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EFFECT OF FEED AND WATER DEPRIVATION ON NUTRIENTS DIGESTIBILITY, BEHAVIORAL AND METABOLIC PATTERNS OF ONE HUMPED CAMEL (Camelus dromedarius)

(With 10 Tables and 3 Figures)

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تأثير الحرمان من الغذاء والماء على معدل هضم العناصر الغذائية والنمط السلوكى والبنائى للجمال وحيدة السنام

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تـم إجراء هذه التجربة على عدد ٥ من الجمال وحيدة السنام والتي كان متوسط أعمارها ٦ سنوات وأوزانها حوالى ٥٥٠ كيلوجرام. سكنت هذه الحيوانات تحت الظروف البيئية السائدة فـي حظائـر منفصلة بالمزرعة التجريبية الخاصة بكلية الطب البيطري بجامعة أسيوط. تم تغذية هذه الحيوانات على عليقة مكونة من مخلوط مركزات الأعلاف والتبن والبرسيم لمدة ٧ أيـام كفـترة ضـابطة مع تقديم الماء لها بصورة مستمرة طوال هذه الفترة. تلت هذه الفترة الفـترات التجريبية حيث تم حرمان الحيوانات من الغذاء والماء معا لمدة يوم ويومين وثلاث أيـام على التوالي وكانت كل فترة تجريبية من هذه الفترات يتبعها فترة مدتها ٤ أيام يتم فيها إعادة تقديم الماء والغذاء للحيوانات مع مراعاة تنظيف الأرضية بطريقة منتظمة طوال فترة الـتجربة وذلـك لمنع الحيوانات من أكل الروث أثناء فترات الحرمان من الغذاء والماء. تم تحديد المتوسط اليومى للكمية التى تناولها الحيوان من الماء والغذاء مع تقدير التغيرات التى طرأت على متوسط وزن الجسم. تم فحص الجمال المستخدمة في التجربة أثناء اليوم الأخير مـن الفـترة الضابطة وفترات الحرمان من الغذاء والماء وكذلك فترات إعادة التغذية وذلك لتحديد حالتها الصحية مع أخذ عينات من دم هذه الحيوانات وذلك لتقدير نسب بعض مكونات الـدم ومسـتوى هرمون الكورتيزول بها. كذلك تم تحديد وتقدير التغيرات التى طرأت على المعامل الهضمى لمختلف العناصر الغذائية نتيجة هذه المعاملات. تم تسجيل سلوكيات تناول هـذه الحيوانات للغذاء والماء مع ملاحظة التغيرات التي طرأت على هذه السلوكيات. أثبتت النتائج التي تم الحصول عليها أن إطالة مدة الحرمان من الغذاء والماء معا تعتبر من العوامل الضاغطة والتي تنعكس بطريقة سلبية واضحة على الحالة الصحية ونماذج الهضم والسلوك والبناء في الجمال وحيدة السنام مع وجود تأثير معنوى على متوسط الاستهلاك اليومى من الغذاء والماء وكذلك متوسط وزن الجسم مع ارتفاع معنوي لمستوى هرمون الكورتيزول بدم

هذه الحيوانات. وقد أوصت النتائج بملاحظة أي نقص مستمر في الماء والغذاء المقدم للجمال مع التصحيح الفوري لهذا النقص.

SUMMARY

Five of one humped camels of about 6 years in age and 550 kg in weight were used in this investigation. Animals appeared to be clinically healthy and parasitological examination revealed no gastrointestinal affections. The five animals forming one group, were used in four trials alternating in intentionally testing sequence. Trial one was used as control and animals were fed for seven days on the control diet. Trial one followed by three trials of successive periods of feed and water deprivation (trials 2, 3, and 4). Each period of deprivation was interrupted by a phase of 4 days refeeding. During feeding period, all animals were fed as group on commercial concentrate mixture (1.5 kg/head/day), barseem and wheat straw adlibitum. In addition, additives were added daily to the concentrate mixture at a level of 0.14 kg/head/day. Animals were cleaned out periodically to prevent them from eating their dung. On the last day of all the trials, experimented camels were examined clinically to determine their health status. Dry matter and water intake as well as changes in the body weight were recorded. Changes in the digestibility of different nutrients after different periods of deprivation were also estimated. Moreover, blood serum was analyzed for some biochemical parameters. Ingestive behavior of the experimented camels was recorded within the first hour on the last day of the control and the first day of refeeding periods. The obtained results revealed that, prolonged deprivation of food and water appears as a stress factor on camels with a clear and obvious effect on their health status, nutrients digestibility, water intake, body weight, some behavioral and biochemical parameters. This suggests that any prolonged water and food deficit among housed camels must be corrected.

Key words: *Food, water, deprivation, digestibility, behavior, metabolism, camel*

INTRODUCTION

Under traditional production system in arid and semi-arid zones, animal growth is retarded during adolescent age, especially during the dry season, however, animals grow rapidly for variable periods of time when sufficient feeds are available. This compensatory growth may be due to the fact that animals previously underfed consume more feed during the period of realimintation than do previously unrestricted animals of the same weight receiving identical diets, and to lower requriments of metabolizable energy for maintenance responding to lower body weight at the beginning of the refeeding period (Wardeh, 1998).

