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EFFECT OF REDUCECED DRINKING WATER INTAKE ON GENERAL HEALTH STATUS, BEHAVIOUR, MILK YIELD, SOME BLOOD CONSTITUENTS AND SERUM CORTISOL OF HOUSED LACTATING BUFFALOES

(With 5 Tables and 2 Figures)

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تأثير نقص كمية مياه الشرب على الحالة الصحية والنمط السلوكي ومعدل إنتاج اللبن وبعض مكونات الدم في الجاموس المصري

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أجريت هذه الدراسة خلال شهري مارس وأبريل- عام ٢٠٠١ على عدد ١٠ من إناث الجاموس المصري الحلوب والتي تراوحت أعمارها من ٤ إلى ٤.٥ سنوات والتي كانت في الموسم الثاني للحليب وذلك بغرض الوقوف على مدى تأثير النقص في كميات مياه الشرب المقدمة لمثل هذه الحيوانات على الصحة العامة والنمط السلوكي لها وكذلك مدى تأثيرها على المعدل اليومي لإدرار اللبن ومستوى بعض مكونات الدم وكذلك مستوى هرمون الكورتيزول في مصل الدم. وللحصول على نتائج دقيقة, تم تقسيم هذه الحيوانات إلى مجموعتين متساويتين بمعدل ٥ حيوانات لكل مجموعة وتم تسكين كل مجموعة في غرفة مساحتها ٥ x ١٠ متر تحت الظروف البيئية السائدة مع توفير مستوى إضاءة وتهوية مناسب. تم إستخدام مجموعة منها لدراسة السلوكيات والمعدل اليومي لإدرار اللبن بينما أستخدمت المجموعة الأخرى لدراسة التغيرات في الحالة الصحية والفسيولوجية ومستوى بعض مكونات الدم وكذلك مستوى هرمون الكورتيزول في مصل الدم والناتجة من وضع هذه الحيوانات تحت ظروف التجربة. تم تغذية هذه الحيوانات على مخلوط المركزات الجافة الخاص بالحيوانات الحلوب بالإضافة إلى البرسيم وذلك بما يتناسب مع معدل الإنتاج اليومي من اللبن. كما تم تقديم مياه الشرب النقية بحرية في الأحواض المخصصة لذلك لمدة ١٤ يوم كفترة تمهيدية وذلك لتحديد متوسط الإستهلاك اليومي من مياه الشرب لكل حيوان والذي تم تقديره بمعدل ٤٠ لتر لكل حيوان. تم تقديم المياه اللازمة لشرب هذه الحيوانات بنفس المعدل السابق لمدة

١٤ يوم أخرى كفترة ضابطة والتي أعقبتها مباشرة فترة تقليص مياه الشرب المقدمة بمعدل ٥٠% (٢٠ لتر لكل حيوان) لمدة ٤ أيام كفترة تجريبية وذلك لدراسة تأثير هذا النقص في كميات مياه الشرب المقدمة على القياسات سابقة الذكر. تلى ذلك مباشرة العودة إلى المعدل الطبيعي لمياه الشرب (٤٠ لتر لكل حيوان)) لمدة ٧ أيام أخرى مع تقييم النتائج التي تم الحصول عليها. أثبتت النتائج التي تم الحصول عليها أن الحالة الصحية و السلوكيات المختلفة للجاموس المصري والمعدل اليومي لإدرار اللبن و كذلك مستوى بعض مكونات الدم و مستوى هرمون الكورتيزول في مصل الدم لهذه الحيوانات قد تأثرت تأثيرا معنويا بالنقص في كميات مياه الشرب المقدمة. وقد تم التوصية بمراعاة كمية مياه الشرب اللازمة خاصة للحيوانات المسكنة داخل الحظائر والتي يتم تتغذيتها بطريقة رئيسية على مخلوط المركزات الجافة الخاص بالحيوانات الحلوب مع سرعة تعويض أي نقص قدر يطرأ على هذه الكميات لما له من مردود سيئ على سيكولوجية وصحة وإنتاجية هذه الحيوانات.

