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PHYSICO-CHEMICAL ANALYSIS AND COMPOSITION OF CAMEL MILK

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Abstract

Unique composition and nutritional values of camel milk are well known from ancient times for its beneficial health effects. It is known for its substantial socio-economic significance in many arid and semi arid areas of the world and in these areas human as well as animal dietary necessities are satisfied from camel milk. Camel milk was taken from one-humped camels herd in Cholistan desert Bahawalpur on alternate days. Milk was well-preserved in air tight bottles and used for its further analysis in biochemistry and biotechnology laboratory. Milk composition was analyzed fat, protein, lactose, minerals, ash and total solids as well as for its physico-chemical characteristics of pH and acidity. The mean value for pH of camel milk was 6.63 and the percentage mean values for acidity, total solids, solid not fat, fat, lactose, ash, total protein, non protein nitrogen and non casein nitrogen were; 0.15, 10.9, 7.8, 3.2, 3.97, 0.75, 3.07, 0.191 and 0.747 respectively. Compositional analysis for fresh camel milk carried out for a period of nine weeks (on weekly basis). Camel milk is full of evenly balanced nutritional constituents and also displays a wide variety of biological actions that influence growth and development of particular body organs, metabolic responses towards nutrients absorption, digestion and fight against diseases.

***Key words**:* Physico-chemical, camel, composition, pH, analysis.

1. Introduction

In Pakistan 0.8 million heads of camels are reared in the desert areas mostly of Sindh province, Cholistan (Punjab) and hilly areas of Balochistan (Anonymous, 2002). These animals are utilized mainly for transportation and much less for meat and milk. Average milk yield of camel ranged 3.5 to 35.0 liter per animal per day with an average lactation yield of 4575 to 20675 liter (Sawaya *et al*., 1984). The major portion of this milk is used to feed their young ones, and rest of the milk is consumed by the owner as fresh or when just slightly soured or mixed with buffalo milk and sold to consumers in big cities.

Despite the large camel population in Pakistan, camel milk is not utilized to any significant extent probably due to unawareness of the use, and the market value of camel milk or because of its saltish taste and high acidic nature (Sawaya *et al*., 1984; Abu-Lehia, 1990; El-Bataway, 1991; Abu-Tarboush, 1996). However, it is much more nutritious than that from cow milk because it is low in fat contents and higher in potassium, iron and vitamin C (Anonymous, 1996).

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 areas. Camel milk is unique from other ruminant milk in terms of composition as well as functionality as it contains high concentration of immunoglobulins and insulin. It is high in vitamins (A, B-2, C and E) and minerals (sodium, potassium, iron, copper, zinc and magnesium) and low in protein, sugar and cholesterol (Kamal *et al*., 2007; Al-Hashem, 2009). Camel milk is full of evenly balanced nutritional constituents and also displays a wide variety of biological actions that influence growth and development of particular body organs, metabolic responses towards nutrients absorption, digestion and fight against diseases. These biological actions are chiefly due to the proteins and peptides in milk. Biologically active peptides are generated in the gastrointestinal tract by the digestive action on milk (Korhonen and Pihlanto, 2001). The positive health effects of milk proteins can be presented as antioxidative, anti-microbial, antihypertensive or immuno-modulatory and anti-thrombotic (FitzGerald and Meisel, 2000).

1.1 Nutritional value and physico-chemical properties of camel milk

In nutritional point of view, 14 cups (1 cup equivalent to 245 mL) of camel milk can meet the daily energy requirements (2,300 or 2,200 Kcal) of adult man or woman. Similarly, daily protein needs of a person can be met with 8 cups of camel milk. In case of minerals, such as calcium or phosphorus the minimum daily requirements are 800 mg which can easily be obtained by 2.5 and 4 cups of camel milk for calcium and phosphorus, respectively (Podrabsky, 1992). The value for acidity of camel milk is similar to cow milk between pH 6.5 and 6.75. The maximum buffering capacity of skim camel milk is at pH 4.95, compared to about pH 5.65 for skim cow milk (Al-Saleh and Hammad, 1992). Titratable acidity is between an equivalent of 0.13-0.16 percent lactic acid in fresh milk, which is slightly lower than the mean value of 0.17 percent for cow milk and seems to depend on the breed (Wangoh, 1997).

