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***Research Article***

# INVESTIGATING THE EFFECT OF WATER DEPRIVATION ON MILK COMPOSITION AND BLOOD PARAMETERS OF CAMEL

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## ABSTRACT
Camel is known as a valuable and adapted to heat and drought climate with a remarkable ability to cope with the drought. It is involved in production of livestock products, especially milk in hot and dry areas. Therefore, the present study is conducted to investigate the effects of water deprivation on camels' milk composition and biochemical characteristics of its blood by using four lactating camels in two squares format, ("control" Latin, with four cases and four replications (4 of 4). The treatments included camels having access to water for 2 hours (case1) every day, (case 2) a day in between (case 3) four days in between and (case 4) six days in between. This experiment was conducted in 4 phases of 12 days in rotational form and 15 days were considered as adjustment period between each phase (to prepare camels for main experiment period). The diet of camels was constant throughout the experiment. In each period of 12 days (main experiment period), two times milk samples (in the middle and at the end of the period) and one time blood sample (at the end of the period) were taken and camels' weight, water intake, dry matter intake, milk composition (total solids, fat and protein) and blood biochemical characteristics (number of red blood cells, white blood cells, hemoglobin, hematocrit, and glucose) were measured. Due to the 6-day water deprivation, camels' weight decreased about 10% ($P < 0.01$). The amount of dry matter intake significantly decreased in the fourth group compared to the other groups ($P<0.05$). The amount of water intake in the first, second, third and fourth group respectively were 24. 02, 61. 54, 70.08, and 76. 04 liters that the difference between them was significant ($P < 0.01$). Also, a significant difference was observed between the fourth groups and the first group (control) in terms of the amount of solid matter in milk ($P<0.05$). But, in terms of blood biochemical characteristics, no significant difference was observed between groups ($P>0.05$). The results of this study showed that in general, water deprivation led to the weight reduction in camel's body that after drinking water compensated to a great extent. On the other hand, two and four days water deprivation had no adverse effect on dry matter intake, milk composition, and blood biochemical characteristics of camels while 6 days water deprivation decreased dry matter intake, total solid matter, and the amount of milk.

***Keywords:*** *Camel, Water Deprivation, Milk Composition, Blood Parameters*

***Abbreviations:*** *PT = personality trait; CM = conceptual metaphor; FDI = field dependence/ independence; EX/IN = extroversion/introversion; MS = metaphoric schema; GEFT= Group Embedded Figures Test; EPQ-R = Eysenck Personality Questionnaire-Revised Short Scale; CMEP = Conceptual Metaphor Elicitation Prompt; MC = metaphoric category; FD=field dependents; FI = field independents; N = neutrals; EX = extroverts; IN = introverts.*

## INTRODUCTION
The population of dromedary and camel in 1988 is reported about 18.5 million people in which 16.5 million were dromedary camel that are mainly scattered in tropical and subtropical dry areas (Ben *et al.*, 1993; FAO, 1993; Bekel, 2004). The camel population is about 149,600 people in Iran that Hormozgan province with 15,000 camels is allocated the third place to oneself (The Ministry of Livestock Department, 2005). Among domestic ruminants, dromedary camel is a species that, due to behavioral and physiological adaptations, can survive in extreme heat despite facing with water shortages (Yagil, 1982; Wilson, 1984). One of the most valuable and important products for people living in the dry and hot areas

