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EFFECT OF DIFFERENT LEVELS OF SODIUM CHLORIDE ON PHYSIOLOGICAL PARAMETER AND PRODUCTION PERFORMANCE IN FRIESIAN LACTATING COWS

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ABSTRACT

The effect of different levels of sodium chloride (NaCl) on water and feed intakes, milk yield and its composition and some physiological responses in Friesian cows was examined in this study during the three months of summer season (June, July and August). A total of 25 cows averaging 482.4±20.5 kg LBW, ranging 41-76 months of age and 2- 4 parities was used. All cows were at post-partum period after 25 days of calving. The cows were divided equally (five animals) into five groups according to their LBW, parity and its milk production. The 1st group cows were fed a basal diet without any treatment, that were considered as a control group (G1), and the cows in the three groups (G2), (G3) and (G4) were received a daily drinking water containing NaCl as 2000, 5000 and 7000 mg/l, respectively, during the experimental period. While, the 5th group cows (G5) were received drink water containing 2000, 5000 and 7000 mg/l NaCl during the first, the second and the third months of the experiment, respectively. Results showed that rectal temperature values (RT, ^{o}C) were significantly ($P<0.05$) lower in groups G3, G4 and G5 than in groups G1 and G2 in June, July and August, and the lowest value was in group G3 in June month. Values of white skin temperature (^{o}C) and respiration rate were significantly lower in groups G3, G4 and G5 than in groups G1 and G2. And values of black skin temperature (^{o}C) were significantly lower in groups G2, G3 and G5 than in groups G4 and G1. Water intake values of the treatment groups were significantly ($P<0.01$) higher than the control group as follows 12.3, 30.56, 54.49 and 18.6% in G2, G3, G4 and G5, respectively, where the highest value of the water intake was in group G4. Total dissolved solids (TDS) of SO_4, CO_3, Cl, Na and Ca were significantly ($P<0.01$) higher in treated groups than in the control group, TDS were increased with the increased amount of salt in the drinking water. Concentration of total protein, albumin and globulin in blood plasma were not significant. Glucose concentration was higher significantly ($P<0.05$) in G4 and G5 than the control group. The effect of NaCl treatment in drinking water on daily milk production as actual milk yield, fat corrected milk (FCM) as well as fat and protein yields in G3 and G4 tended to be significantly higher than the control and other treatment groups (G2 and G5). Milk composition was not affected by salt treatments. Cows in groups G3, G4 and G5 showed significantly ($P<0.05$) lower somatic cell counts (SCC) in milk yield as compared with G1 and G2 groups. Conclusively, the obtained results recommend common salt addition to the drinking water at 5g/L to improve the performance and production in Friesian lactating cows.
Keywords: Friesian cows, sodium chloride, water intake, milk production.

INTRODUCTION

Common salt (NaCl) was used as a mineral supplement for hundreds of years before its composition was known. Salt was low price, convenience and availability have made it the preferred way to supplement sodium and chloride. Salt is used to limit feed intake of highly palatable feeds such as grain (Lusby, 1993).

Common salt (NaCl) is essential in many plants and in the diet of humans and animals (Salt institute, 2007). It prevents dehydration, stimulates digestion and improves the body's ability to absorb minerals and elements. Salt deficiency can lead to decreased appetite, weight gain and even weight loss. Dairy cows excrete sodium output the body in urine, feces, saliva and milk which needs to be replaced. At the same time, soil reserves of sodium seem to be declining (O'Connor *et al*. 2000). Lactating dairy cows were requirement 0.22% sodium and 0.20% chloride under no heat stress conditions (NRC, 2001). However, the NRC (2001) estimates that when environmental temperatures are 86 °F or increased average size dairy cow will lose an additional 3.5 grams of sodium (9 grams of salt) per day in sweat. Salt requirements of cattle are higher under hot environmental, semi-arid conditions due to large losses of water and salt occurring via sweat (McDowell, 2003). Also, Johansson, (2008) reported that cows produced on 31 kg energy-corrected milk had a sodium deficiency of between 3.3 and 17.7 g/day, depending on the feeding system. Problem in extensive systems is that cattle use the land unevenly (Ganskopp, 2001), and water and salt are two of the most used tools to control the land use. Also, he showed that water is better than salt and using salt as a tool for influencing the movement of cattle. The highest level of sodium chloride in feed for dairy cattle was around 40 g NaCl/kg DMI, almost 1.0 kg NaCl/day or 1.40 g NaCl/kg body weight (NRC, 2001). That is a little higher than in humans, where a daily intake of 1.0 g NaCl/kg body weight results in severe salt poisoning (Andersson *et al.,* 1989). Feeding recommendations for minerals have been set to maximize animal growth rate, milk yield and reproduction (Beede, 1992). However, high levels of salt in feed will increase the sodium and chloride concentrations in urine and feces. These nutrients can limit its application of waste to soils in low rainfall or irrigated areas due to increased salinity of the soil (Van Horn *et al.,* 1994). The objectives of the present study were to test the effect of NaCl levels on feed and water intakes. In addition, to examine the effect of NaCl treatments on milk yield and its composition. Moreover, to measure the physiological responses as affected by the supplemented NaCl levels.

