Evaluation of the Factors Affecting the Variation of the Physicochemical Composition of Algerian Camel’s Raw Milk During Different Seasons

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ABSTRACT

The camel is of considerable socio-economic value in many arid and semi-arid areas of the world and its milk comprises a significant part of human dietary habits in these regions. Camel milk is just like the bovine milk in terms of its essential nutrients and since ancient times it is being used for curing a number of diseases. In order to determine the effect of some factors, as feeding and season on the physico-chemical composition of the milk, a total of twenty seven samples of raw camel’s milk were collected from Bechar in the south of Algeria during different seasons. Milk was analyzed for its chemical composition fat, dry, lactose, and ash and for its physical characteristics: pH, acidity and density. A survey was conducted before to determine factors influencing the variety of the milk composition. These analyses showed that collected milk presents a variety in its composition during the seasons namely: temperature, pH, acidity and density ranged from (38 to 38.7°C, 6.60 to 6.8, 16.28 to 18.3°D, 1.0227 to 1.0310) respectively. The values for fat matters, dry matters, lactose and ash were between (31.8 and 40.2, 98.4 and 119.05, 30.82 and 38.87, 7.2 and 8.6 g/L) respectively. Regarding seasonal variation, maximum level of fat, dry and ash was observed in sample 2 (winter) and sample 3 (spring) while the minimum in sample 4 at summer time thus as in sample 1 (autumn). For lactose, the maximum mean value was obtained in sample 4 (summer) and the minimum value in sample 2. The ash content was high in sample 2 (winter) then stable all over the year. The nutritional value of forage species that represent the only available food resource for the dromedary also varies during the season. The great variation in camel milk composition was attributed first to the feeding and season which are directly related.

INTRODUCTION

The Camel is a considerable socio-economic value in many arid and semi-arid areas of the world, it is used as beasts of burden by humans and also provide them with milk, meat, wool, [35], the camel milk comprises a significant part of human dietary habits in these areas. There are about 19 million camels in the world. The place of the Dromedary in the regional development of the Algerian Sahara is not negligible [10], according to Food and Agriculture Organization of the United Nations (FAO) statistics, the population of camels increased since 2000 until 2011 from 235.000 to 318.755 head, whereas there was not a good progress in camel milk production except in 2002.

However, the camel as the other herbivorous species needs a diet to maintain good health and enable it to express its genetic potential. They eat primarily thorny plants, dry grasses, saltbush and most anything that grows in the desert [31]. In Algeria, It should be noted that the camel system breeding practiced in the majority of cases is extensive type, based on the exploitation of desert pastures spontaneous [38]. The richness and floristic diversity varies according to the different types of courses constituting these areas [10].

Thus, camel provides humans with milk that has long been used to feed their calves and own consumption; it has not had much attention in research than bovine milk [16]. However recent studies have mainly focused on its nutritional composition, various physicochemical characteristics and functionality [21,33,38]. Camel milk was found to be different in some aspects than the milk of other animal species, such as bovine milk. (Omar A. Al haj, et al., 2010), it is much more nutritious than that from cow milk because it is low in fat and lactose contents, and higher in potassium, iron and vitamin C [22]. Fresh or fermented camel milk is valued for its anti-
infective, anti-cancer, diabetes and more generally as a restorative in convalescent patients [36]. Variations observed in camel milk composition were linked to several factors: stage of lactation, breed, and type of livestock, season...etc [21,5]. Like cattle, the camel feeding is the most critical factor [28,37,41].

The objective of this study was to evaluate the physicochemical parameters of camel milk and the different factors mainly feeding and season involved in the change of the quality and quantity of the component elements of the camel milk.

**MATERIALS AND METHODS**

**Study area:**
In steppe areas, it is difficult, if not impossible, to collect reliable figures. It is therefore necessary to involve observation or appropriate investigative methods.

In this context, the means used for the realization of this work were based on documentary research, an investigation in order to collect information about camel’s population and to know their way of life as well as the factors that may affect the milk composition.

Bechar region is located in the Western South of Algeria, It is characterized by a desert climate continental, very hot in summer (+45°C) and severely cold in winter (2°C to 3°C). Precipitation is about 60 mm/year. The territory of Bechar province consists of five major landforms: the mountains: they are bare and sometimes high, the beds of wadi(Six major rivers crisscross the area), the valleys (these are large rocky areas), the Regs: they represent dune massifs reaching up to 300 m in height [29].