1.2 Compositional characteristics

1.2.1 Proteins

It is found that dromedary camel milk contains protein contents in range of 2.15 to 4.90 percent (Konuspayeva *et al*., 2009). Camel milk from same strain has similar protein content (whey proteins and caseins) and different for other genotypes (Elamin and Wilcox, 1992; Sawaya *et al*., 1984). Hamara and Wadha milk has less protein content as compared to Majaheim milk (Mehaia *et al*., 1995). With the change in season, protein content of same strain varied. It is found low in August (2.48 percent) and high in December (2.9 percent). Camel milk protein is classified into two main groups.

1.2.2 Caseins

Casein is a major part of protein in camel milk. Milk of Dromedary camel has 1.63 to 2.76 percent casein protein that constitutes 52 to 87 percent of total milk protein (Khaskheli *et al*., 2005). In whole casein portion, β-CN is 65 percent and α_{s1}-CN is 21 percent (Kappeler *et al*., 2003), Camel milk has more digestibility and less allergic reactions in infants as α_s-CN slowly hydrolyze than β-CN (El-Agamy *et al*., 2009). 3.47 percent k-casein is present in camel milk casein (Kappeler *et al*., 2003), while 13 percent is found in milk of bovine (Davies and Law, 1980).

1.2.3 Whey proteins

After the casein protein in camel milk, whey protein constitutes 20 to 25 percent that make it the second biggest fraction of protein. The milk of Dromedary camel has a whey protein in range of 0.63 and 0.80 percent (Khaskheli *et al*., 2005; Mehaia *et al*., 1995). Camel milk β-lactoglobulin is found in traces, while α-lactalbumin comprises the major camel milk portion. In the milk of bovines, α-lactalbumin constitute only 25 percent, while β-lactoglobulin made 50 percent of the total whey protein that make it the major whey protein of bovine milk (Kappeler *et al*., 2003; Laleye *et al*., 2008). Whey protein of camel milk consists of some other main components such as peptidoglycan recognition protein, immunoglobulins, lactoferrin and serum albumin (Kappeler *et al*., 2004; Merin *et al*., 2001).

1.2.4. Fats

It is reported that dromedary camel milk fat level varies from 1.2 to 6.4 percent and a constructive association between protein and fat contents of camel milk was observed (Haddadin *et al*., 2008). It was also revealed that fat contents can be reduced from 4.3 to 1.1 percent in the milk of thirsty camels (Konuspayeva *et al*., 2009). The lipid fraction in camel milk is characterized by a high proportion of long chain fatty acids, which accounts for 96.4 percent compared to 85.3 percent in bovine milk (Schlimme, 1990). It is reported that the cholesterol level of fat of camel milk (34.5 mg.100 g^{-1}) is higher as compared to cholesterol level (25.63 mg.100 g^{-1}) of bovine milk fat (Konuspayeva *et al*., 2008). Milk fat of dromedary camels carries a lower level of carotene and lesser concentrations of short chain fatty acids as compared to milk of bovine (Stahl *et al*., 2006).

1.2.5 Lactose

The dromedary camel milk lactose contents ranged between 2.40 to 5.80 percent (Konuspayeva *et al*., 2009). The nature of vegetation eaten by the camels in desert areas could be a significant factor for extensive variation in lactose contents. Camels generally like to take halophilic plants like Salosa, Acacia and Artiplex to fulfill

their physiological necessities of salts (Yagil, 1982). However, in some dromedary varieties of the world lactose contents found to be changed slightly over a period of time (Elamin and Wilcox, 1992; Yagil and Etzion, 1980).

1.2.6 Mineral contents

The total amount of minerals is generally presented as total ash and in case of dromedary camel milk this value ranged between 0.60 to 0.90 percent (Konuspayeva *et al*., 2009). Fluctuations in mineral level were proposed to be due to the differences in feeding, breed, water intake (Haddadin *et al*., 2008) and analytical procedures (Mehaia *et al*., 1995). The mean values for zinc, manganese, magnesium, iron, sodium, potassium and calcium in mineral contents of dromedary camel milk ($100g^{-1}$) are 0.53, 0.05, 10.5, 0.29, 59, 156 and 114 mg respectively (Elamin and Wilcox, 1992; Sawaya *et al*., 1984).