is milk. Several factors influence the camel milk composition and production rate such as nutrition, lactation stage, breed and water quality and quantity and among them (due to the camel's biodiverse areas where water availability is limited) access to water is one of the most influential factors (Elagamy, 2000; FAO, 1993; Wilson, 1989). Etzion (1980) have reported that when camels are deprived of water for a week, the amount of water of milk increase from 86% to 91% and milk is diluted. Ahmad (1990) reported that the milk solids of camels that do not have access to sufficient water in summer are reduced. The red blood cell of mammalian is spherical shaped with concave sides, with the exception of the camel family that all members of this family have elliptical-shaped red blood cell, but like other mammals, are without nuclei (Azwai *et al.*, 2007; Goniakowska-Witalinska and Witalinski, 1976). Hemoglobin of red blood cells of camel has a greater number of amino acids with polar side chains compared to mammalian species like human, cows, sheep, goat, pig, cat, dog, horse, rabbit and monkey. Therefore, camel's hemoglobin has higher hydrophilicity property. It seems that high resistance to water loss in these animals is due to the existence of such hemoglobin in their red blood cells (Bekel, 2004). Some researchers have reported that the number of lymphocyte, Eosinophils and also blood hemoglobin concentration are increased in camels that live in dry regions and are facing to water shortages compared to the camels that have access to sufficient water (Kataria and Kataria, 2004). Generally, it seems that the blood glucose level in female camels is higher than the male camels and also camels' blood glucose level decreases in the dry season compared to the wet season that the green forages are abundant (Wilson, 1984). It is also reported that glucose level, hematocrit and blood hemoglobin of camels increase due to the water deprivation (Ben *et al.*, 1993; Wilson, 1984). Therefore, considering that most camels live in dry and insufficient water regions that accessibility to sufficient water (especially in hot and dry seasons) is limited and yet a study about the impact of limited access to water on production rate, milk composition and blood factors has not been conducted on camels of Iran country and external resources are limited. This study aimed to investigate the effects of water deprivation on camel milk composition and blood parameters.

## MATERIALS AND METHODS

This study was conducted in Sarkhoon Animal Research Station the Agriculture and Natural Resources Research Center of Hormozgan Province located in 35 kilometers of north east of Bandar Abbas during the February of 2006 to May of 2007, in the minimum temperature of 23 and maximum 32° C. Before entering camels into the project implementation place, four separate boxes were designed by using wire mesh and in each division proper manger and watering was constructed and location was completely cleaned and disinfected. Four lactating camels along with their babies with 8 to 12 years and a mean weight of 362 kilograms were selected from a herd located in the central part of Bandar Abbas. Each mother camel with her own baby is settled in a box. The birth time of camels was very close to each other (all 4 camels gave childbirth within 10 days). About 25 days were considered as adaptation period for camels' compatibility with the situation, diet and manger and watering place. The experimental treatments were randomly applied on camels by using lottery from the middle of adaptation period (from the $10^{th}$ to the $25^{th}$ day of adaptation period) to prepare camels with the original experiment. The main experiment began after adaptation period. Each experiment period was 12 days which was conducted rotationally and 15 days (adaptation period) were considered between each major period. The cases consisted of the first case (control): when camel drank water every day (C1). The second case: when camel drank water after 2 days deprivation (of water) (C2). The third case: when camel drank water after 4 days deprivation (of water) (C3). The fourth case: when camels drank water after 4 days deprivation (of water) (C4). In each of the above cases, water was given to camels in specified time (4 to 6 pm) only for 2 hours. The amount of water intake were poured in watering to each value that camel drinks by using a 20-liter module of water with specific weight of water and at the end of 2 hours, the remaining water in watering was collected and weighed and recorded. It should be noted that in order to prevent error, the baby camel was prevented to drink water within 2 hours of water drinking of mother camel. The twelve four-day schedule of water deprivation is as follows:

**Table 1: Twelve four-day schedule of water deprivation (C1, C2, C3, C4 are cases)**

| 4 | 3 | 2 | 1 | Camel no. / Stage |
|---|---|---|---|---|
| $C_1$ | $C_2$ | $C_3$ | $C_4$ | **1** |
| $C_2$ | $C_1$ | $C_4$ | $C_3$ | **2** |
| $C_4$ | $C_3$ | $C_2$ | $C_1$ | **3** |
| $C_3$ | $C_4$ | $C_1$ | $C_2$ | **4** |

As it is clear from the above table, in the first phase of experiment, the fourth case (6 days of water deprivation $C_4$) on Camel number 1, the third case (4 days of water deprivation C3) on a camel number 2, the second case (2 days of water deprivation $C_2$) was applied on camel number 3 and camel number 4 was placed in the control group that drank water every day (first case C1). Camels were placed in the above cases approximately for 15 days (as adaptation period) and after this time period, the camels were individually weighed (initial weight). Then, camels entered into the main period of the experiment (for 12 days) with recording and the sampling and at the end of the 12 days period, the camels were weighed again (final weight). Then, based on the map of the second phase of the table, cases were rotated and adaptation period of 15 days and then the main period of experiment were implemented to the new conditions. This rotation method was performed during the four-phase based on the presented map in Table 1 (until the end of the experiment).