**Dromedary feeding:**
The study of Chehma [10] revealed six different morphological zones representing the six dromedary courses of the Sahara (sandy soils, beds of wadi, depressions, Hamadas, Ergs and salty soils), that offer the only available food resource for the dromedary, and which cover 112 species divided into two categories: Ephemeral (88 species): still called "achebs", appear only after the rainy season and perform all of their growth cycle before the soil dries.

Permanents or vivacious (24 species): have the ability to survive in life slowed down for long periods and have mechanisms for storage and effective water. They are the only camel’s courses available even in summer. The table (1) shows some species recorded in these courses of the Sahara appreciated by camel.

**Table 1:** Species recorded in these courses of Bechar region in Algerian Sahara appreciated by camel.

<table>
<thead>
<tr>
<th>Family</th>
<th>Scientific name</th>
<th>Vernacular name</th>
<th>Course</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chenopodiaceae</td>
<td><em>Traganum nudatum</em></td>
<td>Damrane</td>
<td>Beds of wadi, Ergs, Hamadas</td>
<td>Evergreen shrub and halophyte. Dry or green eaten and appreciated by camels.</td>
</tr>
<tr>
<td>Ephedraceae</td>
<td><em>Ephedra alata</em></td>
<td>Alanda</td>
<td>Ergs, Beds of wadi</td>
<td>Very rich and very much appreciated by the camels.</td>
</tr>
<tr>
<td>Poaceae</td>
<td><em>Aristida pungens</em></td>
<td>Drinn</td>
<td>Sandy soils</td>
<td>Resistant to drought and an essential pasture for camels.</td>
</tr>
<tr>
<td>Brassicaceae</td>
<td><em>Savignya longistyla</em></td>
<td>Gougène</td>
<td>Beds of wadi, Depressions, Hamadas, Sandy soils, Ergs.</td>
<td>Annual plant very abundant in all the northern Sahara.</td>
</tr>
<tr>
<td>Rosaceae</td>
<td><em>Neurada procumbens</em></td>
<td>Saadane</td>
<td>Beds of wadi</td>
<td>For animals is one of the best pastures gives a good recovery of milk, it is very rich in water.</td>
</tr>
</tbody>
</table>

**Sampling:**
Twenty seven samples of raw camel’s milk were collected from Bechar in the south of Algeria. The same camels were milked during different seasons of the year in the early morning on October 2011, January 2012, May 2012 and August 2012 (Table 2). Milk samples (about 50 ml each) were collected in clean and sterilized sample bottles and brought to the laboratory of Applied Microbiology at Es-Senia university of Oran for acidity and density analysis, the other physicochemical parameters were performed in the Algerian Centre of Quality Control and Packing.

**Table 2:** Samples of camel milk collected.

<table>
<thead>
<tr>
<th>Number of sample</th>
<th>Collection period</th>
<th>Race</th>
<th>Quantity of sample</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>Autumn (October)</td>
<td>Ouled sidi cheikh</td>
<td>(5 simples)</td>
<td>between 5 years and 9 years</td>
</tr>
<tr>
<td>Sample 2</td>
<td>Winter (January)</td>
<td>Ouled sidi cheikh</td>
<td>(7 simples)</td>
<td>between 4 years and 19 years</td>
</tr>
<tr>
<td>Sample 3</td>
<td>Spring (May)</td>
<td>Ouled sidi cheikh</td>
<td>(10 simples)</td>
<td>between 5 years and 12 years</td>
</tr>
<tr>
<td>Sample 4</td>
<td>Summer (August)</td>
<td>Ouled sidi cheikh</td>
<td>(5 simples)</td>
<td>between 6 years and 14 years</td>
</tr>
</tbody>
</table>

**Physicochemical analysis:**
After milking, temperature and pH was measured immediately using electronic thermometer and pH meter (Hanna instrument) respectively.

The Dornic acidity was titrated with NaOH 1 N in the presence of phenolphthalein 1% and was expressed in a percentage of lactic acid [15]. Density was measured using a thermo-lactodensimeter which was reduced at 20°C.

Milk fat was determined by the butyrometric method and expressed in grams per 100 ml of milk. The milk proteins and carbohydrate were digested by sulfuric acid; isoamyl alcohol was added before the centrifuging in order to complete fat separation. The fat content was read directly on the butyrometer and an average value of the two determinations was calculated. (ISO 488: 1983)

The dry matter was measured, after desiccation by evaporation of 5 g milk deposited in a dried capsule in 103°C during 4h by [7].