1.3 Vitamins

Numerous vitamins such as D, E, A, C and vitamins of B group are found in dromedary camel milk (Haddadin *et al*., 2008; Stahl *et al*., 2006). Rich amount of vitamin C is present in camel milk. It was revealed that camel milk contained three to five times more vitamin C as compare to bovine milk. The mean value of vitamin C concentration present in camel milk is 34.16 $mg.L^{-1}$. It was reported that camel milk contained higher concentration of niacin (B3) as compared to bovine milk (Farah and Atkins, 1992; Sawaya *et al*., 1984). According to USDA (2009), milk (250 mL) of dromedary camel nourish a normal adult by means of 10.5 percent of ascorbic acid (C), 5.25 percent of vitamin A, 8.25 percent of riboflavin (B2), 15.5 percent of cobalamin and pyridoxine and thiamin of the Recommended Daily Intake (RDI). In comparison, bovine milk (250mL) nourish a normal adult by means of 9 percent of vitamin A, 3.5 percent of ascorbic acid (C), 11.5 percent of pyridoxine (B6), 36 percent of riboflavin (B2) and 43.5 percent of cobalamin (B12) and thiamin of the RDI.

1.4 Bioactive native proteins

1.4.1 Immunoglobulins

Immunoglobulins are called as antibodies, which are present in human or animal blood serum or body fluids to build body's immunity in response to certain antigens e.g bacteria and virus. Immunoglobulins are high molecular weight polypeptide chains. Immunoglobulins are categorized into five classes: immunoglobulin A (IgA), immunoglobulin D (IgD), immunoglobulin E (IgE), immunoglobulin G (IgG) and immunoglobulin M (IgM). The concentration of immunoglobulins in milk fluctuates depending on several factors such as species, health status of animal and stage of lactation. Level of immunoglobulin G in camel milk is 1.64 $mg.mL^{-1}$ compared to 0.70, 0.67, 0.55, 0.63 and 0.86 $mg.mL^{-1}$ for goat, cow, sheep, buffalo and human milk respectively (El-Agamy and Nawar, 2000).

1.4.2 Lactoferrin

Lactoferrin is a glycoprotein and also known as lactotransferrin. It belongs to a class of transferrins. A familiar characteristic of this protein family is its ability to bind two metal cations (preferably $Fe\ 3^{+}$) to the binding sites that are structurally closely related. The majority of lactoferrin is needed for transportation or storage of iron. Lactoferrin was reported to act as iron scavenging in body secretions (Brock, 1997).). Lactoferrin contents of camel milk (0.22 $mg.mL^{-1}$) were significantly higher than goat, sheep, buffalo and cow milk (El-Agamy *et al*., 1997). Changes in lactoferrin level in normal camel milk and colostral camel milk showed that the lactoferrin concentration was maximum at first day and then reduced with milking (El-Agamy, 1994), which was just like the pattern discovered in

bovine milk (Korhonen, 1977). The research of El-Hatmi *et al*. (2007) revealed that highest level of lactoferrin (2.3 $g.L^{-1}$) was noticed after 2 days of parturition.

1.5 **Indigenous enzymes**

1.5.1 Lysozyme

Immunological research (El-Agamy *et al*., 1996) on camel milk lysozyme revealed that there is no antigenic resemblance between bovine and camel milk lysozyme, indicating alike structures. The level of lysozyme in milk differs extensively from 79 $mg.100\ mL^{-1}$ in mare milk (Jauregui-Adell, 1975) to 13 $\mu g.100\ mL^{-1}$ in buffalo milk (El-Agamy *et al*., 1998). According to different researches, camel milk contains 228 and 500 $\mu g.100\ mL^{-1}$ of lysozyme (Duhaiman, 1988; El-Agamy *et al*., 1998) compared to 13 (Korhonen, 1977) and 37 $\mu g.100\ mL^{-1}$ in cow milk (El-Agamy *et al*., 1996). The variations in the observed values were mainly due to the effect of lactation period.