SUMMARY

This experiment was carried out during March and April, 2001. Changes in health status, behavioral pattern, milk yield, some blood constituents concentrations as well as serum cortisol level of in door housed dairy buffaloes subjected to a water restriction had been studied. 10 Egyptian buffalo cows on their second lactation season (about 4-4.5 years) were used in this experiment. For the accuracy of the experiment, they were divided into two groups (5 buffalo cows each). Each group was housed in a well-ventilated and well-lighted 5x10 m room under the prevalent environmental conditions. The first group was used in studying the behaviour and milk yield while the other one was used in studying the health status, some blood constituents and serum cortisol levels. A commercial concentrate mixture for dairy cows was fed to the animals in the milking parlour according to the average milk yield. However, barseem was offered to cows in their housing rooms. Mineral salt rocks were hanged freely infront of the animals. In each room, water was supplied directly from tap water in a large, well-cleaned concrete water trough, which placed on the ground. Animals were allowed free access to the water troughs all the times except during milking where there was no water available in the collecting yards or milking parlour. Buffalo cows were milked separately twice a day at 6:00 a.m. and 6:00 p.m. Animals in both groups were allowed water ad libitum for a 14 days preliminary period to determine the average water intake for each animal, which was about 40 liters / dairy buffalo cow. After that, buffalo cows were allowed water in an average of 40 liters / buffalo cow for the following 14 days as a control period followed by a water restriction

period of 4 days as the animals were received only 50% of its water requirement (20 liters). This was followed by a recovery period of 7 days during which, cows were regained 100% of its water requirement (40 liter / animal). During the control, water restriction and recovery periods, health status, behaviour pattern, milk yield, some blood constituents concentration and serum cortisol level of the examined animals were estimated. The obtained results revealed that, reduced water intake acted as a stress factor on housed dairy buffaloes that given mainly a dry diet of concentrates and a little amount of forages, with a clear and obvious effect on their health status, behaviour, milk yield, some blood constituents and serum cortisol level. This suggests that any continuous water deficit than the normal limit among housed dairy animals, which given mainly a dry ration must be readily detected and corrected before their milk yield is affected and depressed.

Key words: *Water restriction, health, behaviour, physiology, buffaloes.*

INTRODUCTION

Water often is not thought as a nutrient even though it clearly meets all criteria for definition as one. Life could not be sustained without water. It makes up about one half to two thirds of the body mass of adult animals and up to 90% of that of newborn animals and accounts for more than 99% of the molecules in the body (Pond et al., 1995).

The importance of an adequate supply of potable water for livestock is well recognized and currently is receiving more emphasis in the quest to clean up polluted environments by improving the quality and dependability of water supplies. From a functional viewpoint, water is essential for life. All of the biochemical reactions that take place in an animal require water. Many of the biological functions of water are dependent on the property of acting as a solvent for a wide variety of compounds. In addition, water serves as a medium for transportation of semisolid digesta in the gastrointestinal tract, for various solutes in blood, tissue fluids, cells, secretions and excretions as urine and sweat. Thus, water serves to transport absorbed substances, conveying them to and from their sites of metabolism (Pond et al., 1995).

It has been suggested that, either grazing cows or housed indoors dairy ones, may be inadvertently deprived of some of required water intake because of a faulty or inadequate supply to troughs. It has also been suggested that if troughs are too small to accomodate all animals at

peak drinking times, some might be prevented from drinking and might not return to the trough for a considerable time. In either events, there might be an adverse effect on the cow's milk yield especially those housed indoors because of the shortage of green forages as they mainly fed dry concentrates (Little et al., 1979).

As few studies were done to clarify how housed dairy buffaloes react with that situation, so the aim of the present research is to study the drawback effects of reduced water intake on dairy buffaloes with special references to their health status, behaviour, some blood constituents and milk yield.

MATERIALS and METHODS

I- Animals used:

10 Egyptian buffalo cows of their second lactation season (about 4-4.5 years) were used in this experiment. For the accuracy of the experiment, they were divided into two groups, each of 5 cows. Each group was housed in a well-ventilated and well-lighted 5x10 m room under the prevalent environmental conditions. One group was used in studying the behaviour and milk yield while the other group was used in studying the health status, some blood constituents and serum cortisol levels.

II- Feeding, watering and management:

A commercial concentrate mixture for dairy cows was fed to the animals in the milking parlour according to the average milk yield. However, barseem was offered to cows in their housing rooms at a rate of 10 kg dry matter / cow / day (Little et al., 1979). Mineral salt rocks were hanged freely infront of the animals.

In each room, water was supplied directly from tap water in a large, well-cleaned concrete water trough, which placed on the ground. Animals were allowed free access to the water troughs all the times except during milking where there was no water available in the collecting yards or milking parlour.

Buffalo cows were milked separately twice a day at 6:00 a.m. and 6:00 p.m.

III- Experimental design:

This experiment was carried out during the months of March and April, 2001.