The diet of camels was constant and every day 4. 06 kg hay and 6. 24 kg concentrate was given to each camel. The amount of daily food intake was measured for each camel throughout the study. In this experiment,10.300 kg feed was considered for each camel that they were fed twice a day in4 and 8 pm. Remnants of food were collected, weighed and recorded in the next morning before feeding. Also, at the beginning and end of each main experiment period, camels were weighed individually before feeding and drinking water. During each main experiment period, camels' milk was milked every morning and after weighing the obtained records was registered. In this phase, before drinking water the milk sample was taken for 2 times (in the middle and at the end of the period) and each time 200 ml milk was milked that was sent to laboratory to determine the amount of solids, fat and protein. Chemical analysis of milk samples was performed by using an ultrasonic milk analyzers machine (Ekomik-M, Milk Analyzer). At the end of each major period of experiment, before drinking water 5 cc blood was drawn from the jugular vein of camels. This blood sample immediately was divided into two parts, 2 cc of blood was kept in the laboratory bottle with anticoagulant for complete blood count (CBC) to count these cells and to determine the amount of the hemoglobin poured and in order to mix anticoagulant with the blood sample, the contents of the bottle were gently shaken. The rest of the blood (approximately 3 cc) was poured into the test tube to determine the amount of blood glucose and allowed to clot. Finally, the number of red and white blood cells and the amount of blood hemoglobin were determined in the laboratory by using Cell Counter Micros 60.The COBAS MIRA S machine was used to determine the glucose of coagulated blood plasma. The project of study was conducted during four stages in the form of Latin square (4 × 4) with four cases (four periods of water deprivation) and four replications (four camels). Data analysis was done by using SAS statistical software and one-way ANOVA test and the comparison between means was performed through Duncan test. The statistical modeling project is as follows:

j= 1, 2, 3, 4 water deprivation periods
i= 1, 2, 3, 4water deprivation periods of each row
i′=1, 2, 3, 4water deprivation periods of each column
$Y_{iij}$: The amount of each observation
μ: mean
$\delta_i$: The effect of $i^{th}$ repetition from $j^{th}$ water deprivation time of each row
$\delta_{i'}$: The effect of $i^{th}$ repetition from $j^{th}$ water deprivation time of each column
$T_j$: The effect of $j^{th}$ water deprivation time
$e_{iij}$: The effect of test error.

## RESULTS

### *Weight, the Amount of Water Intake, Dry Matter Intake*

Camels' weight significantly decreased about 10%after 6 days of water deprivation ($p< 0.01$). The amount of water intake in water-deprived groups showed significant differences ($p< 0.01$). Due to the 6 days water deprivation, the amount of water intake increased from 24. 02 liters in the control group to 76. 04 liters in the fourth group (Table 2). Due to the 6-day water deprivation, the amount of dry matter intake reduced from 10 kg per day (control group) to 6. 67 kg per day (fourth group) ($p<0.05$).

