Serum lipid, glucose, free fatty acids and liver triglyceride in sub-adult and adult camels (Camelus dromedarius)

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SUMMARY

The dromedary camel (Camelus dromedarius) is one of the most important ruminants in the desert area of Africa and Asia. Establishing biochemical reference intervals is important in evaluating health status and the purpose of this study was to determine reference values for serum biochemical parameters and liver triglyceride concentrations in dromedary. The distribution range of serum concentrations of triglycerides (TG; 0.41-0.55 mmol/L), cholesterol (TC; 0.01-1.2 mmol/L), phospholipids (PL; 0.16-0.18 mmol/L), glucose (GLC; 3.15-4.30 mmol/L), total protein (TOP; 1.23-9.34 g/L), free fatty acids (FFA; 0.3-0.45 mmol/L) albumin (Alb; 0.4-40.9 g/L), globulin (Glb; 0.4-60.3 g/L), Alb:Glb ratio (0.1-14) and liver TG (25.76-40.02 mg/g liver) were determined in samples from 93 camels of both sexes and different age groups. Serum concentrations of TG, PL, TOP, Alb, Glb, Alb:Glb did not show any significant difference among different age groups of both sexes. Moreover, adult camels showed higher liver TG compared to the sub-adult ones (P=0.003). Female camels showed higher values of glucose and liver TG compared to the male ones when comparison was done between combined age groups. These values may be used as a standard profile for healthy dromedary camel and be useful in evaluating metabolic diseases in the camel.

Keywords: Camel, serum, triglyceride, fatty acid, lipid.

Introduction

Alterations in concentrations of lipid and lipoprotein analytes in various physiological conditions have been described for different ruminants and laboratory animals such as cattle [1]; goats [2], guinea pig and rabbit [3] and horse [4] but there are few reports on serum biochemical parameters in one-humped camels (Camelus dromedarius) [5, 6]. The dromedary is native to the unfavorable conditions of rough mountain as well as dry and desert areas. They have unique adaptation to hot and arid environments. In Iran camels are found in the Eastern and North-Eastern desert regions.

We know relatively little of the range of variation in serum biochemical profiles within populations of camels and thus this information is of use in understanding the basic physiological patterns for this mammal. On the other hand, different response of blood glucose elimination, insulin response and the changes of NEFA in response to intravenous glucose load were shown among camels (Camelus dromedarius and crossbred of C.bactins and C. dromedarius) and some other domestic animals [7]. Moreover, animals of various species are widely used as models to study different diseases; hence a detailed knowledge of the biochemical pattern of animals is important [3]. Furthermore, such data may be useful in selecting suitable animal models.

Camel serum triglyceride (TG), total cholesterol (TC) and glucose (GLC) have been the subject of some investigations. Significant variations in TC, TG and total lipids were observed between different breeds of camels and animals [8]. The available knowledge in dromedary camels show that serum TG, TC and GLC concentrations show changes in the ranges of 0.3-0.9, 1.04-1.3 and 53-62, respectively [5, 9, 6]. Moreover, the lipoprotein profile in 1-humped camels differs substantially from that of other ruminants. In our previous study we showed different distribution of TG, TC and phospholipid (PL) concentrations in the major lipoprotein classes (LDL, VLDL, HDL) compared to the other ruminants [10]. There is close relation between excessive hepatic TG accumulation
results from disruption in the balance between import and export of precursors and metabolites of TG. Suggested mechanisms include increased flux of free fatty acids (FFA) to liver, increased de novo lipogenesis and decrease in clearance of TG through impairment in beta oxidation or VLDL assembly [11].

To our knowledge there have been no comprehensive studies addressing serum lipids, free fatty acid (FFA), total protein (TOP), GLC and liver TG concentrations in sub-adult and adult dromedaries. Establishing reference intervals for various blood analytes of *C. dromedarius* is important for evaluating the health status of camel for research purposes and for evaluating the effects of various environmental changes on the health of populations of camels in the wild. Therefore, the aim of the present study was to investigate these analytes among different age groups in both sexes and determine the reference intervals for these analytes.

**Materials and Methods**

Ninety three camels (*Camelus dromedarius*) of different age and sex groups of male sub-adult (≤5 years old; n=14), male adult (>5 years old; n=41), female sub-adult (≥4 years old; n=8) and female adult (>4 years old; n=30) living under similar conditions of management and diet were studied. These camels were privately owned and kept in the Sistan and Balochistan desert area at the eastern borders of Iran. Camels were reared in the desert area for the entire of year and for evaluating the effects of various environmental changes among different age groups in both sexes and determine the reference intervals for these analytes.