MATERIALS AND METHODS

The present study was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, during the period from June to August 2014.

Animals:

A total of 25 Friesian cows averaging 482.4±20.5 kg LBW and ranging between 41 - 76 months of age and 2- 4 parities was used in this study. All cows were at post-partum period (25 days post calving). In the beginning of the experimental period (the 1st week of June), cows were divided into five similar groups. Every group had five cows according to their LBW, parity and milk production. Cows in the 1st group were fed a basal diet without treatment and were considered as a control group (G1), while cows in 2nd (G2), 3rd (G3) and 4th (G4) groups were received a daily drink water consisted of water and sodium chloride (NaCl) 2000, 5000 and 7000 mg/L, respectively, during the experimental period (summer months). While, the 5th group (G5) was received 2000 mg/L for one month followed by 5000 mg/L for the next month and followed by 7000 mg/L for the last month of the summer months. All cows were free of any diseases with healthy appearance and housed in separated groups under semi-open sheds, partially roofed with asbestos.

Feeding system and management:

Throughout the experimental period, cows in all groups were fed concentrate feed mixture (CFM), which composed of 37.5% yellow corn, 20% soybean meal, 15% corn gluten, 22.5% wheat bran, 3% molasses, 0.5% and 1.5% common salt. Cows in all groups were fed equal amounts of a diet containing CFM, rice straw (RS) and corn silage (CS) according to the recommendation of the NRC (2001) allowances for dairy cows based on live body weight and milk yield.

Chemical analysis of representative monthly samples of foodstuffs was analyzed for CP, CF, EE, (NFE) and ash on DM basis according to the official methods of the A.O.A.C. (1984). The chemical composition of CFM, RS and BH as well as the calculated chemical composition of the basal diet that used in feeding cows in all groups is shown in Table 1.

Table 1: Chemical analysis of different feed stuffs (based on dry matter) used in feeding cows in the experimented groups.

Item (%)	Chemical composition (%)		
	CFM	**Rice straw**	**Corn silage**
DM	90.42	88.74	36.90
OM	89.54	82.83	89.32
CP	15.34	1.61	9.52
CF	11.46	37.36	18.83
EE	5.02	1.51	2.45
NFE	57.72	42.35	60.60
Ash	10.46	17.18	8.60
Na	0.652	0.487	0.564
K	0.782	0.592	0.685
Ca	0.362	0.425	0.265

Experimental procedures:

Temperature humidity index (THI):

Daily maximum and minimum values of ambient temperature (AT, °C) and relative humidity (RH%) during the entire length of the experimental period are shown in Table 2. The temperature-humidity index (THI) was estimated according to livestock and poultry heat stress indices, suggested by The Agricultural Engineering Technology Guide (AETG, 1980) using the following formula:

$$THI = db\,^{o}F - (0.55 - 0.55\ RH)\ (db - 58)$$

Where:

db ^{o}F = dry bulb temperature in Fahrenheit.

RH = relative humidity (RH / 100).

The obtained values of THI were classified as follows:

Less than 72 = absence of heat stress. 72 to 74 = moderate heat stress.
74 to < 76 = severe heat stress. Over 76 = very severe heat stress.

Body temperatures and respiration rate:

Throughout the experimental period from June up to August, body temperatures including rectal (RT, ^{o}C) as well as skin temperatures at white (WST, ^{o}C) and black (BST, ^{o}C) sites were recorded twice weekly at 13:00 h using digital precision thermometer (TRD, Ellab Cropcopen Hagen, Denmark). At the same time, respiration rate (RR, count/minute) was measured by counting the flank movements for one minute using stop watch.

Water intake:

Daily water intake was recorded during the last daily of each day in all groups. The volumes of water offered to the cows or refused were estimated using a graduated tall ruler with the water trough dimensions. The difference between both estimates (offered and refused) represented the total drunk water.

Water samples:

Water samples were collected biweekly in order to analyze concentrations of sulfate, bicarbonate, chloride, sodium and calcium ions according to Richards (1954) and FAO (1992).

Blood sampling:

During the experimental period, blood samples were biweekly collected in clean test tubes via the jugular vein from all cows in each group. Blood plasma was separated by centrifugation of the collected blood at 15 *g* for 10 min, and then plasma was kept frozen at –20 ^{0}C until chemical analyses. Concentration of total proteins (Gornall *et al.,* 1949), albumin (Weichselaum, 1946) and glucose (Trinder, 1969) in blood plasma were determined using commercial kits (Diagnostic System Laboratories, Inc USA). Plasma globulin was calculated by subtracting concentration of albumin from total proteins.