1.5.2 Lactoperoxidase

Lactoperoxidase is present in tears, saliva and milk. It exerts bactericidal activity generally on Gram negative bacteria thus contributing to non immune host defense system. It is thought that the major function of lysozyme in milk is the protection of the udder against infections caused by microbes (Ueda *et al*., 1997). Lactoperoxidase is quite resistant to acidic and proteolytic digestion. Lactoperoxidase present in camel milk is a monomeric protein, which shows about 79.2 percent sequence likeness to human eosinophil peroxidase and 79.3 percent sequence likeness to human myeloperoxidase. Both eosinophil peroxidases and myeloperoxidase are dimeric proteins (Kappeler, 1998). Lactoperoxidase was extracted and purified from bovine and camel milk and their molecular weights were approximated at 88 and 78 kDa respectively (Yoshida and Ye, 1991).

2. Material and methods

2.1 Procurement of milk and pasteurization

Fresh raw bulk camel milk was collected from one-humped camels herd in cholistan desert Bahawalpur on alternate days in a cool airtight container. Milk was well-preserved in air tight bottles and used for its further analysis in biochemistry and biotechnology laboratory in the department of biochemistry and biotechnology, The Islamia university of Bahawalpur, Pakistan. Milk was pasteurized at 72 °C for 5 minutes (Hassan *et al*., 2007).

2.2 Physico-chemical analysis

Milk was studied for its physico-chemical analysis in Dairy laboratory of National Institute of Food Science and Technology, University of Agriculture, Faisalabad.

2.3 pH

The pH of milk was measured with digital pH meter (model No. wtw82362 Wellheim). 4 and 7 pH buffers were used for the calibration of pH meter. After calibration, 20 mL of milk was taken in a beaker and then electrode was immersed in the milk until constant reading attained (Ong *et al*., 2007).

2.4 Acidity

Acidity of milk was determined by titration method given in AOAC (2000). Acidity was determined by taking 10 mL of milk in 100 mL Erlenmeyer flask and after adding 2-3 drops of phenolphthalein, it was titrated against 0.1N NaOH until development of pink color. The percent acidity was calculated by following formula:

$$\text{Acidity (\%)} = \frac{0.009 \times \text{Vol. of NaOH used (mL)}}{\text{Wt. of Sample}} \times 100$$

2.5 Compositional analysis

Compositional analysis on raw camel milk was carried out in Dairy Laboratory of the department of biochemistry and biotechnology, The Islamia university of Bahawalpur, Pakistan.

2.6 Total solids

Total solids were determined by (AOAC, 2000), heating 5 mL sample in oven at 100 ºC for 3 hrs. Total solids were calculated by the formula:

$$\text{Total Solids (\%)} = \frac{\text{Wt. of residue after drying}}{\text{Wt. of Sample}} \times 100$$

2.7 Fat

Fat in milk was determined by the Gerber method (Marshall, 1993). 10.94mL of milk was taken in the butyrometer, 10 mL H_2SO_4 and 1 mL isoamyl alcohol was added to it and centrifuged at 1100 rpm for 5 minutes at 65 ºC.

2.8 Solids-not-fat

Solids not fat (SNF) content was determined by difference as reported by Harding (1995), using the following formula:

SNF content (%) = TS (%) – Fat (%)

2.9 Total protein

Total protein in the milk was determined by the international dairy federation method, IDF 20-1 (2001). Nitrogen from protein and other nitrogenous sources was converted into ammonium sulfate, and then ammonium is distilled in boric acid solution and titrated against known normality acid.

2.9.1 Reagents

- H_2SO_4

- Digestion tablet
- 4% boric acid solution
- Methyl indicator
- 40% NaOH
- NH_2SO_4

2.9.2 Procedure

Three gram of milk was weighed and poured in digestion tube along with a digestion tablet and 20 mL of concentrated H_2SO_4. Digestion was done initially by slow heating for 45 minutes to avoid frothing and then at 80 °C until appearance of clear or pale green color. The digested sample was allowed to cool for half an hour. Then 100 mL distilled water was added and mixed gradually and transferred to 250 mL volumetric flask, and then digestion flask was rinsed 2-3 times with distilled water and then volume was made up to 250 mL by adding distilled water.

2.9.3 Distillation

10 mL of digested sample and 10 mL of NaOH was distilled in micro Kjeldahal apparatus. The ammonia produce was trapped in 4% boric acid solution containing few drops of methyl red indicator. With the addition of ammonia, boric acid color changed from red to yellow. The distillation was continued for 2-3 minutes after first appearance of yellow color to catch maximum ammonia.