Lactose content was determined by the method given in AOAC, [7]. 40 mL milk sample was taken in the beaker and heated to 65°C in water bath and then 5-8 drops of acetic acid were added and left for 5 minutes to precipitate proteins. The acid treated sample was then filtrated and the volume was made to 100 ml with distilled water. The filtrate was taken in burette and slowly added to conical flask containing 5mL of boiling Fehling’s A:[Copper sulphate solution:69.28g of CuSO4.5H2O was dissolved in 1 liter of distilled water] and Fehling’s B: [Alkaline tartarate solution: 346 g of Rochelle salt (potassium sodium tartrate) and 100 g NaOH was dissolved in 1 liter of distilled water] until the blue remained then 2 drops of methylene blue were added and titration was completed to brick red color end point.

The total lactose volume was multiplied with 0.064 factors for obtaining lactose quantity in the sample.

Lactose % = \frac{\text{dilution} \times \text{equivalent obtained from lactose}}{\text{vol of sample used for titration}} \times 100

Total ashes were measured, after incineration of 5 g milk deposited in a dry and tarred capsule, with the Moufle furnace in 500°C during 3h [7].

Results:

The table 3 and 4 describe the results of physicochemical analysis of camel’s milk samples of Bechar region which were collected during different periods.

**Table 3: Physical analysis of raw camel milk collected from Bechar region in different season.**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Average±SE (samples 1)</th>
<th>Average±SE (samples 2)</th>
<th>Average±SE (samples 3)</th>
<th>Average±SE (samples 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>38.2±0.18</td>
<td>38±0.29</td>
<td>38.3±0.32</td>
<td>38.7±0.15</td>
</tr>
<tr>
<td>pH</td>
<td>6.8±0.08</td>
<td>6.64±0.24</td>
<td>6.67±0.08</td>
<td>6.60±0.13</td>
</tr>
<tr>
<td>Dornic acidity (°D)</td>
<td>16.4±0.95</td>
<td>18.3±1.40</td>
<td>16.28±0.91</td>
<td>17.78±1.30</td>
</tr>
<tr>
<td>Density</td>
<td>1.0227±0.002</td>
<td>1.0252±0.002</td>
<td>1.0310±0.002</td>
<td>1.0220±0.001</td>
</tr>
</tbody>
</table>

**Table 4: Chemical analysis of raw camel milk collected from Bechar region in different season.**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Average±SE (samples 1)</th>
<th>Average±SE (samples 2)</th>
<th>Average±SE (samples 3)</th>
<th>Average±SE (samples 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatty matter (g/L)</td>
<td>32.5±3.10</td>
<td>40.2±1.54</td>
<td>35.7±1.73</td>
<td>31.8±2.11</td>
</tr>
<tr>
<td>Dry matter (g/L)</td>
<td>112.02±1.45</td>
<td>119.05±1.98</td>
<td>117.1±2.01</td>
<td>98.4±1.35</td>
</tr>
<tr>
<td>Lactose (g/L)</td>
<td>32.14±2.12</td>
<td>30.82±2.03</td>
<td>35.5±2.01</td>
<td>38.87±1.25</td>
</tr>
<tr>
<td>Ash (g/L)</td>
<td>7.4±0.064</td>
<td>8.6±0.27</td>
<td>7.6±0.3</td>
<td>7.2±0.25</td>
</tr>
</tbody>
</table>

From the investigation it was noted that the flock size was ranged between 95 to 110 herds, it is characterized by a predominance of female subjects. Camels belonged to Ouled sidi cheikh, the camel Aftouh, and Reguibi race. The extensive breeding system was practiced in this area. According to data collected, farmers practiced one to two daily milking. While the milk was intended primarily for calves, the surplus was reserved for own consumption. The camel milk was sold by breeders.

In the manufacturing of dairy products pH plays a significant role to determine the end product quality. Table 3 shows that pH of fresh camel milk varied from 6.6 to 6.8. The temperature values were ranged between 38 and 38.7 in all the milks.

The titratable acidity of camel milk is the measure of lactic acid formed in camel milk. The Dornic acidity ranged from 16.28 to 16.4(°D) in sample 3 and sample 1 while it was from 17.78 to 18.3(°D) in sample 4 and sample 2 respectively.

The values of the density of the samples were between 1.0220 and 1.0310, the greatest value was observed in the sample 3.