Milk yield and composition:

According to the managerial practices applied in the farm, cows were milked twice daily at 6:00 and 17:00 h by milking machine. Milk yield was individually recorded for morning and evening lactations. Individual milk samples were monthly collected for determining milk composition using milko-scan (Model 133B) and somatic cell count (SCC) were determined for each milk sample with a Fossomatic 90 (A/S N Foss Electric, Hillerod, Denmark) between 24 and 48 h postcollection using the previously described method by (Gonzalo *et al.,* 1993).

Statistical analysis:

The obtained data were statistically analyzed using **SAS (2004)**. The significant differences among treatment groups were tested using Duncan's Multiple Range Test **(Duncan, 1955)**. The statistical model was:

$Y_{ij} = U + A_i + e_{ij}$.

Where as: Y_{ij} = Observed traits, U = Overall mean, A_i = Experimental group 1-5 (1= G1, 2= G2, 3= G3, 4= G4 and 5=G5) and e_{ij} = Random error

RESULTS AND DISCUSSION

Temperature humidity index:

Data in Table 2 revealed that cows in all groups were exposed to heat stress during the experimental period, being very sever (THI over 76) during June, July and August.

Table 2: Average values of ambient temperature (°C), relative humidity (%) and Temperature humidity index (THI) of lactating Friesian cows during the experimental period.

Item	Experimental period		
	June	July	August
Ambient temperature (°C):			
Maximum	31.9±2.2	32.76±1.3	33.2±1.4
Minimum	21.1±1.3	21.0±2.3	19.6±2.4
Relative humidity (RH%):			
Maximum	88.5±12.4	91.15±6.5	92.0±8.4
Minimum	59.0±8.5	66.4±7.4	58.0±6.4
Temperature humidity index (THI):			
Maximum	86.15±9.5	89.23±7.4	90.81±4.6
Minimum	67.50±7.5	69.45±6.2	65.68±3.8
Mean	76.82±6.5	79.34±5.9	78.25±3.6

According to AETG (1980), these results indicated that Friesian cows exposed to very sever heat stress through summer months where the THI values were over 76, in particular during August month as found for a previous study of Abdel-Khalek (2000) and Sayah (2005) on Friesian bulls kept under the same conditions.

Thermoregulatoy responses:

Data in Table 3 and Figures 1-4 showed that body temperatures including RT, WST and BST as well as RR during heat stress period in summer months (June, July and August) significantly ($P<0.05$) decreased for all groups treated with NaCl, in particular by increasing dose from 2000 up to 7000 mg/L in drinking water as compared to the control group. It is of interest to note that the observed increase in THI values in August reflected in tendency of higher response of cows in all groups in terms of higher RT, WST, BST and RR than in June and July, but the response was the lowest in cows of G4 (Table 3).

Rectal temperature (^oC) was significantly (P<0.05) decreased in G3, G4 and G5 during July and August months than in control and G2 groups, but the response was the lowest in cows of G3 only during June month (Table 3). Skin temperatures (^oC) for white sites besides the respiration rate were significantly lower in G3, G4 and G5 during the summer months than in G2 and control (G1) groups. Skin temperature (^oC) for black sites was significantly lower in G2, G3 and G5 during the summer months than in G4 and control (G1) groups (Table 3).

Similar trends of changes in body temperatures were reported on Friesian calves (Abu El-Hamd, 2000) and on Friesian bulls (Fawzy and Rabie, 1996 and Abdel-Khalek, 2000). Generally, exposing cows to heat stress during summer months caused disturbances in animal body thermoregulation, resulting in marked increase (P<0.05) in RT and RR (Abdel-Samee, 1995 & 1997) and Marai *et al*. (1997). The observed trend of decrease in WST and BST in treatment groups than in the control group was similar to that obtained by Salem *et al*. (1984) in cattle and Abu El-Hamd (2000) in Friesian calves. It is worth noting that NaCl treatments resulted in significantly (P<0.05) lower RT rather than those observed in WST, BST and RR (Table 3). This may be a strong reaction of control cows to store heat in their bodies more than treated cows (Abdel-Samee, 1998).

Table 3: Average values of rectal and skin temperatures and respiration rate during postpartum of lactating Friesian cows treated with different levels of sodium chloride.