The experiment was designed and carried out according to Little et al., 1979. Animals in both groups were allowed water ad libitum for a 14 days preliminary period to determine the average water intake for each

animal, which was about 40 liters / buffalo cow. After that, the buffaloes were allowed water in an average of 40 liters / dairy buffalo cow for the following 14 days as a control period followed by a water restriction period of 4 days as the animals were received only 50% of its water requirement (20 liters daily / animal). This was followed by a recovery period of 7 days during which, buffaloes were regained 100% of its water requirement (40 liter / animal).

IV- Health status measurements:

On the last two days of control, restriction and recovery periods, and before supplying the animals with drinking water, buffalo cows were clinically examined according to Blood & Henderson, 1974 and Blood & Radostits, 1990 to determine the average pulse rate, respiratory rate, body temperature as well as the condition of the faecal matter, urinary output, the coat and mucous membranes.

V- Behavioural observations:

Animals were fed and cleaned out at 8:00 a.m. and 3:00 p.m. while they were supplied with water only at 8:00 a.m. However, they were milked at 6:00 a.m. and 6:00 p.m. During the reminder of the day, humans were not normally present. Their behavioural pattern was recorded according to Martin & Bateson, 1988 and Fordham et al., 1991 using the scan sampling method where the observer can study all the behaviour of all animals without being seen by them.

Animals were observed for one hour before supplying them with drinking water, one hour after supplying them with drinking water and one hour after 12 hours elapsed from supplying them with drinking water.

Animals were observed for the following:

Number of visiting water trough / recorded hour.
Time spent on the trough / visit.
Number of high-pitched vocalization (bawl) / recorded hour.
Aggressive behaviour at water troughs (pushing or butting each other at the trough).
Behaviour of stress or restlessness (as pawing, stamping or sniffing the ground).
Bad vices as suckling itself or others.

VI- Milk yield:

The average milk yield / animal was recorded for the last three days of each period (control, water restriction and recovery) and then the daily average was estimated.

VII- Blood sampling and analysis:

On the last day of control, water restriction and recovery periods, and one hour before supplying the animals with water, blood samples (10 ml each) were collected from the animals by Jugular vein puncture and collected on the wall of centrifuge tubes. The sera of the collected samples were separated by centrifugation at 3000 r.p.m. for 30 minutes and were freezed at –80°C. Blood serum was analyzed for urea, total protein, sodium, copper and glucose following the methods of Hallett and Cook, 1971; Weichselbaum, 1946; Michael et al., 1992; Parker et al., 1967 and Tinder, 1969, respectively. Moreover, serum cortisol level was estimated using TDxFLx system according to Dandliker & Feing, 1970 and Dandliker & Saussure, 1973.

VIII- Statistical analysis:

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

RESULTS

The results of this study were illustrated in Tables (1 – 5) as well as Figures 1 and 2.

DISCUSSION

1- Water restriction and the health status of dairy buffaloes:

The data represented in Table (1) showed that average pulse rate (No./min.), respiratory rate (No./min.) and body temperature (°C) of the examined dairy buffaloes was 65, 27 and 38.7 during the control period while it was 77, 38 and 39.2 during the period of water restriction, however, it was 67, 26 and 38.8 during the recovery period, respectively.

The same Table showed that water restriction obviously affected the faecal matter of the examined animals. Faeces became harder in consistency and darker in colour after water restriction. Moreover, urine output was also affected where the frequency of urination was reduced.

At the same time, the obtained data showed that the condition of the mucous membranes and the coat of the examined animals were somewhat normal either during control, water restriction or recovery periods.

The previous results indicated that, water restriction had a significant effect ($p<0.01$) on the health status of the examined dairy

buffaloes with a significant increase in their average pulse and respiratory rates and a non-significant increase in their body temperature. These findings were agreed with Park, 1970; Cockrill, 1974; Satyapal and Thomas, 1975; Little et al., 1978; Sainsbury, 1986 and Radostits et al., 1994 and may be related to the fact that insufficient water intake affects significantly on the blood water content and increases the blood viscosity which reflects on the animal with an obvious effect on their health condition (Blood and Radostits, 1990).

II- Water restriction and the behavioural pattern of dairy buffaloes:

The data represented in Table (2) showed the effect of drinking water restriction on the behavioural pattern of dairy buffaloes which had been recorded for one hour before supplying them with their drinking water, one hour after supplying them with their drinking water and one hour after 12 hours elapsed from supplying them with their drinking water. These data illustrated that, water restriction had a significant effect ($p<0.01$) on the number of visiting water trough (No./hour), time spent on the trough / visit (sec./visit), number of high pitched vocalization (No./hour) and pushing or butting each other at the trough (No./hour). However, water restriction had no effect on sniffing and/or pawing the ground. No bad vices as suckling itself or suckling other animal had been done by the examined animals.

