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EFFECTS OF HYDRATION STATUS ON OSMOLALITY AND MINERALS PROFILE OF SERUM AND FORESTOMACH LIQUOR IN DROMEDARY CAMEL (*Camelus dromedarius*)

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ABSTRACT

This study aimed to monitor the changes in osmolality and concentrations of sodium and potassium ions of serum and forestomach liquor that accompany dehydration and rehydration in dromedary camels. The effects of 7 days dehydration and the following rehydration were examined. Seven days water deprivation significantly elevated PCV, serum osmolality, Na, K and aldosterone concentrations and forestomach liquor osmolality and Na concentration. On the second day of rehydration all tested parameters retained to the pre-dehydration level with the exception of serum aldosterone concentration which maintained at high level to prevent possible haemodilution. The results showed rapid recovery of camels after rehydration.

Key words: Blood composition, camel, forestomach liquor composition, hydration status

Camels are famous for their capacity to undergo prolonged periods (as long as 15 days) of water deprivation (Macfarlane *et al,* 1963; Kay and Maloiy, 1989). The ability of grazing animals to survive prolonged periods of water deprivation allow them to graze far from the watering site and to exploit the desert pasture evenly and efficiently (Brosh *et al,* 1986; Nicholson, 1987 and Amin *et al,* 2007a). The importance of this characteristic is that camels are most valuable to the economy in dry areas of tropical and subtropical regions. Beside the tolerance to water shortage in desert areas camel rearing might have the potential to become of crucial economical importance. In many cases, their role in supplying food to small farm-holders and to nomadic pastoralists is indispensable (Nicholson, 1987). The capacity for rapid rehydration in the camel was first described about 50 years ago and was interpreted as an important adaptation to life in the desert (Schmidt-Nielsen *et al,* 1956 and Schmidt-Nielsen, 1964). Camels were reported to drink 97 litre water and thereby replace their water deficit within a few minutes (Engelhardt *et al,* 2006). In other studies it had been estimated that at rehydration camels actually drink even more water than they have lost (Robertshaw and Zine-Filali, 1995). Camels can overcome a rapid absorption of a hypotonic fluid due to the resistance of erythrocytes to haemolysis (Perk, 1963; Yagil *et al,* 1974 and Etzion *et al,* 1984), (Al Qarawi and Mousa, 2004 and Amin *et al,* 2007b). On the other hand it had been reported that rumen may act as a protective osmotic mechanism (Hoppe *et al,* 1976; Chosniak and Shkolnik, 1977) or the hypotonic fluid may be recycled to the foregut by the hepato-salivary route (Silanikove 1989 and Silanikove, 1991). The data on camel with respect to the changes in the forestomach ecology that accompany dehydration and rehydration are scarce. Therefore, this study was designed to monitor the changes in osmolality and concentrations of sodium and potassium ions of serum and forestomach liquor that accompany dehydration and rehydration in dromedary camels.

Materials and Methods

Animals and samples collection

This study was carried out at Shambat (16° N) – Sudan during summer in May, 2009. The study was conducted on four clinically healthy (1-2 years old) one-humped camels (*Camelus dromedarius*) of different sex. Camels were offered hay *ad libitum* and

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Fig 1. Forestomach liquor collection.

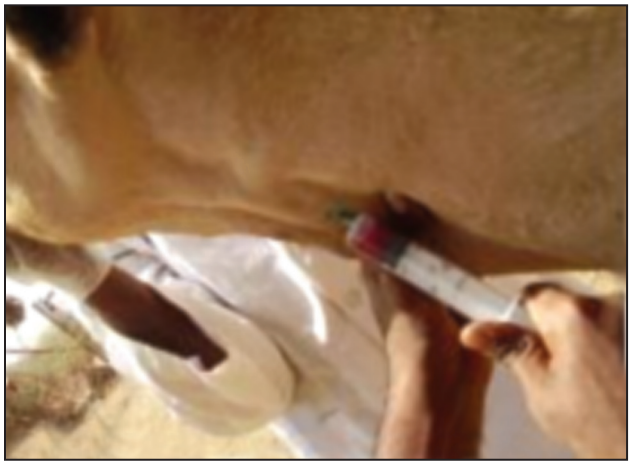

Fig 2. Collection of blood samples from jugular vein.

subjected to experimental water deprivation for one week. Forestomach liquor and blood samples were collected prior to water deprivation (day zero), after one week of water deprivation (dehydration), and on the second day of rehydration. Forestomach liquor samples were collected using stomach tube connected to special pump (Fig 1), while blood samples were collected using jugular vein puncture (Fig 2).