**Table 2: The initial and final weights, water intake, dry matter intake in the different experimental groups (cases)**

| Group/measured features | C1 | C2 | C3 | C4 | Standard error of measurement | Result |
|---|---|---|---|---|---|---|
| Initial weight (Kg. ) | $^{a}$416/55 | $^{a}$419/60 | $^{b}$402/28 | $^{c}$389/05 | 19/20 | ** |
| Final weight (Kg. ) | $^{a}$+0/80 | $^{b}$415/05 | $^{c}$394/23 | $^{d}$375/45 | 23/26 | ** |
| Weight change to first weight% | $^{a}$+0/80 | $^{b}$-0/37 | $^{c}$-5/36 | $^{d}$-9/87 | 0/16 | ** |
| Consumed water (Lit) | $^{b}$24/02 | $^{a}$61/54 | $^{a}$70/08 | $^{a}$76/04 | 23/38 | ** |
| Raw consumed materials (Kg.) | $^{a}$10 | $^{a}$9/66 | $^{ab}$8/11 | $^{b}$6/67 | 1/ 68 | * |

** = significant difference at the 5% level, ** = significant difference at 1% level*

### *Camels' Milk Composition*

The chemical analysis of the camel's milk composition and the amount of taken milk in Table 3 shows significant difference between the amount of solid matter of camels' milk indifferent groups of water deprivation ($P <0.05$). For this purpose, the solid matter of milk in the control group was 13. 37%, which due to the 6-day water deprivation reduced to 11. 88%. The amount of camels' milk fat and protein in the different groups did not show significant difference ($P>0.05$). The amount of the milk's water was increased gradually from first case to the fourth case. The significant difference was observed between the fourth group and first group (control) about the amount of taken milk ($P <0.05$). The amount of taken milk decreased with prolonged water deprivation, in a way that in fourth group reached to lowest level.

**Table 3: Camels' milk composition in the four water deprivation groups**

| Group/measured features | C1 | C2 | C3 | C4 | Standard error of measurement | Result |
|---|---|---|---|---|---|---|
| Raw materials (%) | $^{a}$13/37 | $^{ab}$12/84 | $^{ab}$12/45 | $^{b}$11/88 | 0/35 | * |
| Fat (%) | 3/18 | 2/75 | 2/67 | 2/55 | 0/22 | NS |
| Protein (%) | 3/82 | 3/77 | 3/68 | 3/60 | 0/13 | NS |
| Milk water (%) | $^{b}$86/63 | $^{ab}$87/17 | $^{ab}$87/55 | $^{a}$88/12 | 0/37 | * |
| Expressed milk (g.) | $^{a}$880 | $^{ab}$640 | $^{ab}$620 | $^{b}$530 | 0/09 | * |

*NS = no significant difference * = significant difference at the 5% level*

### *Camel's Blood Factors*

Results obtained from camel's blood factors (red cells, white cells, hemoglobin, hematocrit, glucose) are presented in Table 4. As seen in the table, the number of red and white blood cells, hemoglobin, hematocrit, and glucose did not show significant difference in different groups.

**Table 4: Biochemical characteristics of camels' blood in different experimental groups**

| Group/Blood biochemical features | C1 | C2 | C3 | C4 | Standard error of measurement | Result |
|---|---|---|---|---|---|---|
| RBC | $5/24\times10^{6}$ | $5/5\times 10^{6}$ | $5/8\times10^{6a}$ | $6/18\times10^{6}$ | 0/4 | NS |
| WBC | $13/25\times10^{3}$ | $13/15\times10^{3}$ | $13/05\times10^{3}$ | $12/53\times10^{3}$ | 1/43 | NS |
| Hemoglobin | 9/35 | 9/85 | 10/53 | 11/03 | 0/83 | NS |
| Hematocrit | 20/6 | 21/6 | 23/63 | 24/38 | 1/87 | NS |
| Glucose | 110 | 90/75 | 85/75 | 105/5 | 13/68 | NS |

*1. NS = not significant difference 2. Red and white blood cell (number per cubic millimeter of blood), hemoglobin (gram per deciliter of blood), hematocrit (percentage) - glucose (mg per deciliter of blood)*

## DISCUSSION

The 2-day water deprivation led camels to drink considerable amount of water when accessed to water compared to the control group (first) while such a significant difference was not observed between the 2-day water deprivation and 4-day and 6-day water deprivation (Table 2). It seems that the limited access time to water (2 hours) and the finite volume of digestive system do not allow the camels to drink more water. As reported in this regard, those camels that were deprived of water for 14 days, when water was given to them for 12-hour time period, in the first few minutes drank 80-70 liters of water and in the rest time, only drank the average amount of waterabout19-21 liters (Bekel, 2004).