Item	Control (G1)	Treatment groups			
		G2	G3	G4	G5
Rectal temperature (^oC):					
June	$39.38±0.20^{a}$	$38.96±0.11^{ab}$	$38.78±0.12^{b}$	$38.80±0.20^{ab}$	$38.91±0.10^{ab}$
July	$39.24±0.18^{a}$	$39.12±0.12^{ab}$	$38.70±0.10^{b}$	$38.69±0.10^{b}$	$38.54±0.07^{b}$
August	$39.56±0.20^{a}$	$39.14±0.12^{ab}$	$38.92±0.14^{b}$	$38.73±0.10^{b}$	$38.58±0.10^{b}$
Skin temperature (^oC) for white site:					
June	$33.79±0.10^{a}$	$33.26±0.10^{b}$	$32.81±0.10^{b}$	$32.14±0.20^{b}$	$32.69±0.08^{b}$
July	$33.02±0.12^{a}$	$32.86±0.11^{ab}$	$32.58±0.11^{b}$	$31.82±0.13^{b}$	$32.24±0.12^{b}$
August	$34.56±0.20^{a}$	$34.02±0.14^{ab}$	$33.92±0.16^{b}$	$33.38±0.20^{b}$	$33.58±0.20^{b}$
Skin temperature (^oC) for black site:					
June	$35.49±0.14^{a}$	$35.01±0.12^{b}$	$34.84±0.13^{b}$	$35.11±0.11^{ab}$	$34.51±0.12^{b}$
July	$36.01±0.21^{a}$	$35.16±0.16^{b}$	$35.42±0.16^{b}$	$35.74±0.20^{ab}$	$34.05±0.23^{b}$
August	$35.52±0.20^{a}$	$34.92±0.15^{b}$	$34.54±0.17^{b}$	$34.95±0.12^{ab}$	$34.93±0.17^{b}$
Respiration rate (times/min)					
June	$65.58±3.5^{a}$	$59.5±3.1^{ab}$	$53.03±3.7^{b}$	$56.25±3.5^{ab}$	$60.25±3.4^{ab}$
July	$61.27±3.4^{a}$	$54.6±3.2^{ab}$	$49.51±3.6^{b}$	$52.54±3.1^{ab}$	$46.33±3.1^{b}$
August	$64.53±3.6^{a}$	$55.2±3.4^{ab}$	$52.08±4.1^{b}$	$55.08±3.6^{ab}$	$52.42±3.8^{b}$

[a, b and c]: Means having different superscripts within the same row are significantly different at P<0.05.

Generally, physiological response in terms of RT, WST, BST and RR in June, July and August (Table 3) was in relation to THI values during these months (Table 2). In cows exposed to heat stress, respiratory rate decreased and both peripheral blood flow and sweating increased. These responses have a deleterious effect on physiologic status of the cow **(West, 2003).**

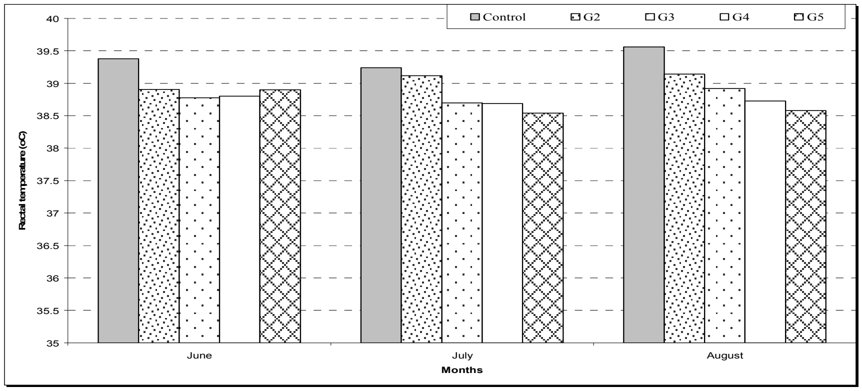

Figure 1. Effect of sodium chloride on rectal temperature (°C) of lactating Friesian cows during the experimental period.

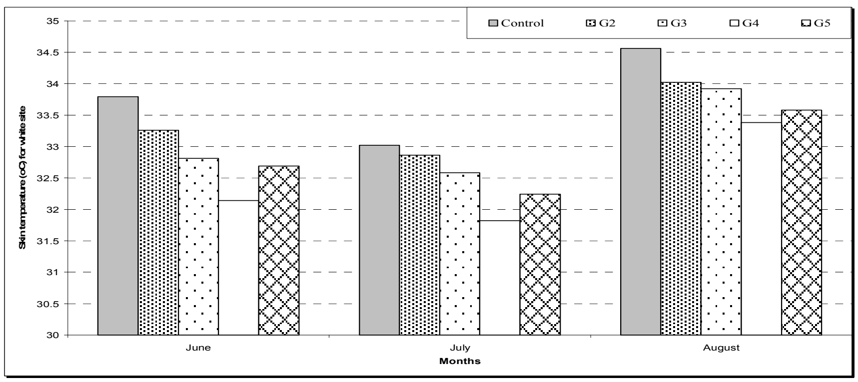

Figure 2. Effect of sodium chloride on skin temperature (°C) for white sites of lactating Friesian cows during the experimental period.