Laboratory analysis

The samples of the forestomach liquor were sieved and after that a 10 ml samples was centrifuged at 6000 rpm for 10 minutes. The blood samples were centrifuged at 3000 rpm for 10 minutes and the supernatant fluid (serum) was pipetted in clean vials. All samples were stored at -18°C for subsequent analysis. Packed cell volume (PCV) was determined using capillary tube and haematocrit centrifuge. Na and K concentrations in serum and forestomach liquor were determined using flame photometer (Jenway, England). The osmolality of serum and forestomach liquor samples were measured using Osmometer (Osmomat® 30; Gonotec, Germany). Serum aldosterone level was analysed by radioimmunoassay.

Statistical analysis

Statistical evaluations were carried out by means of SPSS program version 10.0 for Windows. Analysis of variance (ANOVA) test was used to evaluate the effects of hydration status on the measured parameters. In the case of a significant difference between groups, Dunnett's test was performed versus control (pre-dehydration values).

Results

Effect of hydration status on packed cell volume (PCV, %)

The packed cell volume was significantly ($p<0.05$) increased by 70% from 20±3.3% to 34±3.3% after one week dehydration and returned to the pre-dehydration level (20±0.7) on the second day of rehydration (Fig 3).

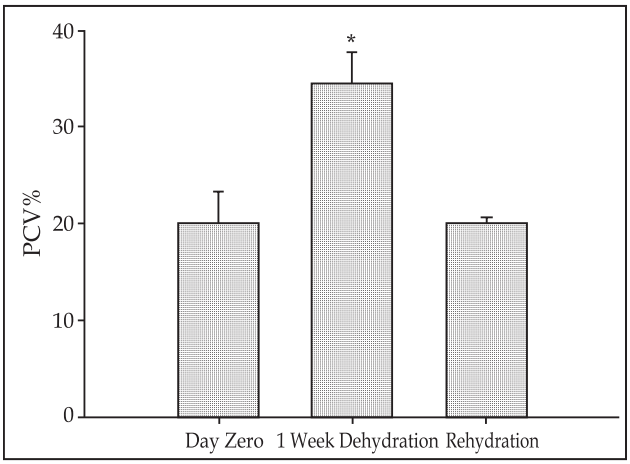

Fig 3. Effect of hydration status on packed cell volume (PCV) of dromedary camel [N = 4, *p<0.05].

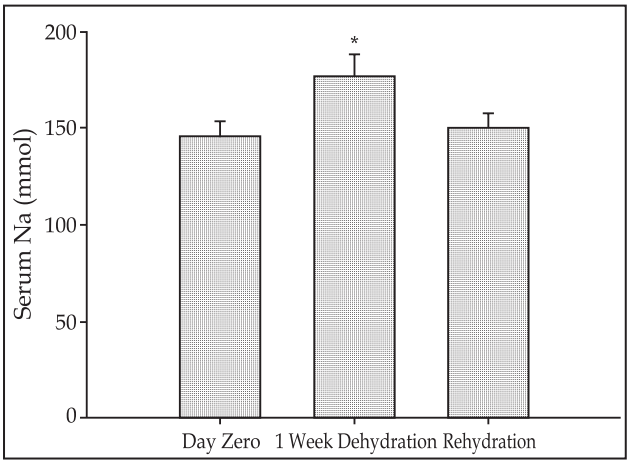

Fig 4. Effect of hydration status on serum Na concentration of dromedary camel [N = 4, *p<0.05].