The 6-day water deprivation led camels' feed to reduce significantly. This reduction in feed intake in thirsty and deprived of water camels have been reported by other researchers but its amount differs based on the duration of water deprivation, temperature of environment and type of feed (dry or wet) (Von *et al.*, 2006; Kurtu, 2004; Cianci*et al.*, 2004; Bekel, 2004). Some researchers believe that the feed intake reduction during the water deprivation period is because of the reduced salivary secretions and reduced amount of water in the gastrointestinal tract of camel (Wardah, 1992).

As can be seen in Table 2, the initial weight of camels, the weight that was recorded in the beginning of the main period of experiment, showed significant difference among different water deprivation groups ($P<0.01$),which is due to the rotation method of experiment. Thus, a camel that at a phase of the experiment was placed in the control group and drank water every day, when in the next phase of experiment was placed, for example, in the second group (the second case was applied on a camel), was faced with losing weight because before the beginning of the main experiment period, 15-day adaptation period was applied on camel in which the weight of camel decreased due to the 2-daywater deprivation. As, in the next phase of experiment, the fourth case was applied, the weight reduction caused by the new stage of adaptation period added to the weight reduction resulting from the previous step of experiment and led to the further reduction of initial weight in the fourth group. On the other hand, when this camel in the next stage was placed in the third experimental group (third case), spent shorter water deprivation periods than the previous stage (6 days of water deprivation) and was faced to less weight reduction and even partially experienced weight gain. This process is applied to every four camels in four stages of experiment. Thus, the initial weight of camels in the second, third and fourth stage of experiment influenced by the experiment implementation of the previous stage (the main period along with the adaption period),so that when camels from the control group (first group) and shorter periods of water deprivation reached to the prolonged periods of water deprivation (the third and fourth group) had weight loss and vice versa when the camels from prolonged periods of water deprivation went to the control group or shorter period of water deprivation had less weight loss and even slightly experienced overweight. As seen in Table 2, the initial weight of second group increased compared to the control group which is due to the adequate water and feed intake in the previous group (control). Because these camels lived in the dry desert that had insufficient feed and water to provide all the nutritional requirements of them before entering into the study and also due to the greater mobility and passing large distances for grazing in pastures, the energy consumption was higher in them. But, after transporting them into the plan, implementing site reduced mobility, attention to health issue and adequate supply of water and feed caused camels of control group had weight gain that this after rotation increase of camels caused the initial weight of the second group were also higher. Final weight of camels, the weight was recorded at the end of the original experiment, showed significant difference in different experimental groups ($p<0.01$). For this purpose, the final weight of camels significantly reduced from the first group to fourth. Its main reason is due to the effect of water deprivation so that, whatever water deprivation time is prolonged, the ultimate weight loss of camels has also increased. Also, water-deprived camels (for 6 days) lost about 10 percent of their weight that the major weight loss is related to dehydration. Because these water-deprived camels (for 6 days) once their experiment period finished and were placed in first group (according to the rotating schedule plan were placed in the control group or a group that drank water every day), gained back most of their lost weight in the initial adaption period days. This indicates that body weight of camel was reduced during the water deprivation period, so that, after accessing to water,

the lost weight can be compensated. The amount of weight reduction differs in terms of water deprivation duration, environmental temperature and type of feed intake. Some sources have reported the one-third weight reduction of body (Bekel, 2004; Farah, 1993; Wilson, 1984; Yagil and Etzion, 1980).

