, calcium, zinc, magnesium, copper, and potassium), and vitamin C compared to cow milk[9,10].

Camel milk has less vitamin A and E than cow milk[11-15]. On the other hand, the milk of she-camels raised in the traditional nomadic system contained greater levels of vitamins A and E than those raised in the semi-intensive system[16].

The mean value of vitamin A in camel milk was 0.1 mg/L, with a range of 0.14-0.5 mg/L[17]. The vitamin A content of Saudi Dromedaries camel was 0.15 mg/kg[18]. However, another study reported a level of 380 ± 3 µg/L for camel milk samples in Saudi Arabia[19]. Moreover, vitamin A content in Sudan varied between locations and ranged 0.02–0.09 mg/100 g[20].

Vitamin E levels in camel milk were 530 g/L, compared to 200-1300 and 2800 g/L in cow and human milk, respectively[18,21,22]. Another survey reported that the mean vitamin E content in camel (*Camelus dromedaries*) milk was 0.56 mg/L, averaging 0.21-0.91 mg/L[17]. A study demonstrated camel vitamin E concentration varied by region, ranging from 0.32-0.85 mg/100g[20]. On the other hand, in another study, the mean vitamin E content in camel milk was just 1.78 ± 0.58 g/100 mL[23]. There was a higher concentration of 2.6 mg/100 mL in whole fresh milk and 2.34 mg/100 mL in freeze-dried camel milk[19]. The current study measured the amounts of vitamins A and E in camel milk and assessed the impact of parity order and

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management methods on these levels.

2. Material and Methods

2.1 Ethical approval

The current study was conducted according to the Institutional Animal Care and Use Committee guidelines of Khartum University (Sudan).

2.2 Areas

The current study was carried out in the state of Khartoum, Sudan. Seven samples (n= 42) of she-camels at the second and third parity were chosen from the three management methods. The influence of various management methods and parity orders on camel milk's vitamins A and E levels was studied.

2.3 Management systems

The first kind of management is a closed system, and it is located on a private farm near Khartoum, North Sudan. Kenani and Anafi are camels' type who reside in this area. Because there was no grass available, the farm had to rely on its workers to provide food and care for the camels under this arrangement. Their diet contains groundnut cake, alfalfa, and sorghum bicolor (Abu 70). Water is never in short supply (Table 1). The camels are separated into different fences based on their ages and the physiological states they are in. Camel bulls are also kept apart. Milking is done by hand three times a day, and each female camel produces an average of 4.4 liters daily.

The second system is a semi-closed system in West Omdurman, Sudan, owned by a private farm. The camels were Arabi-type female camels. In addition to being provided with water at all times, the camels are given a diet that consists of alfalfa, Abu 70, and groundnut cake (Table 1). The lactating female camels spend the lactation season (about eight months) at the farm, and they spend the dry season grazing on the pasture. The she-camels produce an average of 4.4 liters of milk daily, and the milking process is done manually four times a day.

The grazing range system is the third type of management system, and it is found in Western Omdurman, Sudan. She-camels were Arabi type. The camels were only given access to grazing, and they were only given water once every seven days (Table 1). The she-camel will produce an average of 5 liters of milk daily, and the manual milking process is performed twice daily.

2.4 Milk sampling

The camel milk samples were taken in the early morning from the she-camels maintained in the semi-closed farm, the she-camels kept in the closed farm, and the she-camels kept in the grazing area. Samples of approximately 50 mm camel milk were taken from each of the 42 lactating she-camels. The samples were collected in clean bottles and stored in the ice box. At the same time, they were transported to the Crop Protection laboratory at the College of Agriculture (Sudan) for pretreatment before vitamin analysis. Vitamins A and E were determined at the Central Laboratory Shambat University of Khartoum in Sudan.

2.5 Determination of vitamins A and E

The AOAC-approved method was used to determine vitamin A and E levels using the High-Performance Liquid Chromatography (HPLC) methodology[24].

The standards were prepared using Sigma products from St. Louis, MO, USA, as retinol palmitate for vitamin A and α-tocopherol acetate for vitamin E. A saponification solution of 10.5 mol 1^{-1} KOH and as an antioxidant solution of 1% pyrogallol in 100% ethanol was used. Similarly, the extraction solution was hexane-methylene chloride (HMC, 75+25), and the wash solution was water-ethanol (60+40).

2.5.1 Preparation of standards solutions

For standard stock solutions of retinol palmitate and α-tocopherol acetate, 100 ppm were prepared using methanol by dissolving 0.1 mg from each standard in 100 mL volumetric flasks. Working standard solutions of vitamin A were prepared by appropriately diluting 0.1, 0.2, and 0.4 mL from the stock solution to a series of 10 mL volumetric flasks. The volume was completed with the methanol to obtain 1, 2, and 4 ppm of vitamin A solution.