Animals living in the desert exhibit high levels of adaptation to the stressful conditions in which they live. Unlike some other species, camel exhibits an extreme tolerance to heat and lack of drinking water (Schmidt-Nielsen, 1964). The dromedary camel survives in very high air temperature despite the lack of drinking water as a result of physiological and behavioral adaptation (Yagil, 1985 and Wilson, 1989). Through evolution, camels have specially adapted to arid environments and developed especial physiological mechanisms to face heat stress, dehydration and shortage of nutrients. Over a period of 2-3 weeks without drinking water, camels lose body water in an amount exceeding a third of their body weight without suffering ill effects (MacFarlane *et al.,* 1971; Hassan, 1971; Schmidt-Nielsen, 1964; Yagil *et al.,* 1974a and Yagil, 1985). However, dehydrated camels can quench their thirst by drinking about 20-30% of their body weight and restore their initial weight within few hours (Schmidt-Nielsen *et al.,* 1967 and Huda, 2001). Moreover, camels are known for their lower basal metabolism and their maintenance energy requirements represent about two thirds of the requirements of cattle (Guerouali *et al.,* 1994). At the same time, camels are able to maintain fermentation to meet some of the nutrients required for fasting metabolism through fermentation products. They are able to develop digestive metabolic adjustments in order to suffer less from fast (Guerouali *et al.,* 1997).

The camel is a better-adapted animal to arid zone conditions than other animals. Nevertheless, there are many important questions still unanswered with respect to its nutrition and management. Among these is the magnitude of tolerance of camels to water deprivation and feed starvation. These two conditions are prevailing at least seasonally in arid and semi-arid range lands where the camel is known to survive, produce and reproduce. As camel feeding system in arid zones is based on grazing of large areas with little vegitation and they may go through periods of fasting for few days in search of new grazing areas, the aim of the present study was to investigate the digestive, metabolic and behavioral adjustments developed by the camel to face these periods of deprivation.

MATERIALS and METHODS

I- Animals, feeding and management:

Five of one humped camels of about 6 years in age and 550 kg in weight were used in this investigation. Animals appeared to be clinically healthy and parasitological examination revealed no gastrointestinal affections. The five animals, forming one group, were used in four trials alternating in intentionally testing sequence. Along all the trials, normal feeding practice of the farm was followed. All animals were given commercial concentrate mixture (1.5 kg/head/day), barseem and wheat straw adlibitum. In trials 2,3 and 4, the animals were deprived food and water for one, two and three days successive periods. Each period of deprivation was interrupted by a phase of four days refeeding. In addition, additives were added daily to the concentrate mixture at a level 0f 0.14 kg/head/day, which consists of common salt, mineral mixture, monobasic sodium phosphate and chromic oxide (60, 15, 35 and 30 g/head/day, respectively). Feed intake was recorded on all the trials by weighing the feed residue every morning. A known volume of water was offered in containers every day after measuring the volume of water residue from the previous day. For estimating digestibility, chromic oxide was mixed with the concentrate mixture at a rate of 0.5% of total dry diet, as an indicator, and faecal matter was collected over four days pre and post fasting.

Camels were managed individually and housed under the prevalent environmental conditions in separate pens belonging to the experimental farm of faculty of veterinary medicine, Assiut University. Allover the experiment, pens were cleaned out periodically to prevent the animals from eating their dung.

II- Estimations:

Body weight estimation:

Body weight of the experimented camels was estimated on the last day of trial one, refeeding and deprivation periods in the morning before the camels have been watered according to Kohler-Rollefsen *et al.* (2001) using the tape measure method as follows: -

Shoulder height = Height of the shoulder (in meters)

Chest girth = Distance (in meters) around the camel's chest, measured in front of the hump and behind the front legs and chest pads.

Hump girth = Distance (in meters) around the camel's body, measured at its widest point, from the top of the hump around the belly.

Live weight (in Kg) = Shoulder height x chest girth x hump girth x 50

Health status measurements:

On the last day of all trials, experimented camels were examined clinically according to Blood and Henderson (1974) and Blood & Radostits (1990) to determine their average pulse rate, respiratory rate and their body temperature as well as the condition of their mucous membranes, fecal matters and coats.

Chemical analysis of feed and fecal samples:

Fecal matter was collected from each animal during the collection period at a rate of one kg/day, where it was interpolated and sampled.

Feed and fecal samples were dried, ground and mixed, then stored for further analysis. They were analyzed for the several chemical components following AOAC (1984) official methods.