2.9.4 Titration

The content was titrated against 0.1 N H_2SO_4 solutions till pink color end point appeared. The volume of H_2SO_4 used was noted.

2.9.5 Calculation

Total nitrogen % was calculated with the formula mentioned below and this value was multiplied to get total protein.

$$\% \text{ Nitrogen} = \frac{\text{Vol. of H2SO4 used (mL)} \times 250 \times 0.0014}{\text{Vol. used for digestion} \times \text{Vol. of digested sample}} \times 100$$

Total protein % = % Nitrogen × 6.38

2.10 Non casein nitrogen (NCN)

NCN fractions were prepared and determined according to IDF standard (2001). Forty gram (by weight) of milk was taken in a beaker. Acetic acid was used to drop its pH to 4.1. Then milk was left for 10 minutes for complete dispersion. Sodium acetate solution was used to raise its pH up to 4.6. Then it was left for 5 minutes to stabilize pH and then final weight was taken. After that it was filtered with whattman filter paper No. 40. Then 10 mL of filtrate was digested in Kjeldhal digestion flask with 20 mL concentrated sulfuric acid and digestion tablets until clear solution was obtained. After making the dilution with distilled water, the solution was distilled by adding 40% NaOH in the solution and the produced gas was trapped in 10 mL of 4% boric acid. It was then titrated against 0.1N acid solution. Methyl red was used as an indicator. NCN content in milk was determined by multiplying %N with a

factor 6.25.

$$\% \text{ Nitrogen} = \frac{\text{Vol. of H2SO4 used (mL)} \times 250 \times 0.0014}{\text{Vol. used for digestion} \times \text{Vol. of digested sample}} \times 100$$

Non casein nitrogen % = % Nitrogen × 6.25

2.10 Non protein nitrogen (NPN)

Non protein nitrogen was analyzed according to IDF standard 20-4 (2001). Ten gram (by weight) of milk was taken in a beaker and it was coagulated with 40 mL of 15% tricholoroacetic acid (TCA) solution and final weight was noted. It was left for 15 minutes and filtered with whattman filter paper No. 42. Then 20 mL filtrate was digested in kjeldahl digestion flask with 20 mL of H_2SO_4 and digestion tablet until light green or clear solution obtained. After making dilution with distilled water, the solution was distilled by adding 40% NaOH solution and the ammonia gas produced was trapped in 10 mL of 4% boric acid solution. It was then titrated against 0.1 N H_2SO_4 solution using methyl red as indicator. Non protein nitrogen was calculated by following formula:

$$\% \text{ Nitrogen} = \frac{\text{Vol. of H2SO4 used (mL)} \times 250 \times 0.0014}{\text{Vol. used for digestion} \times \text{Vol. of digested sample}} \times 100$$

Non protein nitrogen % = % Nitrogen x 3.6

2.12 Ash

Ash content of milk was determined by the incinerations of dried sample in muffle furnace at 550 °C using method given in AOAC (2000).

$$\text{Ash } \% = \frac{\text{Wt. of ash}}{\text{Wt. of Sample}} \times 100$$

2.13 Lactose

Lactose content was determined by method given in AOAC (2000).

2.13.1 Reagents

- Copper sulphate solution (Fehling's A). 69.28g of CuSO4.5H2O was dissolved in 1 liter of distilled water and filtered through whattman filter paper No.4.
- Alkaline tartarate solution (Fehling's B). 346 g of Rochelle salt (potassium sodium tartrate) and 100 g NaOH was dissolved in 1 liter of distilled water.
- Methylene blue indicator

2.13.2 Procedure

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 and Fehling's B until the blue remained then 2 drops of methylene blue were added and titration was completed to brick red color end point.

2.13.3 Calculation

The total lactose volume was multiplied with 0.064 factor for obtaining lactose quantity in the sample. Lactose percentage was calculated by the formula given below.

$$\text{Lactose } \% = \frac{\text{dilution} \times \text{equivalent obtained from lactose}}{\text{Vol. of sample used for titration } \times 10} \times 100$$

3. Results and discussion

3.1 Physico-chemical analysis of camel milk

pH is the negative log of the hydrogen ion concentration and thus is a very crucial factor to determine the activity of enzymes, dissociation of acid and also the structural conformation of protein. The acidic and bitter taste is also caused due to the pH that is the non-dissociation of the acids. In the manufacturing of dairy products pH plays a significant role to determine the end product quality. Fresh camel milk pH is ranges from 6.5 to 6.7 (Khaskheli *et al*., 2005).

