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AMELIORATIVE EFFECT OF ASCORBIC ACID ADMINISTRATION AND CHILLED DRINKING WATER ON RAM LAMBS EXPOSED TO HEAT STRESS DURING SUMMER SEASON.

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ABSTRACT

The ameliorative effect of ascorbic acid supplementation and drinking chilled water on heat stress was studied on ram lambs. Twenty male ram lambs were randomly divided into four equal groups of five animals each and nearly similar in age and weight. The 1st group served as control (CTR), the 2nd group was given cold water (10-15 °C) without adding vitamin C (G1), the 3rd group was supplemented with ascorbic acid at rate 2.5 g/h/d (G2), the 4th group was supplemented with ascorbic acid in addition to the cold water (G3). All animals exposed to the same managerial and climatic condition during the complete experimental period. Body weight (BW) recorded at the beginning, then at biweekly intervals until end of the experiment. Feed intake, feed conversion efficiency, water intake per unit body gain and water intake per unit feed intake were calculated for each lamb. Rectal and ear temperatures, respiratory and pulse rates were measured. Blood plasma samples were analyzed for some blood constituents (total protein, albumin, globulin, glucose, total cholesterol, ALT, AST, calcium (Ca^{++}) and potassium (K^{+})). Total protein, albumin, globulin, glucose, cholesterol and calcium concentrations were significantly higher ($P \leq 0.001$), however liver enzymes AST and ALT were significantly lower ($P \leq 0.001$) in the blood plasma of treated lambs (G1, G2 and G3) than those in control group. Cumulative feed intake, body weight gain, and cumulative water intake were significantly higher ($P \leq 0.01$) in G3 than other three groups. Rectal temperature ($P \leq 0.05$), respiration rate and pulse rate ($P \leq 0.01$) increased significantly, while ear temperature was not significantly affected by treatment. In conclusion, ascorbic acid supplementation ameliorates the adverse effect of heat stress during summer season. The body temperature, respiration and pulse rates have decreased as a result of the use of cold water or supply of ascorbic acid. Therefore, availability of cold water is paramount to prevent heat stress in sheep, especially during periods of extended hot and humidity.

Key words: Ascorbic acid, heat stress, productive performance, physiological responses.

INTRODUCTION

Heat stress can be a welfare issue for all types of livestock. Egypt is in the north-eastern corner of Africa between latitudes 21° and 31° North and longitudes 25° and 35° East **(El-Nahrawy, 2011)**. Assiut city sandwiched between two mountain ranges about 600 m height and it is located at 27°03' N, 031°01'E and 69 m of elevation. During summer season, the ambient temperature can exceed 42 °C. Yet, in winter season Assiut gets below 0 °C temperatures during the night and frost can easily formed, while hail or snow are rare because of the low average of the city's precipitation and general lack of humidity **(NOAA, 2013)**. According to **Stott (1981)**, stress is the result of environmental forces continuously acting upon animal that disrupt homeostasis resulting in new adaptation that can be detrimental or advantageous to the animal. The degree to which an animal resists change in body temperature varies with different species because of differences in their heat regulating mechanisms **(Salah *et al.*, 1995)**. Sweating, high respiration rate, vasodilatation with increased blood flow to skin surface, high rectal temperature, reduced metabolic rate, decreased dry matter intake, efficiency of feed utilization and alteration of water metabolism are the physiologic responses that are associated with negative impacts of heat stress on production and reproduction in dairy animals **(West *et al.* 1999)**. It is well known that the physiological responses, particularly rectal temperature and respiration rate reflect the degree of stress imposed on animals by climatic parameters. The ability of an animal to withstand the rigors of climatic stress under warm conditions has assessed physiologically by means of changes in body temperature, respiration rate and pulse rate **(Leagates *et al.*1991 and Sethi *et al* 1994)**. Many attempts have done to overcome the adverse effects of heat stress by modifying environmental condition through nutritional, managerial, and physiological manipulation of animals. There is a reasonable body of evidence supporting the use of ascorbic acid (vitamin C) in reducing different kind of stresses in animals **(Ali and Al-Qarawi, 2002, Ayo *et al.*, 2006 and Powers and Jackson, 2008)**. **Minka and Ayo (2011)** concluded that, the administration of ascorbic acid prior to loading and transportation ameliorate the adverse effects of loading, transportation, and high ambient temperature and relative humidity on the immune status of the goats and overcome the stress with less response. Recent research indicated that the supply of ascorbic acid for Awassi sheep led to the alleviation of heat stress and reduced the loss in body weight **(Ghanem *et al.*, 2008)**.