Digestion coefficient:

Digestibility of the dry matter and the several nutrients were calculated using the following equations:-

$$\text{DM digestibility} = \frac{\text{(g) indicator/kg faeces} - \text{(g) indicator/kg food}}{\text{(g) indicator/kg faeces}} \times 100$$

(McDonald *et al.,* 1995)

$$\text{Nutrient digestibility} = 100 - \left(100 \times \frac{\text{\% indicator in feed} \times \text{\% nutrient in faeces}}{\text{\% indicator in faeces} \times \text{\% nutrient in feed}}\right)$$

(Cho *et al.,* 1982)

Biochemical parameters:

Blood samples were collected pre and post fasting immediately from the jugular vein of the animals. The samples were allowed to coagulate at room temperature and serum separated by centrifugation. The sera were freezed at -20 °C till further analysis.

Total serum protein, serum glucose, urea, calcium, phosphorus, sodium, copper and cortisol were determined using standard test kits supplied by Biomerieux (Baines/France).

Behavioral observation:

Ingestive behavior of the experimented camels was recorded following the method of Martin & Bateson (1988) using the scan sampling method where the observer can observe all the animals without being seen by them. Ingestive behavior was observed and analyzed according to Huda (2001). On the last day of the control as well as the first day of refeeding periods after each deprivation one, the time spend in drinking, eating roughage, eating concentrates and resting without performing any ingestive activities within the first hour of supplying the animals with feed and water was measured. Moreover, upon offering feed and water, the preference of the animals for feed (either concentrates or roughage) or water was also recorded.

Statistical analysis:

Statistical analyses of the collected data were carried out according to procedures of completely random design, SAS (1995).

RESULTS

The composition of the feed and amount of experimental diets are summarized in tables (1,2 and 3). Data of faeces analysis are presented in table (4). Table (5) and fig.(1) present the dry matter and water intake in addition to the body weight changes of the experimented camels. Digestibility of dry matter and nutrients were estimated and presented in table (6). Health status of the experimented animals are manifested in table (7) while tables (8 & 9) and fig.(2) show the time spent in different ingestive activities and the preference of food or water by the animals. Table (10) and fig. (3) present the results of the blood biochemical estimations.

DISCUSSON

Feed and water intake:

The data represented in table (5) showed that, the dry matter intake was 51.42 g/kg $^{0.75}$, which represents 1.06% of the average body weight of the experimented camels. This finding is similar to that reported by Farid *et al.* (1985) who stated that, the dry matter intake by camels at the maintenance level was ranged between 45.8 – 52.0 g/kg $^{0.75}$, and represents 1.02% of the average body weight. With the prolongation of food and water deprivation, this level was found to be insignificantly differed and the values were 51.95, 49.31 and 53.01 g/kg $^{0.75}$ after one, two and three days deprivation periods, respectively. These results did not agree with that reported by Kandil (1984) and Guerouali & Wardeh (1998) who found that, food starvation, with or without water deprivation decreases the dry matter intake by camels with a significant level. However, Wardeh (1998) indicated that, animals previously underfed consume more feed during the period of realimentation than do previously unrestricted animals of the same weight receiving identical diets.

At the same time, table (5) showed the average water intake by the examined animals after different periods of food and water deprivation. These data indicated that, food and water deprivation had a significant effect ($p<0.01$) on average water intake by these animals. On the first day of refeeding after a period of deprivation, the amount of water consumed was much higher than the control and it increased progressively with the prolongation of the deprivation period. The amounts were 12, 13, 19 and 26 L/h/d for the control and after one, two and three days deprivation periods, respectively. This increase in water intake may be considered as a physiological adaptive mechanisms related to flexibility of mobilization of water from different compartments of the camel's body. Also, it may be related to the inherited behavior of camels as a species adapted to arid environment. Therefore, the camel consumed more water than its normal consumption under conditions of regular water availability in preparation for the forthcoming periods of drought or water deprivation (Huda, 2000).

At the same time, Fig. (1) indicated that, the average amount of water consumed by the examined camels decreased on the second day of refeeding, thereafter showing smaller fluctuations and returning to a value near to that of the control day by the fourth day of refeeding. This result agreed with Huda 2000 and 2001 and may be related to the fact that, camel not only rapidly absorbs water, but also has the ability to restore body functions, especially renal function, within half an hour of drinking, a capability which gives the camel another advantage over other animals in the ability to survive in the desert (Adolph, 1982; Etzion *et al.,* 1984 and Etzion & Yagil, 1986).

Body weight changes:

The trend of changes in the body weight of the control camels reflected a progressive decline with the advancement of the deprivation period (Table 5). Camels lost 5, 9 and 13% of their body weight after one, two and three days deprivation periods, respectively. The rate of decline, however, was lowest in camels compared to sheep and goats as reported by Huda (2001) who found that, after two days of fasting, camels lost only 11.5% of their body weight compared with 17.6 and 18.9% for sheep and goats, respectively, a result indicating the superiority of camels in digest retention and / or in body reserves mobilization when fasted. The higher methane production observed in camels after two days fasting is in favour of more digest retention in the tract to allow fermentation (Guerouali *et al.,* 1997). This finding tend to confirm the lower rate of body loss found in camels compared to sheep and goats. In this experiment, a refeeding period of four days appeared to be sufficient as a recovery period for camels to regain their lost weight and achieve their initial (control) body weight. This result agreed with Guerouali *et al.* (1997) and Huda (2001).