The table 4 reveals that fat contents in camel milk during seasons varied from 30.8 to 40.2 g/L, while the highest value were recorded in the sample 2 with 40.2 g/L.
The values for dry matter contents in Algerian camel milk varied from 98.4 to 112.02 g/L in sample 4 and sample 1, and from 117.05 to 119.05 g/L in sample 3 and sample 2 respectively.

Lactose contents in camel milk was high in sample 3 and sample 4 (35.5, 38.87 g/L), and low in sample 1 and sample 2 (32.14, 30.82 g/L) respectively.

The total amount of minerals is usually expressed as total ash; the table 4 demonstrates that this value ranged between 7.2 to 8.4 g/L. The highest value was recorded in the sample 2.

Discussion:

The results of physiochemical analysis of Algerian camel milk during the four seasons of the year show a variation in parameters and were linked to several factors:

Camel milk is Matt White, slightly salty taste this feature differs depending on the food and water availability [17]. The ingestion of some salt-tolerant plant makes it salty [15,17]. Compared with bovine milk, Dromedary camel milk fat contains smaller amounts of short chain fatty acids [1] and a lower content of carotene [39]. This lower carotene content could explain the whiter color of camel milk fat [1].

Fresh camel milk pH ranges from 6.5 to 6.7. The values of pH of camel milk were almost similar to that obtained by [22].

Based on the survey of Kamoun M, [20], the camel milk is characterized by a higher buffering capacity compared to cow's milk, which explains the absence of a direct relationship between pH and titrable acidity.

Camel milk samples analyzed have a titrable acidity near standards and similar to those given by several authors. In fact fresh camel milk is more acidic than cow's milk [5].

The variation of pH and acidity for the same source of milk could be due to differences in hygiene of the actual milking and the total microbial count of the milk [33].

The results obtained from analysis of the density were in the same as the survey reported on camel milk and (FAO, 1995). Density of camel milk depends directly on the dry matter content, strongly related to the frequency of watering that function by the season [38].

The fat content of the sample 2 and sample 3 appears similar to that reported by Alloui-lombarkia O, [4] and slightly higher in sample 1 and sample 4 compared to Melaia et al., [28].

Variations in fat contents depend on several factors; such as fat contents can be reduced from 4.3 to 1.1 percent on the milk of thirsty camels [24]. It is probably due to the stage of lactation, food. As set out in the race, the time of milking affects the fat content. Indeed, the morning milking gives a relatively poor milk fat compared to other milk, although quantitatively are most important [8].

The dry matter content was in line with those reported by Siboukeur, [28] and Gnan et al., with a slight variation.

In summer, the milk content of the water increases, however, the rate of dry matter decreases under the effect of water stress. The milk content of dry matter also varies depending on the stage of lactation [4]. Thus, it decreases during the month after calving and then increases due to higher fat contents and nitrogen (FAO, 1995).

Numerous studies have shown that the average rate of lactose can vary between 29 and 58 g/L. The results obtained within this range with a small variation between samples. The wide variation of lactose content could be due to the type of vegetation eaten in deserts areas [22]. Camels habitually prefer halophilic plants such as Atriplex, Salosa and Acacia to meet their physiological requirements of salts [42]. A dehydrated diet decreases the rate of lactose in the milk of camel; this variability is a specific milk of these animals [34].

The total amount of minerals is usually expressed as total ash; this value ranged between 0.60 to 0.90% in camel milk [24]. The ash content of samples was in the range of that reported by other authors as it is between 8.6 g/L and 7.26 g/L [4].

Variations in mineral content were proposed to be due to the differences in breeding, feeding, analytical procedures [28] and water intake. The ephemeral species eaten by camels such as Atriplex and Acacia are rich in ash, and these plants are abundant after the rain falls that usually lasted from late January to late April [26].

Conclusion:

The variability in milk yield is linked to various factors like stage of lactation, breed, and type of livestock, season...etc. Like cattle, the camel feeding and season are the most critical factors.

This survey showed that the spatio-temporal productivity of the Sahara course is very variable (ephemeral and the permanents species). The nutritional value of these species varies during the season; this variety influences the physicochemical quality of camel milk. However, further studies with larger number of samples must be performed for a better evaluation of the factors affecting this quality.

Despite the physicochemical properties and characteristics of Camel milk, it remains a relatively low consumed and little transformed product because it is not well valued by the citizen in general and farmers and inhabitants of the plateau and south in particular, it is fully used for breastfeeding of calves and self-consumption.
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