Table 4.1 shows that pH of fresh camel milk varied from 6.60 to 6.67. The grand mean value of pH was 6.63 with a standard deviation of 0.04. The titrateable acidity of camel milk is the measure of lactic acid formed in camel milk. Titratable acidity is between equivalents of 0.13-0.16% lactic acid in fresh camel milk (Wangoh, 1997). Table 4.1 shows that camel milk acidity varied from 0.13 to 0.17%, for a period of nine weeks. The grand mean value of acidity was 0.15% with a standard deviation of 0.007.

Table 1 Physico-chemical analysis of raw camel milk

Weeks	pH	Acidity %
1	6.61±0.03	0.16±0.008
2	6.63±0.04	0.15±0.007
3	6.61±0.04	0.16±0.009
4	6.66±0.06	0.14±0.008
5	6.62±0.03	0.16±0.007
6	6.67±0.06	0.13±0.005
7	6.6±0.04	0.17±0.008
8	6.63±0.04	0.15±0.007
9	6.61±0.03	0.16±0.008

Mean	6.63±0.03	0.15±0.007

3.2 Compositional analysis of camel milk

Fresh raw bulk camel milk was collected from one-humped camels herd in cholistan desert Bahawalpur on alternate days in a cool airtight container. Milk was well-preserved in air tight bottles and used for its further analysis in biochemistry and biotechnology laboratory in the department of biochemistry and biotechnology, The Islamia university of Bahawalpur, Pakistan. Compositional analysis for fresh camel milk carried out for a period of nine weeks (on weekly basis).

Table 2 demonstrates that mean values for total solid contents in camel milk varies from 9.8±0.59 to 11.9±0.71%. The variation in total solids of camel milk is mainly due to the changes in fat, lactose, minerals and protein content of camel milk. The grand mean value for total solids was 10.9±0.66%. Solid not fat is the portion of milk other than fat. SNF also varies when total solids in milk increased or decreased. Table 4.2 explains that solid not fat contents were found minimum in the 7th week (7.2±0.36%) and maximum in the first week (8.3±0.41%). The grand mean value for SNF was 7.8±0.39 %.

It is reported that dromedary camel milk fat level varies from 1.2 to 6.4 percent. Variations in fat contents depend on several factors, such as fat contents can be reduced from 4.3 to 1.1 percent in the milk of thirsty camels (Konuspayeva *et al*., 2009). Table 4.2 reveals that fat contents in camel milk varied from 2.6±0.08 to 3.7±0.11%, while the grand mean of 3.2±0.09% was recorded. The dromedary camel milk lactose contents ranged between 2.40 to 5.80 percent. The nature of vegetation eaten by the camels in deserts areas could be a significant factor for extensive variation in lactose contents (Konuspayeva *et al*., 2009). Lactose contents in camel milk was found highest (4.21±0.25%) in the first week of treatment and lowest (3.66±0.22%) in the 7th week of treatment. The grand mean value for fat content was 3.97±0.24%.

The total amount of minerals is generally presented as total ash and in case of dromedary camel milk this value ranged between 0.60 to 0.90 percent. Fluctuations in mineral level were proposed to be due to the differences in feeding, breed, water intake and analytical procedures (Haddadin *et al*., 2008). Table 4.2 illustrates that the mean values of ash contents in camel milk varied from 0.71±0.02 to 0.79±0.03% with a grand mean of 0.75±0.03%. Camel milk protein contents vary from 2.15 percent to 4.90 percent. Camel milk from same strain has similar protein content and different for other genotypes. With the change in season protein content of same strain varied, it is found low in August (2.48 percent) and high in December (2.9 percent) (Elamin and Wilcox, 1992). Table 4.2 depicts that highest level of total protein was observed during the first week (3.33±0.17%) and found lowest in the 7th week (2.81±0.14%). The grand mean of total protein was 3.07±0.15%.