Nutrients digestibility:

Under water deprivation, camels are able to maintain their appetite to show some improvement in feed digestibility and to allow their metabolic rate to decline in order to save energy and water of the body. These metabolic adjustments keep the animals under a positive balance throughout the dehydration period (Guerouali and Wardeh, 1998).

Table (6) illustrated the digestion coefficient of the dry matter (DM) and the different nutrients following each trial. Dry matter digestibility was increased with the prolongation of deprivation period. The values were 62.30, 63.78, 65.71 and 71.70% for control, one, two and three days deprivation, respectively. The digestibility of organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE) and ash followed a pattern similar to DM digestibility and the values were (65.20, 66.27, 68,73, 74.59%); (65.67, 69.72, 70.93, 75.0%); (65.04, 65.79, 72.48, 73.97%); (59.83, 58.39, 60.68, 66.10%); (67.22, 68.71, 71.11, 78.64%) and (41.56, 46.96, 44.97, 52.26%) for the above mentioned nutrients for the control, one, two and three days deprivation periods, respectively.

In a dehydration experiment on camels kept on 12 days watering schedule, Farid *et al.* (1985) reported an increase in the digestibility of DM (3.7%), CP (24.24%) and NFE (1.2%) with a decrease in that of EE (-10.05%). Moreover, Nagpal *et al.* (1993) found an increase in the digestibility of DM, OM, EE, CF and NFE with a decrease in the digestibility of CP in camels on weekly watering schedule during winter. However, Rai *et al.* (1993) observed the digestibility of the proximate components in dehydrated camels and indicated an increase in the digestibility of DM, OM, CP and EE with a 21.4% decrease in that of CF.

On the other hand, Kandil (1984) reported that, feed starvation and water deprivation did not affect the digestibility of the dry matter and the proximate constituents, however feed starvation alone drastically decreases it.

At the same time, table (6) indicated that, calcium and phosphorus availability showed insignificant variation after one, two and three days of food and water deprivation.

Health status:

The data represented in table (7) showed the average pulse rate (No./min.), respiratory rate (No./min.) and body temperature (°C) of the experimented camels in all the experimented trials. These data were 32, 8, 37.4 during the control period; 34, 10, 37.3 by the end of one day deprivation period; 40, 10, 36.8 by the end of two days deprivation period and 46, 10, 36.4 by the end of three days deprivation period, respectively.

The previous results indicated that, food and water deprivation had a significant effect ($p<0.01$) on pulse rate and rectal temperature of the examined camels. However, respiratory rate was not significantly affected. Pulse rate of the experimented camels was significantly increased with prolongation of the deprivation period. On the contrary, rectal temperature of the experimented camels was significantly decreased with that period. These findings were agreed with Sainsbury, 1986; Radostits *et al.,* 1994 and Huda, 2001 and may be related to the fact that insufficient water intake affects significantly the blood water content and increases the blood viscosity which reflects on the animal with an obvious effect on their pulse rate (Blood and Radostitis, 1990). However, decreased rectal temperature following prolongation of deprivation period may be related to lower metabolic activity and heat increment during fasting (Baker, 1989; Naqvi & Rai, 1991 and Ahmed *et al.,* 1994). Moreover, Dahlborn *et al.* (1992) indicated that, strategies for the camel to induced food and water deprivation include lowering of its body temperature to reduce the water requirements for evaporative heat loss.

Table (7) showed that, food and water deprivation obviously affects the faecal matter and mucous membranes of the examined animals. Faeces became harder in consistency and darker in colour while mucous membranes became pale when the period of deprivation was prolonged. Meanwhile, the obtained data showed that the condition of the coat of the examined animals did not vary greatly than normal.

Ingestive behavior:

Time spent in different activities and preference of food or water:

The data represented in table (8) and assimilated in figure (2) showed the time (minutes) spent by the experimented camels in drinking, total eating, eating roughage, eating concentrates and resting without performing any ingestive activities within the first hour of feeding during the last day of trial one and the first hour of refeeding after one day, two days and three days deprivation periods. These data were 9, 35, 12, 23, 16 during the control period; 11, 40, 29, 11.9 after one day deprivation period; 15, 41, 37, 4, 4 after two days deprivation period and 29, 27, 24, 3, 4 after three days deprivation period, respectively.

The previous results indicated that, food and water deprivation had a significant effect ($p<0.01$) on the time spent by the experimented camels in different ingestive activities. Time spent in drinking was significantly affected only after three days deprivation period where it was significantly increased. This result showed that, camels tolerate water deprivation for long periods, hence they known to consume large quantities of water after fasting (Yagil, 1985 and Huda, 2001). On the contrary, total time spent eating was significantly decreased after three days deprivation period as a result of increased drinking one. Camels were observed to spend more time in eating roughage than concentrates and the time spent eating roughage was significantly increased with the prolongation of the deprivation period. This result may reflect the natural eating habits of camels as desert animals that are adapted to eat more green roughage materials than concentrates during water restriction owning to its higher water content (Hassan, 1971; Wilson, 1989 and Huda, 2001).