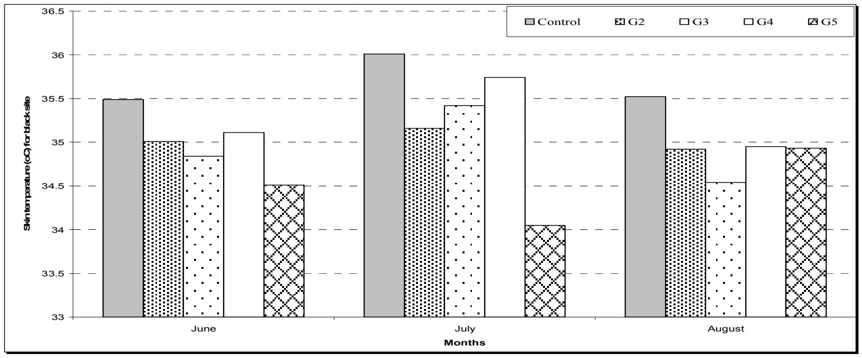

Figure 3. Effect of sodium chloride on skin temperature (°C) for black sites of lactating Friesian cows during the experimental period.

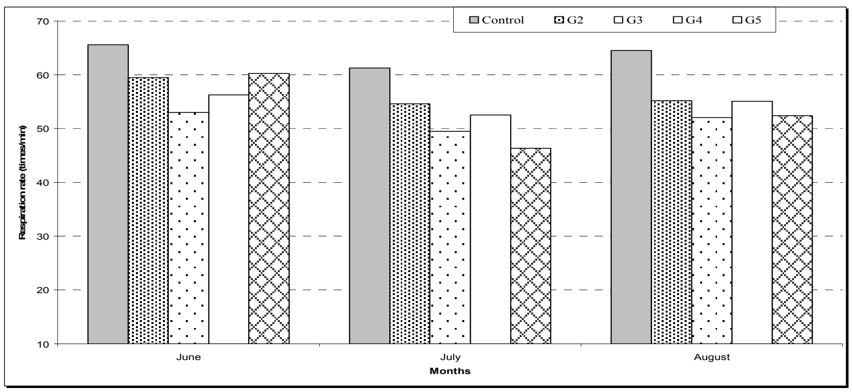

Figure 4. Effect of sodium chloride on respiration rate (count/min) of lactating Friesian cows during the experimental period.

Feed intake:

Data presented in Table 4 showed that average daily feed intake (CFM, RC and CS) and total intake as DM, TDN and DCP were significantly (P<0.05) different among dietary groups, although cows in G4 showed higher total intake as DM, TDN and DCP than the other groups.

Average DMI was significantly (P<0.05) altered by drank salt concentration, tended to increase (18.03, 18.99 and 19.21 kg/head/d, respectively) as level of dietary salt was increased (2000, 5000 and 7000 mg/l water). The increase in DMI from 2000 to 7000 of salt was 6.54%. The results are in agreement with the **Schneider *et al.* (1986)** who found that increasing the sodium level in the diet from 0.18 to 0.55% increased feed intake in during the summer

Table 4: Effect of NaCl treatment on feed intake of lactating Friesian cows.

Item	Control (G1)	Treatment groups			
		G2	G3	G4	G5
Average daily feed intake (kg/h/day):					
CFM	7.11±0.13[a]	7.55±0.11[a]	7.80±0.12[a]	7.75±0.14[a]	7.45±0.13[a]
RC	4.00±0.09[b]	4.10±0.06[b]	4.20±0.08[ab]	4.50±0.12[a]	4.00±0.07[b]
CS	20.00±0.14[d]	21.20±0.13[b]	22.25±0.15[a]	22.25±0.12[a]	20.65±0.12[c]
Total	31.10±1.25	32.85±1.24	34.25±1.23	34.50±1.21	32.10±1.22
Average feed intake (kg/h/day):					
Total DM	17.36±0.4[c]	18.03±0.4[ab]	18.99±0.3[a]	19.21±0.4[a]	17.91±0.2[bc]
TDN	9.99±0.2[b]	10.55±0.3[ab]	10.96±0.1[a]	11.06±0.2[a]	10.33±0.3[b]
DCP	1.71±0.2	1.81±0.1	1.88±0.1	1.88±0.2	1.81±0.2

[a, b and c]: **Means having different superscripts within the same row are significantly different at P<0.05.**

Water intake (L/day/cow):

Data in Table 5 and Figures 5 showed that water intake was significantly (P<0.01) higher in G3 and G4 than the other treatments and control groups. However, the treatment groups were significantly (P<0.01) higher than the control groups being 12.3, 30.56, 54.49 and 18.6%. in G2, G3, G4 and G5, respectively, compared with the control group. Water intake was increasing by the increase salt supplemented between 2000 to 7000 mg/L water, water intake increased about 54.5%. The results are in agreement with La Manna *et al.,* (1999) who, found that water intake increase tended to increase dietary salt concentration (36, 42, and 48 L/day). Changing from 0 to 0.50% of salt in heifers, water intake increased about 30%. Also, water intake was significantly higher for animals in treatment 10000 mg/l (Silvia *et al*. 2008). In the same time, Holter and Urban (1992) and NRC (2001) found that water intake was highest during the hot months because of its relationship with environmental temperature.