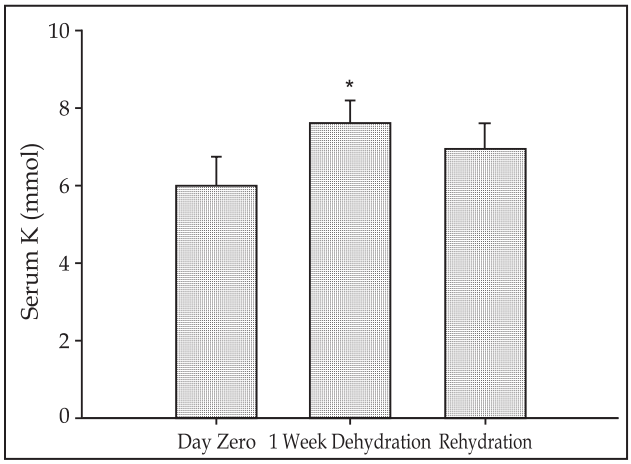

Fig 5. Effect of hydration status on serum K concentration of dromedary camel [N = 4, *p<0.05].

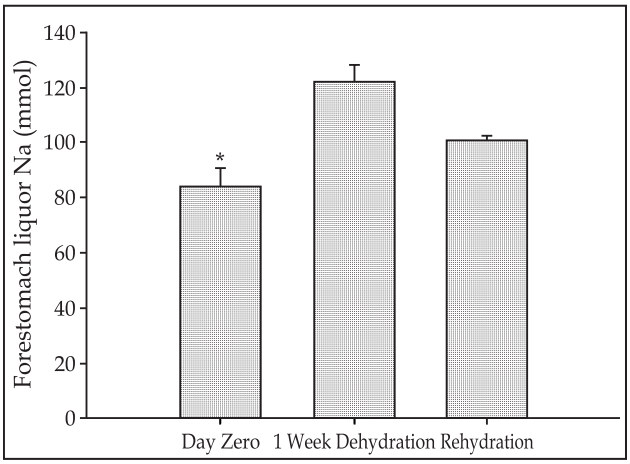

Fig 8. Effect of hydration status on Na concentration in the forestomach liquor of dromedary camel [N = 4, *p<0.05].

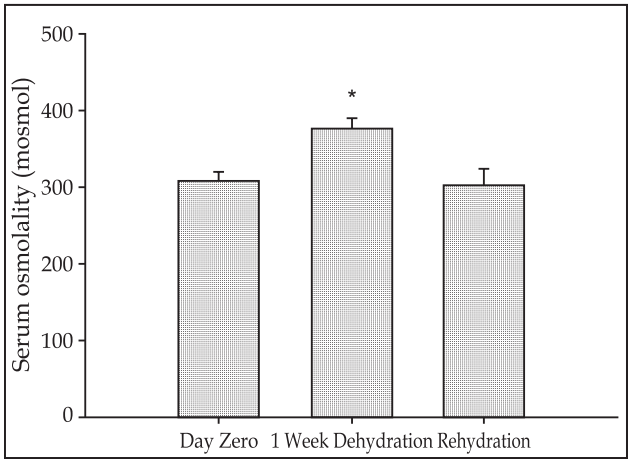

Fig 6. Effect of hydration status on serum osmolality of dromedary camel [N = 4, *p<0.05].

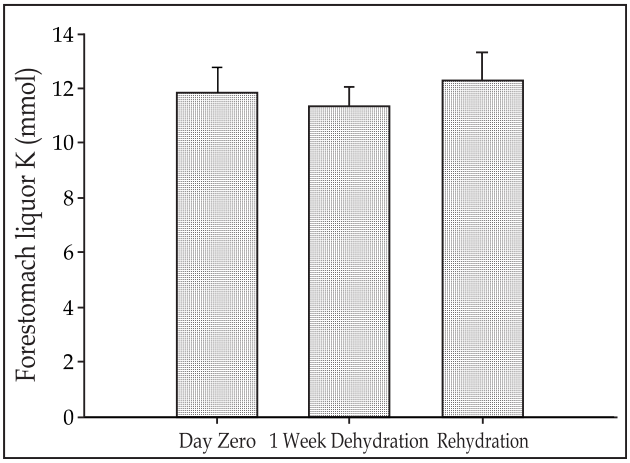

Fig 9. Effect of hydration status on K concentration in the forestomach liquor of dromedary camel [N = 4, *p<0.05].