With regard to resting without ingestive activities, these data indicated that, resting was significantly decreased during the first hour of feeding or refeeding after deprivation and that decrease became more obvious with the prolongation of deprivation period as the animals concentrated mainly on eating and drinking.

The data represented in table (9) showed the preference of food or water by the experimented camels when both food and water became available. These data showed that, the percentages of camels that firstly drank, ate roughage or ate concentrates within the first hour of feeding during the last day of control period and the first hour of refeeding after one day, two days and three days deprivation periods were 0, 0, 100 during the control period; 0, 80, 20 after one day deprivation period; 60, 40,0 after two days deprivation period and 100, 0, 0 after three days deprivation period, respectively.

The previous results indicated that, food and water deprivation had a significant effect ($p<0.01$) on the preference of food or water by the experimented camels. None of the animals drank firstly either during the last day of control period or after one day of fasting. However, camels tended to shift more towards drinking firstly when the period of food and water deprivation was prolonged. At the same time, this result indicated that, all experimented camels ate concentrates firstly during the control period but they tended to shift more towards eating roughage firstly when the period of food and water deprivation started and prolonged. This result agreed with Yagil et al., 1974b; Dill et al., 1980 and Huda, 2001 and may be related to decreased blood water content and increased blood viscosity that resulted in changes in osmotic pressure of the blood of animals. Higher osmotic pressure in the blood of animals after food and water deprivation may be accounted for as a primary driving mechanism for choice of water rather than food after a long period of fasting. However, camels tended to eat roughage firstly after fasting as a result of its natural eating habits as desert animals that are adapted eat more green roughage materials than concentrates during water restriction owning to its higher water content (Hassan, 1971; Yagil *et al.,* 1974a&b; Dill *et al.,* 1980 and Huda, 2001).

Biochemical parameters:

The data represented in table (10) showed the effect of food and water deprivation on the level of some parameters in the serum of the examined camels. These data indicated that, prolongation of water and food deprivation had a significant effect on the estimated levels of total protein, glucose, urea, sodium and copper ($p<0.01$). However, calcium and phosphorus levels were not significantly affected.

The level of total protein was significantly increased after two and three days of food and water deprivation. This increase may be related to reduction in plasma volume with more increase in blood albumin than globulin level which seems to play an important role in water retention of camel packed cell volume as compared to other ruminants (Siebert and MacFarlane, 1975; Khalil *et al.,* 1985 and Wilson, 1989).

With regard to serum glucose level, it decreased significantly with prolongation of food and water deprivation. This result agreed with Bergman (1973) and Huda (2001) and may be related to low availability of propionate from the rumen, which is the main precursor for glucose in ruminants. Moreover, Wensvoort *et al.* (1996) in a similar trial showed that, camels had low rates of increase in serum non essential fatty acids (NEFA) and higher glucose levels, compared with other ruminants and concluded that, camels seem to do better than other ruminants in controlling their lipolytic and gluconeogenic rates in order to prevent the pathological state of ketosis after a period of fast.

The overall values of urea in the experimented camels serum were significantly increased after two and three days deprivation periods. This elevation may be attributed to the greater efficiency of crude protein digestibility and nitrogen conservation by camels as reported by Barakat and Abdel-Fattah (1970).

At the same time, the levels of sodium and copper were significantly increased in the serum of the examined camels with prolongation of food and water deprivation. Similar findings were recorded in dehydrated sheep (Khan *et al.,* 1978); goats (Choshniak and Shkolnik, 1978) and camels (Siebert and MacFarlane, 1975; Abdalla *et al.,* 1988; CVRL, 1994 and Huda, 2001) and may be related to the effect of water deprivation on water content and plasma volume of the blood and hence, the concentration of these constituents (Blood and Radostits, 1990).

No significant changes were observed in serum calcium and phosphorus concentrations, a result that agreed with that reported by Ben Goumi *et al.* (1996). This would be expected because homeostatic levels of serum calcium are maintained through endocrine regulation of calcium absorption, excretion and bone metabolism (Littledike and Goff, 1987). Furthermore, the excretion of calcium in urine and faeces appeared to be not affected by dietary calcium intake, as the rate of feedback of calcium from bone is sensitive to the level of calcium in the diet (Ramberg *et al.,* 1976 and Cohn *et al.,* 1986). However, blood phosphorus homeostasis is more complicated than it is for blood calcium because phosphorus is in equilibrium not only with bone, but also with several organic phosphorus compounds. Nevertheless, kidney excretion of phosphorus is sufficiently controlled by parathyroid hormone secretion and 1,25-di-hydroxy vitamin D to result in relatively stable serum phosphorus concentration even with sever dietary phosphorus deficiency (Church & Pond, 1990).

Studies on plasma or serum levels of adrenocorticoids showed a marked rise in cortisol after exposure to several or any stressor, which are known to cause an increased outpouring of ACTH that induce the adrenal cortex to increase its secretion of glucocorticoids (McDonald, 1969 and Burchfield *et al.,* 1980).