Table 5: Effect of NaCl treatment on water intake of lactating Friesian cows.

Item	Control (G1)	Treatment groups			
		G2	G3	G4	G5
June	117.1±7.6[c]	127.5±9.4[bc]	155.6±12.3[b]	197.2±12.1[a]	127.7±9.7[bc]
July	124.0±9.2[c]	143.0±11.2[bc]	159.4±12.5[ab]	184.0±11.4[a]	140.0±12.6[bc]
August	130.0±6.8[c]	146.2±10.5[bc]	169.5±10.2[ab]	192.2±7.8[a]	172.5±9.8[ab]
Mean	123.7±8.9[c]	138.9±10.2[bc]	161.5±11.3[ab]	191.1±10.8[a]	146.7±13.6[bc]

[a, b and c:] **Means within the same row with different superscripts are significantly different at (P<0.01).**

The water was increased in August month in all groups because increased temperature, heat stress (THI, 90.81) and excretion of waste products on via urine, feces, and respiration rate. The results are in agreement with Woodford *et al*. (1984) who, water requirement per unit of body weight of a producing dairy cows are highest than that of any other land-based mammal. This is because of the milk yield of a composition that is 87% water, also its required for digestion and metabolism of energy and nutrients, transport in circulation of nutrients and metabolites to and from tissues, maintenance of ion, heat balance; and as a fluid and cushioning environment for development fetus (Houpt, 1984 and Murphy, 1992). Loss of about 20% of total body water is fatal. Body water content of the bodies of adult dairy cow ranges between 56 and 81% of body weight depending upon stage in the lactation (Murphy, 1992).

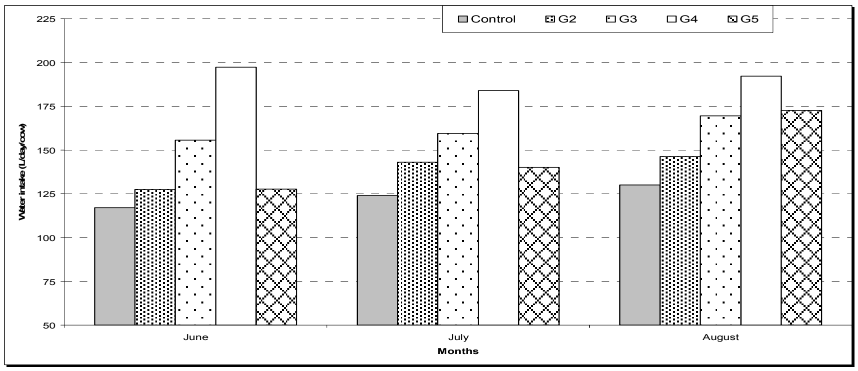

Figure 5. Effect of sodium chloride on water intake (L/day/cow) lactating of Friesian cows during the experimental period.

Water composition:

Total dissolved solids (TDS) were a measure of all constituents dissolved in water utilized including carbonates (CO_3), chlorides (Cl), sulfates (SO_4), sodium (Na), and calcium (Ca) during the experimental period is shown in Table 6. The TDS of SO_4, CO_3, Na and Ca were significantly ($P<0.01$) higher in treated groups than in the control group, TDS were increased with the increase of salt amount in the drinking water.

Table 6: Chemical composition of the water utilized during the experimental period for treatments containing different amounts of salts in the drinking water.

Item	Treatment groups (mg/l water))			
	0.0	2000	5000	7000
SO_4 (mg/l)	68±6.4^d	232±11^c	902.1±39.2^b	1772±92^a
CO_3 (mg/l)	16.2±2.5^d	27.4±3.1^c	59.8±4.2^b	97.14±9.6^a
Na (mg/l)	116±15^d	562±46^c	1624±56.8^b	2214±102^a
Cl (mg/l)	67±14^d	254±41^c	1467±65.2^b	2147±96.5^a
Ca (mg/l)	9±1.2^c	17±2.4^b	61±5.6^a	72±6.7^a

$^{a, b, c \text{ and } d:}$ **Means within the same row with different superscripts are significantly different at (P<0.01).**

The TDS of SO_4, CO_3, Cl, Na and Ca were difference significantly (P<0.01) among treatment groups being higher in animals of G4 and G3 receiving 7000 and 5000 mg/L and maturate in animals of G2 receiving 2000 mg/L (Table 5).