With regard to the number of visiting water trough, it was 1,2,2, respectively for control period; 9,6,7, respectively for water restriction period and 1,1,2, respectively for recovery period (Table 2). This finding indicated that, the animals had visited the water trough with a significant increased number during the period of water restriction, which may attribute either to search for water (one hour before and one hour after 12 hours elapsed from supplying them with drinking water) or drink a large amount of the restricted water (one hour after supplying them with drinking water).

With regard to the average time that the animals had spent on water trough/visit, it was 15,18,18 seconds, respectively for control period; 7,45,10 seconds, respectively for water restriction period and 13,15,14 seconds, respectively for recovery period (Table 2). This finding indicated that, the animals had spent a significantly increased time on the water trough during the period of water restriction either in licking the empty water trough (one hour before and one hour after 12 hours elapsed from supplying them with drinking water) or in drinking a large amount of the restricted water (one hour after supplying them with drinking water).

With regard to the behaviour of high pitched vocalization or bawl, the obtained data indicated that, the animals showed a significant increase in this behaviour during the period of water restriction either during the recorded hour before supplying them with drinking water or during the recorded hour after 12 hours elapsed from supplying the animals with the drinking water as they were calling for watering and searching for water. However, they showed an increased incidence in pushing and/or butting towards each other during the first hour after supplying them with the drinking water as they were crowded on the water trough in a trial of each animal to obtain the water and drink before the other. Also, they showed the same behaviour during the hour recorded after 12 hours elapsed from supplying them with the drinking water as they were crowded on the empty trough for water searching.

This behavioural finding was agreed with that of little et al., 1979, illustrating that, adequate water supply is one of the most important factors for the animal welfare (Hafez, 1975; Banerjee, 1982 and Sainsbury, 1986).

III- Water restriction and the average milk yield of dairy buffaloes:

The data that represented in Table (3) and assimilated in Figure (1) showed the effect of water restriction on the average milk yield of dairy buffaloes. These data indicated that, water restriction had a significant effect ($p<0.01$) on the average milk yield of the examined animals, as 50% restriction in the offered amount of daily drinking water resulted in a significantly sharp drop (about 37%) in the average milk yield, which had returned to its normal level during the recovery period.

This finding agreed with that of park, 1970; Satyapal and Thomas, 1975; Little et al., 1979 and Thomas, 1980 and may be related to the fact that water constitutes about 87% of the milk and so, any decrease in the blood water content will be directly reflected on both secretions and excretions of the animal, including milk (Pond et al., 1995).

IV- Water restriction and the blood constituents of dairy buffaloes:

The data illustrated in Table (4) showed the effect of water restriction on the level of urea (m mole/L), total protein (g/L), sodium (m mole/L), copper (u mole/L) and glucose (m mole/L) in the serum of the examined dairy buffaloes. These data indicated that, water restriction had a significant effect on the estimated blood parameters of the examined dairy buffaloes ($p<0.01$ except with glucose, where $p<0.05$).

The averages of the previously mentioned constituents in the serum of the examined dairy buffaloes were 5.73, 74.1, 140.3, 11.1 and

3.58 during the control period, respectively, while they were 7.84, 78.2, 148.2, 12.7 and 2.81 during the period of water restriction, respectively. However, it was 5.88, 73.8, 139.8, 10.8 and 3.34 during the recovery period, respectively. These data showed that, the blood level of these constituents was significantly increased during the period of water restriction. Similar findings were recorded by Little et al., 1979 and Pond et al., 1995 in dairy cattle and may be related to the effect of water restriction on the water content of the blood and hence, the concentration of the blood constituents (Blood and Radostits, 1990).

V- Water restriction and the serum cortisol level of dairy buffaloes:

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, water restriction had a significant effect ($P<0.01$) on serum cortisol level of the examined dairy buffaloes (Table 5). Average serum cortisol level of the examined dairy buffaloes was 0.64, 0.91 and 0.67 µg/100 ml, during the control, water restriction and recovery periods, respectively. Moreover, Fig. 2 showed that, serum cortisol level of the examined dairy buffaloes was markedly higher during the period of water restriction than control or recovery period.

This result indicated that, water restriction acted as a stressor or stress factor on dairy buffaloes.