***Camels' Milk Composition***

Among the camels' milk compositions, the largest changes have been related to the milk solids and water in such a way that after six days of water deprivation, the amount of milk solids decreased and water of milk has significantly increased compared to the control group. In other words, it can be concluded that water-deprived camels' milk is diluted. This feature is considered as an advantage for the camels. Because camels often live in hot and dry areas and in such regions (especially in the hot months of the year), the access to sufficient quality water is very limited for camels. So, the diluted camel milk in case of insufficient water can provide enough water for the baby camel and it is considered as an adjustment with the warm and low water environment. Camels' milk dilution in the low water cases has been reported by other researchers. Ahmad (1990) pointed out that camel's milk is diluted in the middle of hot summer that the water accessibility has reduced for lactating camels. Also, Yagil and Etzion (1980) stated that, when water is not adequately available for camels, their milk is diluted or in other words, the milk solids decrease and considered this dilution of camels' milk in the warm months when animals are faced with water scarcity as an excellent adaptation for living in the desert environment. Researchers justify the camels' milk dilution in the case of water scarcity in this way that the mammary glands of camel have the same embryonic origin with its sweat glands (Strauss, 1974). When camels encounter to the water shortages, the ADH hormone secretion has increased. The secretion of this hormone in thirsty camel lead to the water removing into the sweat glands and due to the same embryonic origin of sweat glands and mammary glands, water is excreted inside the milk, consequently, the milk solids are decreased and diluted milk is produced (Yagil, 1982).

With regard to the camel's milk fat and protein, any significant difference was not observed in different groups of water deprivation (Table 3). The camel milk fat and protein changes process showed a slight decrease in water deprivation groups. In fact, water deprivation for 6 days had no significant effect on the rate of these two camel milk compositions. While the significant effect of the water deprivation on them have been reported by some researchers, it seems that it is probably due to the different conditions prevailing in different periods of water deprivation test, nutritional status, race, season, stage of lactation which was sampled and the sampling and analysis methods (Ahmad, 1990; FAO, 1993; Mohamed, 1993).

The amount of taken milk significantly decreased due to the 6 days of water deprivation (Table 3). It is reported that a week deprivation from early spring to late summer decreases the milk production and also the lactation length in camels (Yagil and Etzion, 1980). Also, Bekel (2004) stated that the amount of camels milk production that were deprived of water for 16 days is reduced from 2. 17 (in normal conditions) to 1. 24 kg (in water deprivation time), that is higher than the amount of taken milk in this study. The main reason is that, in the present study, camel milk was milked only once a day and after weighing were recorded as the milked milk and the amount of milk ingested by baby camel is not included in the calculations of milk production. However, the lactation rate of camel varies according to the race, species, individual characteristics of animal, living environment, diet, lactation times and lactation period and other factors such as laboratory procedures, etc (Alshaikh and Salah, 1994, Wilson, 1989).

***Camels' Blood Factors***

The significant difference was not observed about the number of red and white blood cells, hemoglobin, hematocrit, and blood glucose in different groups of water deprivation (Table 4). In fact, the 2 days, 4 days and 6 days of water deprivation had no significant impact on the studied blood factors.

***Conclusion***

The results of this study showed that generally water deprivation reduces body weight of camel and the longer the period of deprivation, the more weight is reduced that immediately can be compensated to a large extent after drinking water. However, water deprivation for 2 and 4 days had no adverse effects on

dry matter intake, milk composition and blood biochemical characteristics of camels. While the 6 days of water deprivation decreased the dry matter intake which probably is due to the water loss of the gastrointestinal tract. Also, the total milk solids decrease due to the water deprivation for 6 days, due to the increased anti-diuretic hormone resulting in the entry of water into the mammary gland and milk dilution. Also, this deprivation period leads to the reduction of the amount of taken milk.

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**REFERENCES**

**Ahmad MM (1990).** The analysis and quality of camel milk. Index of Thesis Accepted for Riger Degrees by The Universities of Great Britain and Ireland and The Council for National Academic Awards 38:3.

**Alshaikh MA and Salah MS (1994).** Effect of milking interval on secretion rate and composition of camel milk in late lactation. *Journal of Dairy Research* **61**(4) 451-515.