Water is an excellent cooling agent because of its high heat capacity and high latent heat of vaporization. Chilled drinking water is effective because it absorbs heat directly from the animal's organs and tissues through conduction, which called internal cooling. This has been successful in lactating goats and cattle **(Wilks *et al.*, 1990 and Abdel-Samee *et al.*, 1992)**. Direct wetting of the animal is a very effective practice and often used in an emergency to reduce heat stress. The use of direct wetting by sprinkling as a tool for increased animal performance is still unsettled **(Hahn, 1985)**. Careful perusal of the literature revealed an absence of sufficient information regarding the role of antioxidants during heat stress in ruminants. Therefore, the present study conducted to assess whether supplementation of vitamin C or drinking chilled water or both treatments together could alleviate the negative effect of possible heat stress developed in summer on ram lambs, through measuring some physiological parameters that represent good indicators of animals' performance.

MATERIALS AND METHODS

1- Location and experimental animal:

This study was carried out in the Experimental Farm of the Animal Production Department, Faculty of Agriculture, Al-Azhar University, Assiut Branch. The fieldwork executed during summer season from the beginning of June to the end of August 2011. The laboratory work took place at the Animal Production Department laboratories of the same faculty. Twenty healthy growing male crossbred sheep (Chios x Ossimi) weighed 22.20 ± 0.99 kg randomly divided into four similar groups (5 rams each). The control daily ration consisted of concentrate feed mixture (CFM), Darawa and wheat straw. Components of CFM and chemical analysis presented in Table (1).

2- Feeding and management:

The animals fed in groups on CFM at level 2.5 % of their live body weight (LBW) with *ad libitum* wheat straw, as Darawa offered to animals once daily during afternoon in the four separate pens. All animals fed the same diet throughout the experiment. Lambs were fed twice daily at 07:00 and 16:00 h, and drinking water was available all times. All lambs received control ration and drank water at 23- 30 °C during the first week of experiment as adjustment period to watering and feeding regimen. Following the adjustment period, lambs were received water and ration as following.

The first group continued on the same input and served as control (CTR) group. Meanwhile, the 2nd group was given cold water without adding vitamin C (G1), the 3rd group was administered with vitamin C (2.5 g/h/d) only with non-cold water (G2) and the 4th group was given vitamin C at a rate of (2.5 g/h/d) in addition to the cold water (G3). In the 2nd and 4th groups, drinking water was chilled to 10 - 15 °C by adding ice to the water container. While, drinking water temperature for the lambs in the 1st and 3rd groups was 23 – 30 °C. The ascorbic acid doses were selected based on previous findings of **Ghanem *et al.*, (2008)** whereby a dose of 2.5 g/d (approximately 45 mg/kg body weight) showed promising stress alleviation results for water restricted Awassi ewes. Ascorbic acid as fine powder provided by El-Nasr Pharmaceutical Chemicals Company, Egypt. The 2.5 g of ascorbic acid dissolved in 12.5 ml of water and administered orally on a daily basis through the experimental period. Body weight (BW) was recorded at the start and once biweekly until end of the experiment. The amount of concentrate changed biweekly according to the change in LBW. Samples of feed ingredients and feces taken for chemical analysis according to **AOAC (1990)**. Feed intake (FI), feed conversion efficiency (FCE), water intake (WI) per unit body gain and water intake per unit feed intake were calculated for each animal.

3- Thermo-cardio-respiratory traits:

Rectal temperature (RT) measured using a digital thermometer inserted into the rectum and left for a minute. Ear temperature (ET) was measured using digital thermometer, while pulse rates (PR) were measured using a stethoscope. Respiratory rates (RR) measured by observation of the flank movement of the thoracic cage for a minute. RT, RR, ET and PR were determined throughout the experimental period twice daily (at 06:00 a.m and 01:00 p.m) once a week.

4- Climatic conditions:

The weather conditions in terms of minimum (MAT) and maximum (MXAT) temperatures and relative humidity (RH) recorded inside the barn twice per day (at 02:00 and 14:00 h) using thermo-hygrometers. The temperature-humidity index (THI) was calculated from the following equation $THI = db\ {\circ}C - \{(0.31-0.31\ RH)\ (db\ {\circ}C-14.4)\}$, as proposed by **Marai *et al.*, (2001)** where, db ◦C is the dry bulb temperature (◦C) and RH is the relative humidity (RH %) /100. The THI commonly used as an indicator for the degree of stress on animals caused by weather circumstances.