The amount of non protein nitrogen varies with total protein. During a treatment of nine weeks, minimum level of NPN in camel milk protein was 0.141±0.004% while the maximum level remained 0.219±0.006% (Table 4.2). The grand mean for NPN was 0.191±0.006%. Non casein nitrogen constitutes for about 24 to 27 percent of total protein. Table 4.2 shows that concentration of NCN varied from 0.656±0.026 (minimum level) to 0.799±0.032% (maximum level). The grand mean value obtained for NCN was 0.747±0.030%.

All that data obtained reflects the picture of variations in different components of camel milk. It was observed that composition of camel milk depends on several factors such as water intake, feeding behavior of camels as well as the seasonal variations. At the beginning of the study the atmosphere was nearly moderate, that is why higher level of total solids, fats, proteins, minerals and lactose was recorded. After that atmosphere became warmer that brought fluctuation in almost all the parameters.

Table 2 Compositional analysis of raw camel milk (%)

Weeks	Total Solids	SNF	Fat	Lactose	Ash	Total Protein	NPN	NCN
1	11.5±0.69	8.3±0.41	3.2±0.09	4.21±0.25	0.74±0.02	3.33±0.17	0.219±0.006	0.799±0.032
2	11.2±0.67	8.1±0.40	3.1±0.09	4.13±0.25	0.79±0.03	3.16±0.16	0.211±0.006	0.758±0.030
3	10.5±0.63	7.7±0.38	2.8±0.08	3.93±0.24	0.73±0.02	3.01±0.15	0.181±0.005	0.752±0.030
4	11.3±0.68	7.9±0.39	3.4±0.10	4.02±0.24	0.76±0.03	3.09±0.15	0.154±0.004	0.772±0.031
5	11.9±0.71	8.2±0.41	3.7±0.11	4.07±0.24	0.79±0.03	3.31±0.17	0.221±0.007	0.794±0.032
6	11.4±0.68	7.9±0.39	3.5±0.10	4.05±0.24	0.72±0.02	3.09±0.15	0.207±0.006	0.803±0.032
7	9.8±0.59	7.2±0.36	2.6±0.08	3.66±0.22	0.71±0.02	2.81±0.14	0.141±0.004	0.674±0.027
8	10.3±0.62	7.4±0.37	2.9±0.09	3.81±0.23	0.72±0.02	2.85±0.14	0.188±0.006	0.656±0.026
9	10.9±0.65	7.6±0.38	3.3±0.09	3.85±0.23	0.76±0.03	2.98±0.15	0.199±0.006	0.715±0.029
Mean	10.9±0.66	7.8±0.39	3.2±0.09	3.97±0.24	0.75±0.03	3.07±0.15	0.191±0.006	0.747±0.030

NPN= Non protein nitrogen

NCN= Non casein nitrogen

4. Conclusion

Camel milk plays a significant role in human diet in arid countries and hot regions. It is just like the bovine milk in terms of its essential nutrients and since ancient times being used for curing a number of diseases. It is unique from other ruminant milk in terms of its composition as well as its functionality, as it contains high concentration of

immune globulins and insulin. Furthermore, it is high in vitamins (A, B-2, C and E) and minerals (sodium, potassium, iron, copper, zinc and magnesium) and low in protein, sugar and cholesterol. Vitamins present in camel milk have antioxidant activity and helpful in controlling tissue damage caused by harmful substances. Raw camel milk as well as its fermented goods are used as curative agents to manage constipation, diarrhea, stomach ulcers, wounds, liver disorders and to improve ovulation of female ovaries. It was observed that total solids, including fat and protein contents were vary greatly in camel milk. Moreover, camel milk is full of evenly balanced nutritional constituents and also displays a wide variety of biological actions that influence growth and development of particular body organs, metabolic responses towards nutrients absorption, digestion and fight against diseases. From industrial point of view, Lactoferrin is an appealing option for preservation and maintenance of food products and cosmetics, as it is very stable towards low pH environments and heat treatments. It allows maintaining a positive microflora, encourages development of bifido-bacteria and therefore, can be recommended for use in variety of products as a functional food. The anti-microbial peptides established by the digestion of lactoferrin are also potential applicants as additives for the preservation of food. Overall camel milk is beneficial with enriched nutrients that are good for health as well development of food industry.

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