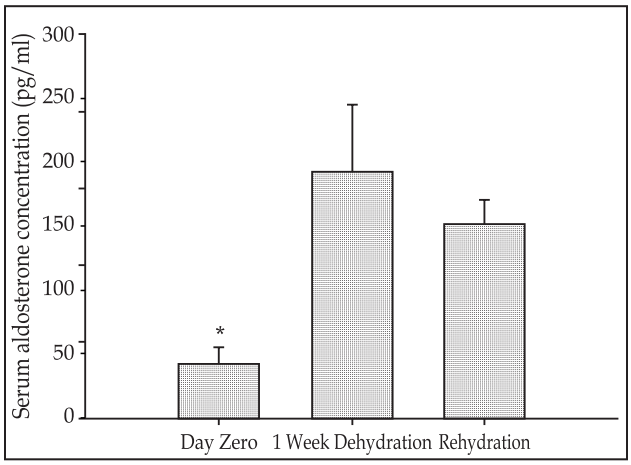

Fig 7. Effect of hydration status on serum aldosterone concentration of dromedary camel [N = 4, *p<0.05].

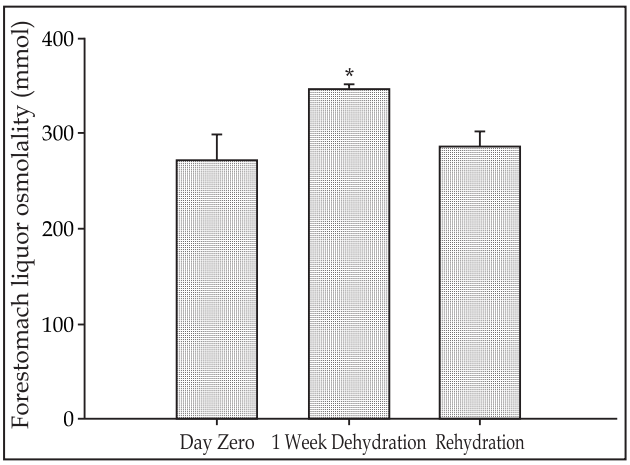

Fig 10. Effect of hydration status on forestomach liquor osmolality of dromedary camel [N = 4, *p<0.05].

Effect of hydration status on serum Na concentration (mmol/l)

Serum Na concentration was significantly ($p<0.05$) elevated by about 22% from 145±8.8 mmol/l to 176±11.3 mmol/l after one week of dehydration and returned to the pre-dehydration level (150±7.0) on the second day of rehydration (Fig 4).

Effect of hydration status on serum K concentration (mmol/l)

Serum K concentration was significantly ($p<0.05$) increased by 26% from 6.0±0.7 mmol/l to 7.6±0.6 mmol/l after one week of dehydration and decreased insignificantly by 9% to 6.9±0.7 on the second day of rehydration (Fig 5).

Effect of hydration status on serum osmolality (mosmol/l)

One week of water deprivation resulted in a significant ($p<0.05$) elevation of serum osmolality by 22% from 308±11.8 mosmol/l to 376±12.9 mosmol/l. Serum osmolality retained to the pre-dehydration level (301±21.9) after 48h of rehydration (Fig 6).

Effect of hydration status on serum aldosterone concentration (pg/ml)

Serum aldosterone level was significantly ($p<0.05$) increased approximately five folds after one week of water deprivation from 42.4±19.4 pg/ml to 191.8±52.3 pg/ml and remained at high level (151.3±19.4) after 48h of rehydration (Fig 7).

Effect of hydration status on forestomach liquor Na concentration (mmol/l)

Sodium (Na) concentration in the forestomach liquor was significantly ($p<0.05$) elevated by about 45% from 84±6.9 mmol/l to 122.3±5.8 mmol/l after one week of dehydration and reduced insignificantly by 22% to 100.8± 1.5 on the second day of rehydration (Fig 8).

Effect of hydration status on forestomach liquor K concentration (mmol/l)

Potassium (K) concentration in the forestomach liquor didn't show significant alteration due to dehydration (11.4±0.7 mmol/l) and rehydration (12.3±1.0 mmol/l) compared to the control level (11.8±0.9 mmol/l) (Fig 9).

Effect of hydration status on forestomach liquor osmolality (mosmol/l)

Water deprivation for one week resulted in a significant ($p<0.05$) elevation of rumen liquor osmolality from 272.3±26.7 mosmol/l to 346.8±4.7 mosmol/l After 48h of rehydration the osmolality of rumen liquor was returned to the pre-dehydration (287.0±14.7 mosmol/l) level (Fig 10).