5- Blood sampling and analysis:

Blood samples of all groups collected by venipuncture from the jugular vein into sterile vials containing anti-coagulant heparin early in the morning before feeding every month post exposure to heat stress. The samples transported in icebox to the laboratory within 20-30 minutes, centrifuged at 3000 rpm for 20 minutes and the plasma was stored at -20ºC until analyzed. Various chemical analyses were determined with commercial test kits and measuring the optical density with wavelength used for determination by spectrophotometer. Total protein (TP), albumin (Alb), Glucose (Glu), AST, ALT and total cholesterol (TC) were determined using assay kits supplied by Diamond Diagnostics Co., Hannover, Germany. However, globulin (Glb) concentration calculated by subtracting the value of Alb from the corresponding value of TP. Albumin/Globulin ratio (A/G) was calculated. TP was determined according to the method of **Dumas (1975),** while Alb was determined according to **Dumas *et al.*, (1997).** According to **Kalpan (1984)** Glu concentration was estimated, AST and ALT were determined according to **White *et al.*, (1970).** The concentration of Ca^{++} ion was determined using atomic absorption spectrophotometer while the K^{+} ion was estimated using Flame photometric method.

6- Statistical analysis:

Analyses of variance performed on all variables measured using the general linear models (GLMs) procedure of **SAS (1998)** according to the following model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: μ = Mean, T_i = Effect of treatment and e_{ij} = Standard error. **Duncan's** multiple range tests (1955) was utilized for determining differences among subgroups means.

RESULTS AND DISCUSSION

1- Climatic conditions:

The average climatic data throughout the experimental period including ambient temperature (AT), relative humidity (RH) and temperature humidity index (THI) presented in Table 2. Overall mean of average AT, RH and THI during experimental periods were 29.62 ± 0.29, 35.30 ± 0.89 and 26.56 ± 0.22, respectively. AT values were significantly (P<0.01) different between summer months, where the MXAT was higher during July. The average RH value was significantly (P<0.05) lower during June. The values of THI were significantly (P≤0.01) higher during July than June and August. Average values of THI during June, Jule and August were 25.73 ± 0.22, 27.43 ± 0.22 and 26.51 ± 0.22, respectively. These results indicate that lambs exposed to extreme severe heat stress during summer season. Since it has been reported that THI values above 25.6 are considered as sever to extreme heat stress **(Marai *et al.*, 2001),** Furthermore, THI below 22.2 is normally considered as comfortable. **Al-Haidary *et al.*, (2012**) reported that Najdi sheep exposed to extreme heat load during summer season when the mean value of THI was (31.41±0.22). For adult sheep, fed above maintenance, **Stockman (2006)** estimated the lower critical temperature as 25^{o}C and the upper critical temperature as 31^{o}C.

Table 1: Ingredients and chemical analyses of the basal ration fed to growing ram lambs.

Ration formula		**Chemical composition of mixed ration**	
Ingredients	Ratio	Contents	%
Yellow corn	30	DM	90.32
Grain sorghum	25	OM	86.85
Soybean meal	15	CP	15.26
Undecorticated cotton seed meal	15	CF	7.93
Wheat bran	12	EE	5.005
Limestone	2	NFE	58.66
Common salts	1	Ash	3.48
		GE, Mcal/Kg DM*	4.10

* GE (Mcal/Kg DM) = CP x 5.65 + CF x 4.15 + Eex 9.40 + NFEx 4.15 **(Blaxter, 1968)**

Table 2: Averages of Maximum, minimum and daily ambient temperatures (◦C) and relative humidity (%) during the complete experimental period.

Variable	LSM ± SE			**Overall mean**	**Significant level**
	June	**July**	**August**		
Maximum temperature	36.03 ± 0.42 ^{b}	38.55 ± 0.42^{a}	36.22 ± 0.42 ^{b}	36.93 ±0.42	**
Minimum temperature	21.33 ± 0.24 ^{b}	22.84 ± 0.24 ^{a}	22.90 ± 0.24 ^{a}	22.36 ±0.24	**
Average temperature	28.67 ± 0.29^{b}	30.74 ± 0.29 ^{a}	29.45 ± 0.29^{b}	29.62 ±0.29	**
Maximum humidity	58.20 ± 1.90	61.35 ± 1.86	59.74 ± 1.86	59.76 ±1.86	ns
Minimum humidity	13.43 ± 0.95^{b}	12.93 ± 0.94^{b}	19.52 ± 0.94 ^{a}	15.29 ± 0.94	**
Average humidity	33.87 ± 0.91^{b}	34.77 ± 0.89^{ab}	37.26 ± 0.89 ^{a}	35.30 ± 0.89	*
Temperature humidity index (THI)	25.73 ± 0.22^{c}	27.43 ± 0.22 ^{a}	26.51 ± 0.22^{b}	26.56 ± 0.22	**

**Significant (P≤0.01), *significant (P≤0.05), ns= not significant. ^{abc} Means with different superscript differ significantly (P<0.05).