Working standard solutions of vitamin E was prepared by diluting 0.2, 0.4, and 1 mL from the stock solution into a series of 10 mL volumetric flasks. The volume was completed with the methanol to obtain the solution in 2, 4, and 10 ppm of vitamin E.

A calibration curve was created by injecting 20 µL of each standard working solution (peak) and graphing the recorded peak area versus the analyte injected mass. The slope intercepts and least square fit of the standard curve were analyzed. Data for the slope and intercept of the calibration curve were used to compute the mass of the analyte sample.

Table 1. Feeding and watering management of camels from different management systems in Sudan

Feeding management of camels	Closed system	Semi-closed system	Grazing range system
Types of camels	Kenani and Anafi	Arabi	Arabi
Camels on pasture	Non	Partial	Always
Supplementary feeding	A mixture of alfalfa, *Sorghum biocolor,* and groundnut cake	A mixture of alfalfa, *Sorghum biocolor,* and groundnut cake	Non
Watering interval	Ad libitum	Ad libitum	Once a week

2.5.2 Method of analysis

The samples were extracted using the AOAC-approved analytical method[24]. Five milliliters of milk were pipetted into a flask, followed by five milliliters of distilled water, fifteen milliliters of the antioxidant solution, and two milliliters of saponification solution. The flasks were immersed in water, magnetically stirred, and maintained at 70° C for 25 minutes. After then, the temperature in the flasks was allowed to return to normal temperature. Then, the experimental contents moved quantitatively into a separating funnel. The flasks were washed with 15 mL of a solution containing HMC (75+25). After which, the washings were added to the separating funnels. After that, 15 mL of an extraction solvent composed of HMC (75+25) was added while the funnel was shaken for two minutes. After 30 seconds of moderate shaking, the aqueous phase was discarded. Then the organic layer was washed three times with the wash solution (which consisted of water and ethanol in a ratio of 60:40). After pipetting five milliliters of the top organic layer into a test tube, and it was then evaporated under a stream of nitrogen until it was completely dry. Before being injected into the LC system, the residue was first dissolved in 2.5 milliliters (mL) of methanol.

2.5.3 Chromatographic procedure

At room temperature, all separations were performed on an Ultras base C_{18} column with methanol-propanol 2 as mobile phase at a flow rate of 1.5 mL min^{-1}. A 40 µL injection volume was used, and vitamins A and E were monitored concurrently at 325 and 292 nm.

2.6. Statistical analysis

The ANOVA and Duncan multiple range tests were employed to separate means throughout the data analysis using the Statistical Package for Social Science (SPSS) version 18. Statistical significance for all tests was set at $p < 0.05$.

3. Results and Discussion

3.1. Effects of the management systems and parity orders on vitamin A level

The estimation of vitamin A content using HPLC was calculated using the standard curve, and the peaks were compared to standards. Table 2 showed that milk's lowest vitamin A content was reported for the she-camels at the second parity in the closed system (0.016±0.025 mg/L). However, the highest value was recorded for the she-camel milk at the third parity in the grazing range system (0.185±0.065 mg/L). Similarly, concentrations of 18.6±1.97 mg/L[3] and 201±100 µg/L[25] were previously given for camel milk vitamin A. The availability of green grasses and the natural grazing pasture could be the main reason for the higher values obtained. This justified the adoption of natural range grazing for rearing the camel[16].

The type of management system and parity order significantly affected vitamin A content in camel milk (Table 2). Overall, milk samples from the grazing range recorded the highest vitamin A level (0.114±0.093 mg/L) compared with those from the closed and semi-closed system (0.036±0.045 m/L and 0.045 mg/L, respectively). The camel milk vitamin A level was affected mainly by the production systems and breeds[16]. However, different values were reported in Saudi Arabia (380 ± 3 µg/L)[19] and in Jordan (267±80 µg/L) [23]. The present study found high variations of vitamin A within different management systems, which supported a recent report that linked the high variability of vitamin A in camel milk to feed [26]. Also, the gross compositional content was found to be better in she-camels reared in the traditional nomadic system of Sudan compared to the semi-intensive production system[27-31].

The present study showed that camel milk vitamin A content was higher in the third parity compared to the second parity. This might be because fat-soluble vitamins were influenced by parity orders[32].

The present study's vitamin A average content was 0.065 mg/L. This result is lower than that reported previously outside Sudan[17,18] and in line with that reported in Sudan[20]. However, the close range for vitamin A concentration in camel milk (50-970 µg/L) was reported [33]. Variations observed in the vitamin A content of camel milk could be due to differences in seasons, camel breed, types of feed, and stage of lactation[32].