Discussion

The general response of ruminants to dehydration and rehydration has been extensively reviewed (Silanikove, 1994). However, there is no information on changes in osmolality and mineral concentrations of the forestomach liquor during dehydration and rehydration. This study was designed to monitor the changes in osmolality and the concentration of sodium and potassium ions of forestomach liquor and serum that accompany dehydration and rehydration in dromedary camel. The observed increase in PCV during dehydration could be due to the shift of body fluids and the reduction of plasma volume as described in Merino sheep (Macfarlane *et al,* 1961) and in cattle (Weeth *et al,* 1967). Similarly, dehydration led to an increase of PCV in dehydrated young Arabian camels (Al-Haidary, 2005) and gazelle (Al-Toum and Al-Johany, 2000). The PCV returned to pre-dehydration level on the second day of rehydration indicting the ability of dromedary camel to recover from the adverse effects of dehydration in short time without any trouble consequences on body fluid balance due to rapid rehydration. This could be due to the persistent elevated aldosterone secretion observed on the second day of rehydration in this study and that reported in previous studies (Yagil and Etzion, 1979), thus preventing possible haemodilution.

One week dehydration resulted in an increase in serum Na concentration, which could be due to the observed haemoconcentration (elevated PCV) and elevated aldosterone concentration countered in this study and reported in previous studies (Macfarlane *et al,* 1961 and Yagil and Etzion, 1979). Similar results had been reported in dehydrated young Arabian camels (Al-Haidary, 2005) and gazelle (Al-Toum and Al-Johany, 2000). Serum Na concentration retained the pre-rehydration level on the second day of rehydration concomittent with the observed changes in PCV and osmolality.

Serum K concentration was increased during dehydration despite the elevated aldosterone concentration reflecting the pronounced effect of haemoconcentration observed in this study and previous studies (Al-Toum and Al-Johany, 2000) on K concentration. Moreover, dehydration has been reported to depress feed intake (Maloiya *et al,* 2008), thus resulting in muscular protein depletion (Singh *et al,* 1974) and the observed increase in serum K

concentration. On rehydration, serum K concentration decreased slightly and didnot reach the level of pre-dehydration. This clearly shows that the effect of dehydration on serum K concentration is secondary to the depression of feed intake caused by dehydration (Maloiya *et al,* 2008).

Dehydration for one week elevated serum osmolality parallel to the observed increase in serum Na and K concentrations. Similar results have been reported in dehydrated young Arabian camels (Al-Haidary, 2005), gazelle (Al-Toum and Al-Johany, 2000), Merino sheep (Macfarlane *et al,* 1961) and in sheep (Fuller *et al,* 2007). Serum osmolality retained to the pre-dehydration level on the second day of rehydration, which could be secondary to the observed reduction in serum Na concentration.

The observed increase in serum aldosterone level during dehydration could be due to the reduction in plasma volume (Weeth *et al,* 1967), reduced effective renal plasma flow (ERPF) and glomerular filtration rate (Yagil and Berlyne, 1978) and possible stimulation of renal renin secretion. Serum aldosterone level remained elevated until the second day of rehydration possibly to counteract the expected haemodilution (Yagil and Etzion, 1979).

The observed increase in forestomach liquor Na concentration during dehydration could be attributed to Na loading effect caused by water uptake from the forestomach (Lechner-Doll *et al,* 1994) and the high level of Na rich salivary secretion (Silanikove and Tadmor, 1989). Na concentration in the forestomach liquor approached the pre-dehydration level on the second day of rehydration. In earlier study, following first huge water intake water is rapidly absorbed from the forestomach, and the control forestomach fluid volume was reached again at the third day of rehydration (Engelhardt *et al,* 2006).

Water deprivation for one week had elevated the forestomach liquor osmolality. This could be attributed to the observed increase in forestomach liquor Na concentration and the reported water loss from the forestomach during dehydaration (Lechner-Doll *et al,* 1994 and Silanikove and Tadmor, 1989). Forestomach liquor osmolality retained to pre-dehydration level parallel to Na concentration on the second day of rehydration. Similar results have been reported in goats (Brosh *et al,* 1983).

Conclusion

One week water deprivation in one-humped camel resulted in significant changes in serum and forestomach liquor Na, K and osmolality. The observed changes enable camels to withstand dehydration without serious changes in the function of forestomach and systemic fluid homeostasis. This explains the rapid recovery of camels following rehydration.

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