Serum samples were analyzed for TG concentrations using the glycerol-phosphate oxidase *p*-aminophenzone method, TC using the cholesterol oxidase *p*-aminophenzone method and for GLC by the glucose oxidase *p*-aminophenzone method.

TOP concentrations were measured based on the Biuret method, a formation of a violet complex between cupric ions and protein [14]. Albumin (Alb) values were determined by a dye binding technique between Alb and bromocresol green that results in a colored complex [15]. Globulin (Glb) values were calculated by difference. Alb: Glb ratios were determined by dividing Alb concentrations by Glb. FFA concentrations were determined by colorimetric microdetermination of FFA based on the estimation of copper in chloroform extract of their cupric salts with oxalic acid bis-(cyclohexyldiene-hydrazide) [16, 17]. Phospholipids (PL) concentrations were measured by the method of ROUSER et al [18].

All reagents was prepared by the Zist-Chimi Chemical Company (Tehran, Iran). To check the accuracy and precision of the assays, all samples were measured in duplicate and a serum control (Randox Laboratories, Ltd., Co-Antrim, United Kingdom) was assayed between each pair of samples. For each test, the spectrophotometer was calibrated by means of a corresponding blank.

Liver tissue were removed from the anterior lobe of the liver at the time of post mortem and transported in a plastic container to the laboratory. Specimens were transported on dry ice to the laboratory. Lipid in the liver tissue was extracted according to the Folch [19] method. Briefly, in a test tube, 1g of liver was weighed, frozen and powdered. Glass beads and 20 ml of chloroform: methanol (2:1) were then added to each test tube and shaken overnight. This mixture was then centrifuged at 1000 × g for 15 min and the supernatant was removed mixed with 4 ml of 0.9% NaCl solution and vigorously mixed for 1 min. After then, solution was centrifuged, the upper phase was discarded and the lower phase removed, dried and reconstituted in 1.5 mL of hexane: isopropanol (3:2) for lipid analysis. TG content was measured using the method of NERI and FRINGS [20].

We used the modified Harris-Boyd partitioning criteria for reporting reference interval values as mentioned by LAHTI et al [21]. Briefly, we determined the Z values of each subgroup of males, females, combined males and combined females according to the equation:

\[
Z = \frac{X_1 - X_2}{\sqrt{S_1^2 + S_2^2}}
\]

where \(X, S, N\) are the mean, the standard deviation and the size of subgroups, respectively. We used Z critical values of 3 and 5 (zCrit 3 = 3 (n/120)1/2 and zCrit 5 = 5 (n/120)1/2) as a decision threshold for partitioning. In this respect, we used the three stage classification procedure as follows:

1) \(Z < z\text{Crit}3\): partitioning is not recommended.
2) \(z\text{Crit}3 \leq Z \leq z\text{Crit}5\): decision on partitioning must be made using other than simple statistical considerations.
3) \(Z > z\text{Crit}5\): partitioning is recommended.

Non-parametric values for each analyte (Maximum, Minimum, Median) were reported in both sub-adult and adult camels. For reference interval construction, the combined values (males and females) of each analyte were checked to ascertain normality by means of Kolmogorov-Smirnov test using Sigma Stat Stat Program 4.01 for Windows. Reference intervals were reported as 95% range for those analytes which could be normal and 2.5 and 97.5 percentiles for those ones which could not be normalized. Difference in the concentrations of GLC, FFA and liver TG between sexes were tested using t-test (α<0.05).
Results

Serum concentrations of TG, TC, PL, TOP, Alb, Glb, Alb: Glb ratio, FFA, GLC and liver TG in different age-sex groups of *C. dromedarius* were tabulated (Table 1). There were no significant difference between sexes for TG, TC, PL, TP, Alb, Glb and Alb: Glb ratio. However, our results have revealed significant differences in the concentrations of FFA and GLC between sexes in the corresponding age groups. On the other hand, while GLC concentrations were lower in older vs. younger camels, the opposite findings were apparent with regard to changes in FFA concentrations.

Our findings on liver TG showed that female sub-adult camel have higher liver TG compared to the adult females. Moreover, female ones have higher values compared to the male ones.

Discussion

The TG concentrations in the present study were consistent with those reported in dromedary camels [22, 23, 24, 25] (Table 2). Meanwhile, our findings on TC levels in *C. dromedarius* were similar to those reported in dromedary camels [22, 23, 24, 25] (Table 2).