2- Physiological responses

2-1. Blood metabolites.

Data of blood plasma constituents of lambs untreated or treated with ascorbic acid or/and cold water are presented in Table 3. Plasma TP, Alb, Glb, TC and Ca concentrations were significantly higher ($P \leq 0.001$) in treated groups, however liver enzymes AST and ALT were significantly lower ($P \leq 0.001$) in the blood of treated lambs (G1, G2 and G3) than those in control group. In this study, although the levels of TP, Alb and Glb differed significantly among the treated groups and the control group, it has been observed that the highest values of these components were in 2^{nd} and 3^{th} groups while difference between them was not significant. Potassium concentration did not show any noticeable change as a result of the treatment. Results also indicate that there was significant increase in the concentrations of Alb, Glb, Glu and TC that agree with the relative decline in the activity of liver enzymes (AST or ALT) in the groups treated with; ascorbic acid, cold water or both. These results are in line with **Babe (2011)** who studied the effect of ascorbic acid on sheep exposed to heat stress. He indicated that, vitamin C has a significant ($P \leq 0.05$) effect on glucose value compared with that of control group, while there are no significant differences in the levels of TC, TP and GOT between control and treated groups (25, 50 and 75 mg/kg BW/daily orally). **Kassab and Mohammed (2014)** found that, treatment of Farafra sheep by ascorbic acid before transport did not show a significant effect on the TP, Alb, Glb, TC and K^+, while it had a significant effect on liver enzymes (ALT and AST) and glucose. Furthermore, **Abdel-Samee (1996)** found that, drinking chilled water improved production of heat stressed goats during the summer season, and caused a significant increase in blood metabolites studied. These increases were 19%-TP, 18%-Alb, 20%-Glb, 31%-TC and 18%-ALT. Researchers attributed the significant decrease in level of blood plasma proteins that accompanied expose of animals to heat stress to; dilution of plasma proteins as a result of increasing body water content; decrease of protein synthesis as a result of depression of anabolic hormonal secretion **(El-Masry and Habeeb, 1989)**; increase of catabolic hormones such as gluccocorticoids and catecholamines **(Alvarez and Johnson, 1973);** decrease of feed nitrogen and mineral intake.

In this study, Glu and TC concentrations decreased significantly in CTR group compared to treated groups; G1, G2 or G3. **Marai *et al.* (1992)** found in mature Ossimi ewes that blood glucose level was significantly ($P<0.05$) higher during summer than winter. The increase in plasma glucose during hot condition may due to the decrease in glucose utilization, depression of both catabolic and anabolic enzyme secretion and subsequent reduction of metabolic rate **(Webster, 1976)** or to the rapid panting which results in increased breakdown of glycogen into free glucose by the increase of glucocorticoid hormones **(Thompson, 1973)**. Reduction of total cholesterol upon vitamin C supplementation was 4.5% **(McRae, 2008)**. While, **Kassab and Mohammed (2014)** reported that reduction of total cholesterol estimated by 3.26 and 13.17% for vitamin C supplemented and non-supplemented groups, respectively. The marked decrease in cholesterol concentration may be due to its dilution because of increasing total body water or decrease in acetate concentration, which is the primary precursor for the synthesis of cholesterol. The marked increase in glucorticoid hormone level (in heat stressed animals) may be another factor causing the decline in blood cholesterol **(Marai *et al*., 2008)**.

Salem *et al.*(1998) found that, the level of ALT in Chios sheep and its crosses with Ossimi was significantly higher in summer than in winter season, while **Baumgartner and Parnthaner (1994)** found that level of AST decreased significantly during summer season in Karakul sheep. **Marai *et al.*, (1995)** explained that reason of increasing activity of liver enzymes (ALT and AST), when sheep exposed to heat stress, is the increased stimulation of gluconogenesis by corticoids (increase in cortisol, cortisone or adrinocorticotrophic hormone).

Table 3: Effect of ascorbic acid supplementation and chilled drinking water on some blood metabolites of ram lambs.