The effect of salt on drinking water salinity was striking, especially considering that treatment 5000 and 7000 mg/L which had a salt considerably above the levels considered to be limiting for lactating dairy cows. The results are in agreement with the Beede (2005) and Silvia *et al.,* (2008) who found that minerals such as sodium, magnesium and sulfur were highly overbalanced in treatments 5000 and 10000. However, higher sodium excretion rates have been described as a response to high potassium levels.

Blood Metabolites

Total proteins and glucose in blood plasma during the experimental period is shown in Table 7. Concentration of total protein, albumin and globulin in blood plasma were not significantly different. But, glucose concentration was higher significantly (P>0.05) in G4 and G5 than the control group, the differences between in G1, G2 and G3 were not significant.

Table 7: Effect of NaCl treatment on some blood biochemical in blood plasma of lactating Friesian cows.

Item	Control (G1)	Treatment groups			
		G2	G3	G4	G5
Total protein	7.68±0.12	7.73±0.11	7.86±0.09	7.95±0.12	7.72±0.13
Albumin	3.86±0.07	3.91±0.08	3.78±0.09	3.91±0.11	3.84±0.1
Globulin	3.82±0.08	3.82±0.11	4.02±0.1	4.04±0.09	3.88±0.1
Glucose	$51.62±1.7^{b}$	$54.52±1.5^{ab}$	$56.84±1.8^{ab}$	$58.14±2.0^{a}$	$57.12±1.9^{a}$

a and b: Means within the same row with different superscripts are significantly different at (P<0.05).

Milk production and compositions:

The effect of NaCl treatment in drinking water on daily milk production as actual milk yield, fat corrected milk (FCM) as well as fat and protein yields was significant (P<0.05) (Table 8). However, daily milk production in G4 and G3 tended to be significantly (P<0.05) higher than the control and other treatment groups (G2 and G5). Interestingly to observe that milk composition was not affected by salt treatment especially percentage of fat and protein, which indicate superiority of cows in G3 and G4 in their daily production from 4% FCM, fat and protein yields. All milk production parameters were not significantly altered in cows treatments and the control groups.

In addition to increasing milk production, cows in G3, G4 and G3 showed significantly (P<0.05) the lowest somatic cell count (SCC) in milk as compared to the control and G2 groups (Table 8).

It is worth noting that the significant (P<0.05) increases in milk production of cows in G4 and G3 were mainly associated with marked reduction in estimated body temperatures and RR and increased water intake of cows in this groups as compared with the control and other treated groups. The SCC was significantly (P<0.01) lower in G3, G4 and G5 than in G1 and G2. These effects may depend on a little increase of the digestibility of the herbage which fertilized with sodium (Table 5). The results are in agreement with the Schneider *et al*. (1986) who found that increasing the sodium level in the diet from 0.18 to 0.55% increased feed intake and milk yield in during the summer. Phillips *et al*. (2000) studied the effects of sodium supplements on milk production and mammary gland health. They fount that on productive pastures, sodium could increase the milk yield of cows and decrease somatic cell count (SCC) in milk.

Sodium is the principal ions in interstitial fluid outside the body cells and has many functions in the body. It is an accessory in many transport systems, such as the absorption of chlorine, amino acids, glucose and water (ARC, 1980; NRC, 1996 and NRC, 2007). Sodium is involved in important transport systems for neuromuscular activity, nerve function and maintenance of body temperature. Together with potassium and chloride, sodium is one of the most important ions for the body to regulate pH and osmotic pressure.

Table 8: Effect of salt treatment on milk production, milk composition and somatic cell count in milk of lactating Friesian cows.

Item	Control (G1)	Treatment group			
		G2	G3	G4	G5
Daily milk production:					
Actual MY (kg)	12.03 ± 0.5^{b}	13.38 ± 0.6^{ab}	13.85 ± 0.6^{a}	14.46 ± 0.4^{a}	13.59 ± 0.7^{ab}
4% FCM (kg)	11.32 ± 1.3^{b}	13.75 ± 1.3^{ab}	12.92 ± 1.5^{ab}	13.28 ± 1.1^{a}	12.49 ± 1.1^{ab}
Fat yield (g)	434.3 ± 23^{b}	483.0 ± 23^{ab}	491.7 ± 19^{ab}	500.3 ± 21^{a}	470.2 ± 20^{ab}
Protein yield (g)	351.3 ± 19^{b}	394.7 ± 21^{ab}	390.6 ± 23^{ab}	417.9 ± 16^{a}	387.3 ± 21^{a}
Chemical composition (%):					
Fat	3.61±0.10	3.62±0.20	3.55±0.20	3.46±0.09	3.46±0.15
Protein	2.92±0.09	2.95±0.08	2.82±0.10	2.89±0.10	2.85±0.10
Lactose	4.25±0.20	4.18±0.20	4.19±0.30	4.24±0.30	4.21±0.25
TS	11.65±0.70	11.20±0.6	10.98±0.70	10.79±0.80	11.22±0.70
SNF	7.79±0.40	7.28±0.50	7.26±0.50	7.29±0.60	7.76±0.40
Somatic cell count (1000/ml):					
SCC	378.4 ± 21^{a}	356.5 ± 19^{a}	287.2 ± 16^{b}	274.4 ± 20^{b}	301.2 ± 18^{b}

MY: Milk yield, FCM: Fat corrected milk, TS: Total solids, SNF: Solids not fat and [a and b:] Means having different superscripts within the same row are significantly different at P<0.05.