In the present study, food and water deprivation had a significant effect ($P<0.01$) on serum cortisol level of the examined camels (table 10). Average serum cortisol levels of the examined camels were 0.93, 0.94, 1.55 and 1.81 μg/100 ml, during the control, one day, two days and three days deprivation periods, respectively. Moreover, figure (3) showed that, serum cortisol level of camels was markedly higher after three days deprivation period. This result indicated that, prolongation of food and water deprivation is considered as a stressor or stress factor on camels facing food and water deprivation.

CONCLUSION

In conclusion, prolongation of food and water deprivation appears as a stress factor on camels with a clear and obvious effect on their health status, nutrients digestibility, water intake, body weight, some behavioral and biochemical parameters. This suggests that any continuous water and food deficit among housed camels must be corrected.

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Table 1: Chemical composition of the used ingredients (% on fresh basis)

Ingredients	DM	OM	CP	EE	CF	NFE	Ash	Ca	P	DE * Mcal/kg DM
Conc. Mixture	89.0	85.4	16.1	3.8	4.1	61.4	3.6	0.12	0.50	3.06
Barseem	14.4	12.0	2.3	0.5	2.9	6.3	2.4	0.51	0.05	0.38
Wheat straw	90.0	80.0	3.4	1.5	36.0	39.1	10.0	0.15	0.07	1.58

* DE for commercial concentrate mixture and barseem were calculated from TDN while for wheat straw according to NRC (1981)

Table 2: Amount of consumed diet (kg/head/day)

Ingredients	Trials			
	1st	2nd	3rd	4th
Concentrate mixture	1.50	1.50	1.50	1.50
Green barseem	10.00	13.60	13.00	16.00
Wheat straw	3.25	2.75	2.5	2.5
Additives *	0.14	0.14	0.14	0.14

1st = Control   2nd = One day deprivation
3rd = Two days deprivation   4th = Three days deprivation
* Consists of common salt, mineral mixture, monobasic sodium phosphate and chromic oxide

Table 3: Nutrients composition and energy content of the consumed diet (% on dry matter basis)

Item	Trials			
	1st	2nd	3rd	4th
Organic matter (OM)	87.67	87.12	87.32	87.04
Crude protein (CP)	9.93	10.85	11.25	11.63
Ether extract (EE)	2.74	2.88	3.04	2.99
Crude fiber (CF)	26.03	24.41	23.93	23.59
Nitrogen free extract (NFE)	48.97	48.98	49.10	48.83
Ash	12.33	12.88	12.68	12.96
Calcium (Ca)	0.99	1.27	1.29	1.46
Phosphorus (P)	0.41	0.44	0.46	0.45
DE (Mcal/kg DM)	2.31	2.39	2.44	2.44

1st = Control　　2nd = One day deprivation
3rd = Two days deprivation　　4th = Three days deprivation

Table 4: Chemical analysis of faecal matter (% on dry matter basis)

Item	Trials			
	1st	2nd	3rd	4th
OM	80.89±1.56	81.14±1.32	79.65±1.76	78.14±1.58
CP	9.04±0.96	9.07±0.69	9.54±1.12	10.27±1.22
EE	2.54±0.25	2.72±0.29	2.44±0.34	2.75±0.45
CF	27.73±0.69	28.04±1.12	27.30±1.35	28.26±1.12
NFE	41.58±1.2	41.31±1.71	40.37±2.15	36.86±1.19
Ash	19.11±1.30	18.86±1.48	20.35±1.70	22.86±1.41
Ca	1.63±0.21	2.15±0.09	2.38±0.17	3.15±0.08
P	0.62±0.12	0.70±0.07	0.76±0.09	0.90±0.10
Cr_2O_3	1.22±0.19	1.27±0.12	1.40±0.19	1.59±0.11

1st = Control　　2nd = One day deprivation
3rd = Two days deprivation　　4th = Three days deprivation

Table 5: Average dry matter intake, body weight loss and water intake by camels during control and refeeding days after different periods of deprivation (Average body weight is 550 kg)

Item		Trials			
		1st	2nd	3rd	4th
DM intake (Kg/h/d)		5.84±0.2	5.9±0.2	5.6±0.4	6.35±0.3
DM intake ($g/kg^{0.75}$)		51.42	51.95	49.31	53.01
Weight loss %		------	5±0.2^{a}	9±0.5^{b}	13±0.3^{c}
Water intake (L/h/d)	1st day	12±1.5^{a}	13±1.8^{a}	19±2.2^{b}	26±2.8^{c}
	2nd day		10±1.1^{b}	6±0.5^{a}	7±0.9^{a}
	3rd day		12±1.3^{b}	8±1.0^{a}	9±1.2^{a}
	4th day		11±1.6^{a}	11±1.1^{a}	10±1.5^{a}

1st = Control 2nd = One day deprivation
3rd = Two days deprivation 4th = Three days deprivation
Figures in the same raw with different superscripts differs significantly ($p < 0.01$)