Items	LSM ± SE				Significant level
	CTR	G1	G2	G3	
Total protein (gm/dl)	6.36 ± 0.06^{c}	6.91 ± 0.05^{b}	7.77 ± 0.05^{a}	7.64 ± 0.05^{a}	**
Albumin (g/dl)	3.53 ± 0.10^{c}	3.91 ± 0.09^{b}	4.20 ± 0.08^{a}	4.07 ± 0.08^{ab}	**
Globulin (g/dl)	2.83 ± 0.13^{b}	3.01 ± 0.11^{b}	3.57 ± 0.10^{a}	3.57 ± 0.10^{a}	**
A/G ratio	1.26 ± 0.08	1.35 ± 0.07	1.22 ± 0.06	1.18 ± 0.06	ns
Glucose (mg/dl)	83.7 ± 1.43^{c}	83.6 ± 1.28^{c}	92.8 ± 1.13^{a}	87.8 ± 1.13^{b}	**
T-cholesterol (mg/dl)	72.8 ± 1.18^{d}	82.7 ± 1.06^{c}	93.6 ± 0.94^{b}	87.1 ± 0.94^{a}	**
AST/GOT (U/l)	81.3 ± 2.41^{b}	87.5 ± 2.15^{a}	75.1 ± 1.91^{b}	78.1 ± 1.91^{b}	**
ALT/GPT (U/l)	57.1 ± 1.58^{a}	59.6 ± 1.41^{a}	47.3 ± 1.25^{b}	48.2 ± 1.25^{b}	**
Ca^{++} (mmol/l)	11.5 ± 0.05^{b}	11.6 ± 0.05^{b}	11.8 ± 0.04^{a}	11.8 ± 0.04^{a}	**
K^{+} (mmol/l)	5.57 ± 0.06	5.65 ± 0.05	5.71 ± 0.05	5.65 ± 0.05	ns

**Significant ($P \leq 0.01$), *significant ($P \leq 0.05$), Ns= not significant. ^{abc} Means with different superscript differ significantly ($P<0.05$). CTR= control group, G1= 2nd group, G2= 3rd group and G3= 4th group

Regarding the present plasma Ca^{++} levels in lambs, there were higher ($P<0.01$) Ca^{++} values in G2 and G3 treated groups than that of G1 and control group, while plasma K^{+} in treated groups was not affected. The decrease in electrolytes concentration in this study supported by earlier findings reported on cattle **(Beatty *et al*., 2006 and Srikandakumar *et al*., 2003)** and buffalo heifers **(Singh *et al*., 2012)**. Heat stressed animals lost more potassium and chloride in sweat than non heat stressed animals **(Singh *et al*., 2012)**. **Al-Haidary (2004)** found that, serum concentrations of TP, Glb, Glu, sodium and chloride were significantly ($P<0.05$) increased while those of Alb and Ca^{++} were decreased under hot summer conditions. He suggested that the decrease in electrolytes concentration might be due to expanded blood volume where water transported in the circulatory system for evaporative cooling.

2-2. Thermo- Cardio- respiratory responses.

RT, RR and PR were decreased significantly, while decrease of ear temperature was non-significant as a result of treatment by ascorbic acid or cold water (Table 4). Results show that, RT of groups treated with cold water or ascorbic acid or of both were significantly ($P \leq 0.05$) less than control group. In addition, RR and PR were significantly ($P \leq 0.01$) decreased in treated groups than control. Meanwhile, improvement resulted from treatment with ascorbic acid or a combination of cold water with ascorbic acid were preferable than treatment with cold water alone. In the present study, vitamin C supplementation in combination with cold water improved ability to overcome the detrimental effect of environment during hot season. In another study, the negative effect of high altitude during transportation on thermal responses prevented by administration of antioxidant vitamin C **(Kassab and Mohammed, 2014)**. **Saidu, *et al*., (2012)** found that ascorbic acid administration did not significantly caused any decrease in RT, PR and RR of the experimental groups compared to the control one, the experimental group was slightly higher than the control group. This increase in body temperature results in increase activity of the heart due to pumping more blood to the peripheral circulation to regulate the temperature thereby resulting in increased PR **(Saidu*et al*., 2012)**. In cattle, ascorbic acid and L-histidine had no effects on RT, PR, RR and DMI **(Chaiyotwittayakun *et al*., 2002)**.No significant differences found in RR, RT or milk yield of cows that consumed water under different temperatures **(Baker *et al*., 1988)**. **Abdel-Samee (1996)** found significant decrease

Table 4: Effect of ascorbic acid supplementation or/and chilled drinking water on temperatures, respiration and pulse rates of ram lambs.