CONCLUSION

In conclusion, reduced drinking water intake appears as a stress factor on housed dairy buffaloes that given mainly a dry diet of concentrates and a little amount of forages, with a clear and obvious effect on their health status, behaviour, milk yield, some blood constituents and serum cortisol level. This suggests that any continuous water deficit than the normal limit among housed dairy animals, which given mainly a dry ration must be readily detected and corrected before their milk yield is affected and depressed.

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Table (1): - Health status measurements of the examined animals

Item	Control Period	Water restriction Period	Recovery Period
Pulse rate (No./min)	65 ± 2^{a}	77 ± 1^{b}	67 ± 2^{a}
Respiratory rate (No./min)	27 ± 1^{a}	38 ± 1^{b}	26 ± 1^{a}
Body temperature (°C)	38.7±0.1	39.2±0.1	38.8±0.1
Faecal matter consistency	Normal	Firm	Normal
Urine output	Normal	Low output	Normal
Mucous membranes	Normal	Normal	Normal
Condition of the coat	Normal	Normal	Normal

Figures in the same raw with different superscripts differs significantly ($p < 0.01$).

Table (2): - Behavioural observations of the animals tested for water restriction (No./hour)

Behaviour	Visiting water trough			Time spent on the trough (sec./visit)			Bawl			Pushing and butting			Sniffing and/or pawing			Suckling itself or others		
Period	One hour before	One hour after	One hour after 12 Hrs elapsed	One hour before	One hour after	One hour after 12 Hrs elapsed	One hour before	One hour after	One hour after 12 Hrs elapsed	One hour before	One hour after	One hour after 12 Hrs elapsed	One hour before	One hour after	One hour after 12 Hrs elapsed	One hour before	One hour after	One hour after 12 Hrs elapsed
Control	1^{a}	2^{a}	2^{a}	15^{a}	18^{a}	18^{a}	0^{a}	1^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0	0	0	0	0	0
Restriction	9^{b}	6^{b}	7^{b}	7^{b}	45^{b}	10^{b}	9^{b}	2^{a}	6^{b}	0^{a}	8^{b}	5^{b}	0	0	0	0	0	0
Recovery	1^{a}	1^{a}	2^{a}	13^{a}	15^{a}	14^{a}	1^{a}	0^{a}	1^{a}	0^{a}	0^{a}	0^{a}	0	0	0	0	0	0

Figures in the same column with different superscripts differs significantly ($p < 0.01$).

Table (3): - Average milk yield (L) of dairy buffaloes tested for water restriction

Item	Control period	Water restriction period	Recovery period
Milk yield	8.3±0.4 [a]	5.2±0.2 [b]	7.9±0.1 [a]

Figures in the same raw with different superscripts differs significantly ($p < 0.01$).

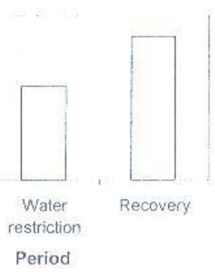

Fig. (1): - Average milk yield of dairy buffaloes tested for water restrictio

Table (4): - Blood constituents of dairy buffaloes examined for water restriction

Estimated parameters	Control period	Water restriction period	Recovery period
Urea (m mole/liter)	5.73±0.11[a]	7.84±0.14[b]	5.88±0.17[a]
Total protein (g/L)	74.1±0.1[a]	78.2±0.1[b]	73.8±0.1[a]
Sodium (m mole/liter)	140.3±0.3[a]	148.2±0.4[b]	139.8±0.2[a]
Copper (μ mole/liter)	11.1±0.1[a]	12.7±0.2[b]	10.8±0.1[a]
Glucose (m mole/liter)	3.58±0.11[a]	2.81±0.08[b]	3.34±0.09[a]

Figures in the same raw with different superscripts differs significantly ($p < 0.01$ except for glucose where $p<0.05$).

Table (5): - Average serum cortisol level (μg/100 ml) of dairy buffaloes examined for water restriction

Item	Control period	Water restriction period	Recovery period
Serum cortisol level	0.64±0.01[a]	0.91±0.02[b]	0.67±0.01[a]

Figures in the same raw with different superscripts differs significantly ($p < 0.01$).

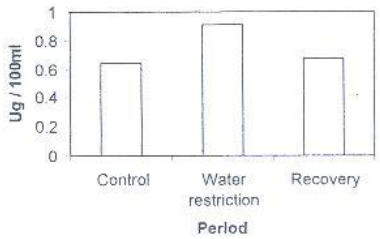

Fig. (2): - Average serum cortisol level (Ug/100 ml) of dairy buffaloes examined for water restriction