**Azwai SM, Abdouslam OE, AL-Bassam LS, AL-Dawek AM and AL-Izzi SAL (2007).** Morphological characteristics of blood cells in clinically normal adult Llamas (Lama glama). *Veterinarski Arhiv* **77**(1) 69-79.

**Bekel T (2004).** The effect of water deprivation on milk production of camels (camelusdromedaries). *Journal of Animal and Food Sciences* **13**(suppl. 1) 456-462.

**Bekel T, Zelek M and Baars RMT (2004).** Milk production performance of the one humped camel (camelus dromedaries) under pastoral management in semi-arid eastern Ethiopia. *Livestock Production Science* **76** 37-44.

**Ben Goumi M, Rtad F, Givy J, Delafarge F, Safwate A, Davico MJ and Barlet JP (1993).** Hormonal control of water and sodium in plasma and urine of camels during dehydration and rehydration. *General and Comparative Endocrinology* **89** 378-386.

**Bogner P, Csutora P, Cameron IL, Wheatlley DN and Miseta A (1998).** Agumented water binding and low cellular water content in Erytrocytes of camels and camelids. *Biophysical Journal* **75** 3085-3091.

**Cianci D, Goio L, Hashi AM, Pastorrelli S, Kamoun M, Liponi GB and Orlandi M (2004).** Feed Intake and Digestibility in Camels Fed Wheat Staw and Meadow Hay. *Journal of Camel Science* **1** 52-56.

**Elagamy EIE (2000).** Effect of heat treatment on camel milk proteins with respect to antimicrobial factors : A comparison with cow milk and buffalo milk protehns. *Food Chemistry* **68** 227-232.

**FAO (1993).** Production Yearbook, *Food and Agricultural Organization of United Nation* 42.

**Farah Z (1993).** Composition and characteristics of camel milk. *Journal of Dairy Research* **60** 603-626.

**Goniakowska-Witalinska L and Witalinski W (1976).** Evidence for a correlation between the numberof marginal band microtubules and the size of vertebrate erytrocytes. *Journal of Cell Science* **22** 397-401.

**Kataria N and Kataria AK (2004).** Use of blood analytes in assessment of stress due to drought in camel. *Journal of Camel Practice and Research* **11**(2) 129-133.

**Kurtu MY (2004).** An assessment of the productivity rormeat and carcass yield ofcamels (camelus dromedaries) and of the consumption of camel meat in the eastern region of Ethiopia. *Tropical Animal Health and Production* **36**(1) 65-76.

**Mohamed MA (1993).** Camel (Camelus dromedarius) milk: chemical composition and traditional preservation methods. In: *The Multi-Purpose Camel: Interdisciplinary Studies on Pastoralism Production in Somalia*, edited by Ornäs AH (Environmental Policy and Society, Uppsala, Sweden) 177-185.

**Strauss JS (1974).** The sebaceause glands. *The New England Journal of Medicine* **291** 46-47.
**The Ministry of Livestock Department (2005).** The estimation of livestock population separated by the type of livestock and province in 2005.
**Von Englehardt W, Haarmeyer P and Lechner-Doll M (2006).** Feed intake, forestomach fluid volume, dilution rate and mean fluid in the forestomach during water deprivation and rehydration camels (Camelus Sp.). *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* **143**(4) 504-7.
**Wardah MF (1992).** Camel nutrition and grazing behavior Arab Center for Studies of Arid zones and Dry lands (ACSAO), 113-123.
**Wilson RT (1984).** *The Camel* (Longman. London) 69-78.
**Wilson RT (1989).** *Ecophisiology of the Camel-Idea and Desert Ruminants* (Springer-Verlag, Berlin) 1-14.
**Yagil R (1982).** Camels and camel milk. *FAO Animal Production and Health Paper* 26:69.
**Yagil R and Etzion Z (1980).** Effect of drought condition the quality of camel milk. *Journal of Dairy Research* **74**(2) 159-166.
**Zine-Fillali R and Shaw R (2004).** Water balance in the camel (camelus dromedaries). *GrassRoots: Journal of Camel Science* **1** 66-70.