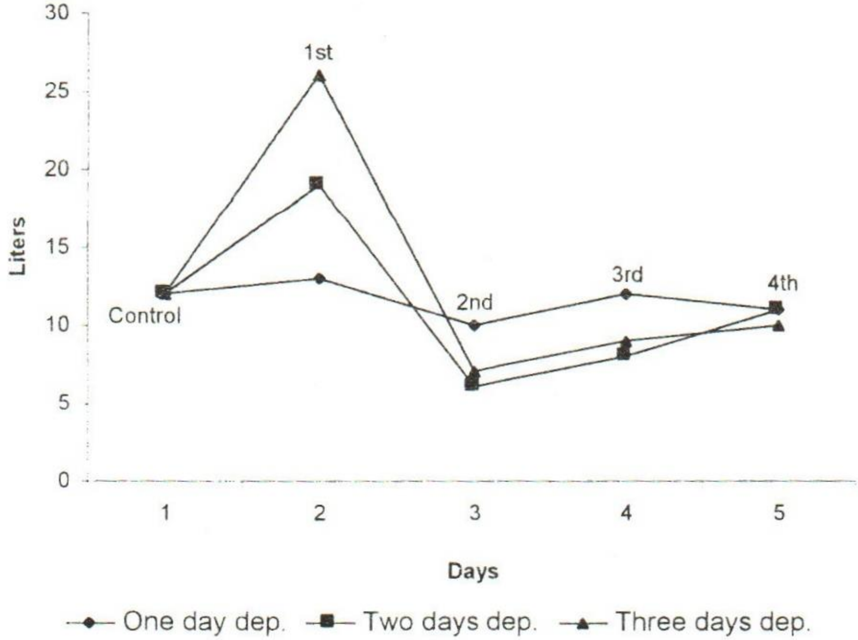

Fig. 1 : - Average water intake by camels (L/head/day) during refeeding days after different periods of deprivation

Table 6: Digestion coefficient (%) and nutritive value of the diet

Item	Trials			
	1st	2nd	3rd	4th
DM	62.30±4.22 [a]	63.78±3.72 [a]	65.71±5.3 [b]	71.70±3.16 [c]
OM	65.20±4.85 [a]	66.27±5.4 [a]	68.73±4.83 [b]	74.59±5.72 [c]
CP	65.67±5.6 [a]	69.72±4.19 [a]	70.93±3.65 [a]	75.00±3.7 [b]
EE	65.04±3.59 [a]	65.79±4.85 [a]	72.48±2.72 [b]	73.97±4.93 [b]
CF	59.83±3.69 [a]	58.39±5.68 [a]	60.86±4.58 [b]	66.10±6.3 [c]
NFE	67.22±9.73 [a]	68.71±10.42 [a]	71.11±8.9 [b]	78.64±9.55 [c]
Ash	41.56±5.22 [a]	46.69±4.9 [b]	44.97±3.7 [b]	52.26±3.61 [b]
Ca	37.92±1.76 [a]	38.68±2.09 [a]	36.74±1.69 [a]	38.93±2.64 [a]
P	42.98±3.71 [a]	42.38±2.91 [a]	43.35±3.11 [a]	43.40±5.02 [a]
………………….. **Nutritive values** …………………..				
TDN %	59.2	59.71	62.41	67.68
DCP %	6.52	7.56	7.98	8.72
ME Mcal/kg DM	2.13	2.16	2.26	2.45

1st = Control   2nd = One day deprivation
3rd = Two days deprivation   4th = Three days deprivation
Figures in the same raw with different superscripts differs significantly ($p < 0.01$)

Table 7: Health status measurements of the experimental animals

Item	Trials			
	1st	2nd	3rd	4th
Pulse rate (No./min)	32±2 [a]	34±2 [a]	40±1 [b]	46±2 [c]
Respiratory rate (No./min)	8±1	10±2	10±1	10±2
Body temperature (°C)	37.4±0.1 [c]	37.3±0.1 [c]	36.8±0.1 [b]	36.4±0.1 [a]
Mucous membrane	Normal	Normal	Normal	Pale
Fecal matter	Normal	Normal	Hard & Dark	Firm & Darker
Condition of the coat	Normal	Normal	Normal	Normal

1st = Control   2nd = One day deprivation
3rd = Two days deprivation   4th = Three days deprivation
Figures in the same raw with different superscripts differs significantly ($p < 0.01$)

Table 8: Time spent in different Ingestive activities by the experimental animals during the first hour of refeeding (min.)