Serum TOP concentration was similar to values reported in dromedary camels [22, 26, 23], in both sexes of Majaheem camels, Maghateer camels and Awarik camels [27]. Moreover, reference interval for Alb concentrations were similar to those reported in dromedary [24,25,26], both sexes of the Majaheem camels, Maghateer camels and Awarik camels [27]. In this respect, Glb concentrations were similar to those reported in llama [28], Majaeheem camels, Maghateer camels and Awarik camels [27]. Our findings on the Alb: Glb ratios were lower than those reported in llama [28], Majaeheem camels, Maghateer camels and Awarik camels [27]. In contrast to the findings of Al-Busadah [18] we have not found high levels for Alb and Algb/Glb ratio. These differences may be due to the feeding. In this respect, GHOSAL *et al* [29] showed that change in the type of feeding will resulted in a decrease in the Alb: Glb ratio of the camels. In GHOSAL *et al* [29] study, camels changed from semi-desert pasture feeding to artificial feeding while at present study camels were fed as full-desert with limited access to the barley concentrate.

Our findings for serum TG, TC, GLC and TOP concentrations in *C. dromedarius* were in line with previous findings. In addition, we described a reference interval for serum biochemical analytes which complete the previous findings.

In spite of some reports about the effect of age on the serum lipid parameters in calves [30], humans [31] and dromedaries [6] no such effect was shown in the present study. A reason for these variations in serum analytes is likely to be seasonal effects as it has been shown that TG concentrations in cattle increase in the winter whereas those in humans decrease as in the horse [32]. Natural seasonal changes occur throughout the year and should be kept in mind when interpreting results [32]. However, additional verification of these results in the future studies is necessary to understand the effects of season on the serum analytes of the camel.

In the present study, GLC concentrations in all age groups were higher than those reported in llama (5.7-8.9 mmol/L).

**Table I :** Minimum, maximum, confidence intervals and median values for serum biochemical analytes of *Camelus dromedarius* (n=93) in different groups of male sub-adult (n=14), male adult (n=41), female sub-adult (n=8) and female adult (n=30), TC, total cholesterol; TG, triglyceride; PL, phospholipids; GLC, glucose; TP, total protein; FFA, free fatty acids; Alb, albumin; Glb, globulin; Alb: Glb, albumin to globulin ratio; CI, confidence interval.

![Table](https://example.com/table1.png)
However, it was lower than that reported by ALI et al [24]. A possible explanation is that increased GLC levels in camel species may be the result of stress-induced hyperglycemia because of their special bleeding status. In this respect, camels were exsanguinated through a cut in the external jugular vein. Such increased plasma glucose concentration has also been documented in some ruminants such as bighorn sheep (Ovis Canadensis) [33]. It has been discussed that camel has the ability to increase its blood glucose concentration during stress and dehydration by decreasing the renal glucose threshold. Under such conditions the glucose concentrations in the camel blood can go up to 72.15 mmol/L [34]. In ruminants and camelids blood glucose has to be generated nearly exclusively from gluconeogenesis. However, concentration of blood glucose differs markedly among them.

We have shown a sex effect on blood GLC and FFA concentrations. In this respect their FFA were higher than those reported in some ruminants such as cow (0.1-0.35 mmol/L) [7]. Our results show that the concentrations of plasma GLC and FFA were in an inverse fashion between male and female ones. Such condition may be due to blood insulin levels. In this respect, KASKE et al (2001) discussed that the release of FFA from adipose tissue is under the influence of insulin and blood glucose levels [35].

There is not any difference between sub-adult and adult males in triglyceride levels. However, we have shown significant difference between sub-adult and adult female camels. Furthermore, liver triglyceride values in the female camels were higher than the male ones. In this respect, HANSEN et al. discussed that in ruminants such as lambs fat deposition occurs earlier and faster in female lambs than in ram [36].

Our analyses revealed that whereas there were no significant differences between sexes in terms of TG, TC, PL, TOP, Alb, and Alb:Glub ratio, significant differences were seen in the levels of FFA and GLC between sexes in the corresponding age groups. While GLC changes showed a biphasic pattern with the higher values in the higher ages, FFA changes showed a linear age dependent increase. It seems that older camels are more dependent on FFA for energy supplying than GLC.

Differences in the concentrations of blood lipids and blood glucose have been found between various breeds of ruminants such as dairy cows, sheep and beef cows [3]. In beef cows and sheep higher concentrations of blood lipids (especially FFA) are found in breeds that gain weight more easily from a given ration [37,38]. In future investigations it will be necessary to follow the relation of rations and serum lipid states with weight gain in C. dromedarius.

Conclusion

Biochemical values in C. dromedarius were comparable to those in related species and may be used as a standard profile for healthy dromedaries.

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References