Most of the kg sodium in the body is found in body fluids and in bone (Underwood, 1981). The normal sodium concentration ranged 3.2-3.5 mg/l in blood plasma. In cows with individual feeding were fed an increased amount of sodium, from 1-6 or 11 g Na/kg DM, by adding salt (Phillips *et al.,* 2000). This increased amount influenced milk yield and SCC which were decreased. When 6 g Na/kg DM was given, only the SCC decreased.

CONCLUSION

The current study concluded that to maximize the beneficial effects of salt treatments for lactating Friesian cows kept under heat stress during summer months in Egypt on heat stress could be eliminated and milk production could be improved by receiving a daily 5000 or 7000 mg/L drinking water.

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تأثير مستويات مختلفة من كلوريد الصوديوم علي الصفات الفسيولوجية والأداء الإنتاجي في الأبقار الفريزيان الحلابة

محمود سيد صياح ، محمد عوض أبو الحمد ،ياسر مبروك الديهي وعرفه عطيه حلاوه
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تهدف هذه الدراسة إلي معرفة تأثير مستويات مختلفة من الملح (كلوريد الصوديوم) مذابة في ماء الشرب والغذاء المأكول وإنتاج وتركيب اللبن والاستجابة لبعض الصفات الفسيولوجية في الأبقار الفريزيان الحلابة خلال أشهر الصيف في مصر. استخدم في هذه الدراسة ٢٥ بقرة فريزيان حلابة متوسط وزنها ٤٨٢.٤±٢٠.٥ كجم وعمرها ٤١-٧٦ شهرا وفي الموسم ٢-٤. قسمت الحيوانات بعد الولادة ب ٢٥ يوم إلي خمس مجموعات متساوية حسب وزن الجسم والموسم وإنتاج اللبن. المجموعة الأولي غذيت علي العليقة الأساسية بدون إضافات (كنترول) بينما أبقار المجموعات الثانية والثالثة والرابعة تم إضافة الملح (كلوريد الصوديوم) يوميا في مياه الشرب بمعدل ٢٠٠٠ و٥٠٠٠ و٧٠٠٠ ملجم/لتر ماء علي الترتيب. أما المجموعة الخامسة أضيف لها ٢٠٠٠ ملجم في الشهر الأول و٥٠٠٠ ملجم في الشهر الثاني و٧٠٠٠ ملجم /لتر ماء شرب في الشهر الثالث من التجربة. وكانت النتائج المتحصل عليها كالتالي:-

- انخفضت درجة حرارة المستقيم ودرجة حرارة الجلد الأبيض ومعدل التنفس معنويا في المجموعات الثالثة والرابعة والخامسة مقارنة بالمجموعة الأولي والثانية خلال أشهر الصيف.
- بينما انخفض درجة حرارة الجلد الأسود معنويا في المجموعات الثانية والثالثة والخامسة مقارنا المجموعتين الأولي والرابعة.
- ارتفع معدل استهلاك الماء معنويا بمعدل ١٢.٣ و٣٠.٥٦ و٥٤.٤٩ و١٨.٦ % في المجموعات الثانية والثالثة والرابعة والخامسة مقارنا بالكنترول علي الترتيب.
- ارتفع تركيز الأملاح الذائبة في الماء (الكبريتات والكربون والصوديوم والكلور والكالسيوم) معنويا في المجموعات المعاملة مقارنا بالكنترول. كما زاد تركيز الأملاح الذائبة مع زيادة مستوي الملح في ماء الشرب.
- تركيز كل من البروتين والألبيومين والجلوبيولين في بلازما الدم لم يتغير. بينما ارتفع تركيز الجلوكوز في المجموعتين الرابعة والخامسة مقارنة بالكنترول.
- ملح كلوريد الصوديوم تأثير ايجابي علي إنتاج اللبن وانتاج اللبن المعدل وإنتاج الدهن والبروتين في المجموعة الرابعة والثالثة مقارنا بباقي المجموعات أما تركيب البن فلم يتأثر.
- انخفض عدد الخلايا الجسدية في البن معنويا في المجموعات الثالثة والرابعة والخامسة مقارنا بالمجموعتين الأولي والثانية.

لذا يوصي باضافة ملح الطعام في ماء شرب الماشية الحلابة بمعدل ٥جم/لتر لتحسين الأداء والإنتاج للأبقار الفريزيان الحلابة.