Item	Trials			
	1st	2nd	3rd	4th
Drinking	9±1[a]	11±2[a]	15±1[a]	29±3[b]
Total eating	35±2[a]	40±3[a]	41±5[a]	27±2[b]
Eating roughage	12±1[a]	29±3[b]	37±3[c]	24±2[b]
Eating concentrates	23±2[c]	11±1[b]	4±1[a]	3±1[a]
Resting without ingestive activities	16±2[c]	9±1[b]	4±1[a]	4±1[a]

1st = Control 2nd = One day deprivation
3rd = Two days deprivation 4th = Three days deprivation
Figures in the same raw with different superscripts differs significantly ($p < 0.01$)

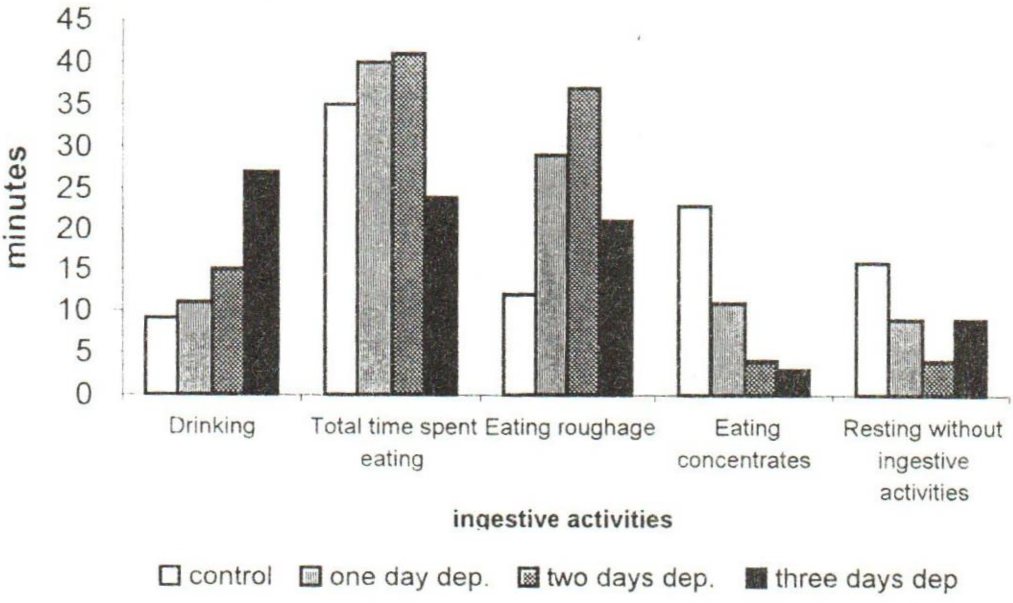

Fig.2: - Time spent in different ingestive activities by the examined animals during the first hour of refeeding

Table 9: Preference of feed or water by the experimental animals

Item	Trials			
	1st	2nd	3rd	4th
	................% of animals.................			
Drinking	0[a]	0[a]	60[b]	100[c]
Eating roughage	0[a]	80[c]	40[b]	0[a]
Eating concentrates	100[c]	20[b]	0[a]	0[a]

1st = Control 2nd = One day deprivation
3rd = Two days deprivation 4th = Three days deprivation
Figures in the same raw with different superscripts differs significantly ($p < 0.01$)

Table 10: Blood parameters of the experimental animals

Item	Trials			
	1st	2nd	3rd	4th
Total protein (g/L)	73.2±1.9[a]	73.9±1.1[a]	76.3±1.7[b]	80.1±1.9[c]
Glucose (mmol/L)	105.3±3.1[c]	101.1±2.9[b]	94.5±1.9[b]	85.3±2.7[a]
Urea (mmol/liter)	115.2±3.2[a]	122.4±2.4[a]	155.1±5.1[b]	176.6±5.4[c]
Calcium (mg/dl)	10.75±2.9[a]	10.20±1.8[a]	9.60±2.3[a]	11.35±1.3[a]
Phosphorus (mg/dl)	6.60±0.6[a]	5.73±0.7[a]	5.90±1.6[a]	7.25±0.9[a]
Sodium (m mol/L)	142.2±2.4[a]	147.3±2.1[a]	156.1±1.9[b]	162.7±2.1[c]
Copper (μmol/L)	11.3±0.77[a]	12.4±0.65[a]	14.9±0.62[b]	16.1±0.45[c]
Cortisol (μg/100 ml)	0.93±0.02[a]	0.94±0.01[a]	1.55±0.02[b]	1.81±0.02[c]

1st = Control 2nd = One day deprivation
3rd = Two days deprivation 4th = Three days deprivation
Figures in the same raw with different superscripts differs significantly ($p < 0.01$)

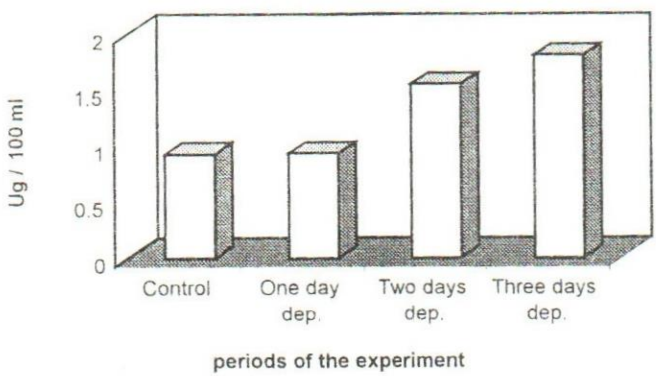

Fig. 3: - Average serum cortisol level of the examined animals