3.2. Effect of the management system and parity orders on vitamin E level

Vitamin E content was determined using HPLC using the standard curve and the peaks compared to standards. As shown in Table 3, the vitamin E content of camel milk was affected significantly by the type of management system and parties number ($p < 0.05$). Data for the she-camels at the second parity in the closed farm recorded the highest value (0.233±0.19 mg/L). Camel milk vitamin E level was affected significantly ($p < 0.05$) by the variation of production systems and breeds of camels[16]. Lower mean values were reported for vitamin E content in camel milk (16.1 mg/100 mL[15] and 1.78 ±0.58 µg/100 mL)[23]. Other authors reported slightly higher concentrations of 27.6±2.07 mg/L[3] and 2.6 mg/100[19] for the camel milk. However, the high standards error reported might be because some samples failed to give readings (Table 3).

Table 2. Effect of management of the system and parity order on vitamin A level of camel milk (mg/L) in Sudan

Management system	Parity orders		Means ± SD
	Second	Third	
Closed	0.016^{a}±0.25	0.056^{b}±0.054	0.036^{b}±0.045
Semi-closed	0.019^{a}±0.009	0.070^{b}±0.050	0.045^{b}±0.043
Grazing range	0.042^{a}±0.052	0.185^{a}±0.065	0.114^{a}±0.093
Parities average	0.026± 0.034	0.104±0.080	

^{a,b} means different superscript letters in the same column show significant differences ($p < 0.05$). Data demonstrated as means ± SD (Standard deviation)

Table 3. Effect of management of the system and parity order on vitamin E level of camel milk (mg/L) in Sudan

Management system	Parity order		Means ± SD
	Second	Third	
Closed	0.233[a]± 0.190	0.022[b]±0.029	0.127[a]±0.170
Semi-closed	0.071[b]±0.044	0.064[b]±0.048	0.068[b]±0.044
Grazing range	0.093[b]±0.058	0.103[a]±0.038	0.098[b]±0.047
Parities average	0.132±0.133	0.063±0.050	

[a,b] means the different superscript letters in the same column show significant differences ($p < 0.05$). Data demonstrated as means ± SD (Standard deviation)

This is against some authors' conclusion that camel milk has no vitamin E[34,35].

Comparing milk samples from closed farms (0.022±0.029 mg/L) and semi-closed farms (0.064±0.048 mg/L), the vitamin E content of milk from she-camels in the third parity in the grazing system had the greatest value (0.103±0.038 mg/L). The parity ordering showed differences in the vitamin E contents of milk samples taken during various parities from two distinct she-camel breeds[16].

The current investigation demonstrated that samples taken from closed farms had the highest mean levels of vitamin E in camel milk (0.127±0.17 mg/L), followed by grazing farms (0.098±0.048 mg/L), and samples taken from semi-closed farms (0.068±0.045 mg/L). Camel milk had an average of 0.098±0.11 mg/L of vitamin E, with a range of 0.07 mg/L to 0.125 mg/L. The outcome was less than the results of some studies[17,20]. However, fresh camel milk has lower amounts of vitamin A and similar quantities of vitamin E to cows' milk[16]. Vitamin E is vital for the body because it can stop tissue damage brought on by free radicals, which stops or delays the onset of inflammation[32]. In addition, it was shown that tocotrienols, as a subclass of vitamin E, had potent neuroprotective, antioxidant, anticancer, and cholesterol-lowering characteristics[36]. Furthermore, vitamin E aids in the metabolism of glucose[37]. Regardless of the lower levels of vitamins A and E in camel milk, it is of value where camel pastoralists live in conditions of limited resources in subsistence production systems.

Most camels in Sudan are kept by migratory pastoralists in arid and semi-arid zones[3,7,30]. Also, the vitamin levels were affected significantly ($p < 0.05$) by the variations of the breeds, parity numbers, and the camel's lactation stages. The highest means of vitamins A, E, and C were recorded for the camels kept under the traditional nomadic system[16].

4. Conclusion

The current investigation showed that the management systems and parity orders could influence camel milk's vitamins A and E levels. She-camels raised in the grazing range management method were shown to have the greatest vitamin A concentration. The level of vitamin E was higher in she-camels milk that was reared in closed farms. Moreover, the overall vitamin E level was higher in second parity she-camel, and the overall vitamin A level was higher in third party she-camel. This study recommended that further studies be conducted to asses various factors associated with vitamin levels in camel milk.

Declarations

Competing interests

The authors declare that they have no conflict of interest or personal relationships that could have influenced the work done in this paper.

Authors' contributions

Miziana M. E. Mohamed designed the study and collected and analyzed the data, and Ibtisam E. M. El Zubeir supervised the work and prepared the manuscript. The final manuscript draft was reviewed by both authors, who approved it.

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Ethics approval and consent to participate

All authors ensured that ethical issues such as plagiarism, consent to publish, misconduct, fabricated and falsified data, dual publishing and submission, and redundancy were examined.

Availability of data and materials

The authors will provide all necessary data to the editor upon request.

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