Items	LSM ±SE				Sign level
	CTR	G1	G2	G3	
Rectal temperature (°C)	39.38 ± 0.224^{a}	38.75 ± 0.251^{ab}	38.80 ± 0.224^{ab}	38.24 ± 0.224^{b}	*
Ear temperature (°C)	38.32 ± 0.279	37.65 ± 0.312	37.86 ± 0.279	38.00 ± 0.279	ns
Respiration rate (cycles/min)	55.20 ± 3.360^{a}	46.50 ± 3.757^{a}	33.60 ± 3.360^{b}	35.00 ± 3.360^{b}	**
Pulse rate (beats/min)	90.20 ± 2.984^{a}	82.25 ± 3.336^{a}	72.60 ± 2.984^{b}	71.40 ± 2.984^{b}	**

**Significant (P≤0.01), *significant (P≤0.05), Ns= not significant. ^{abc} Means with different superscript differ significantly (P<0.05). CTR= control group, G1= 1st group, G2= 2nd group and G3= 3rd group

in RT and RR of lambs due to drinking cold water.

3- Productive performance.

Least square means of body weights, weight gain, cumulative feed and water intake, feed and water efficiencies and water consumption among the three treatments presented in Table 5. Cumulative feed intake was higher by 23.5, 15.3 and 25.8% and body weight gain was higher by 15.9, 34.5 and 25.3% in lambs treated with ascorbic acid, cold water or both compared to the control group, respectively (P≤0.01). However, feed conversion efficiency was not differed significantly among the groups. Cumulative water intake was differed (P≤0.01) among the three treatments, where those of G1, G2 and G3 were 124.7, 111.1 and 128.2% higher than the CTR group, respectively. Average daily water intake varied from 2.04 to 4.7 liters per day among the treatments. The water intake per unit of body gain was increased (P≤0.01), with lambs ofG1, G2 and G3 than control. The consumed water measured per unit gain, was about 93.6, 92.3 and 95.4 % of the CTR group. Treated lambs consumed larger quantities of water per kg of DMI, being 81.9, 82.8 and 81.6% of the control group. These results agree with **Padua *et al.*(1997)** who found that lambs' daily gain was lower in summer than winter, as well, the daily feed intake and feed conversion were significantly decreased in Suffolk lambs exposed to hot condition in climatic chamber (30.5 ◦C), compared to a group under shelter (19.3◦C), during spring. Similarly, body weight, growth rate, total body solids and daily gain of body solids (g) were impaired following exposure to elevated temperatures **(Ismail *et al.*, 1995)**.

The effects of elevated ambient temperature on growth performance are the product of a decrease in anabolic activity and the increase in tissue catabolism. This decrease in anabolism essentially caused by a decrease in voluntary feed intake of essential nutrients. The decrease, especially of metabolizable energy (ME) for both body maintenance and weight gain, causes a loss in the production per unit of feed **(Habeeb *et al.*, 1992; Marai and Habeeb, 1998)**. Studies showed that dry matter intake decreased significantly following exposure to heat stress in Croix, Karakul and Rambouillet **(Monty *et al.*, 1991)**, Sardinian and Comisana sheep **(Nardon *et al.*, 1991)**. Similarly, dry matter intake per kilogram live weight was lower and the maintenance requirements were higher at high ambient temperatures. The decrease in concentrate intake by rams estimated to be approximately 13%, without altering roughage consumption, when lambs kept under 35 ◦C in a climatic chamber **(Nardon *et al.*, 1991)**. **Conrad (1985)** reported that sheep consumed 2-liter water/kg DM at temperature between 0 and 15 ◦C. This ratio increased to 3:1 at temperatures above 20 ◦C.

Drinking chilled water during summer season improved daily body weight, solids gain and dry matter intake (P<0.05 and P<001) by 31, 54 and 45 %, respectively **(Abdel-Samee, 1996)**.

Table 5: Effect of ascorbic acid supplementation or/and drinking chilled water on growth performance, cumulative feed and water intakes, feed and water efficiencies and water consumption of ram lambs.

Items	LSM ±SE				Sign level
	CTR	G1	G2	G3	
Initial body wt, kg	20.90 ± 0.99	22.63 ± 1.11	21.64 ± 0.99	23.62 ± 0.99	ns
Final body wt, Kg	39.20 ± 1.60 [b]	43.83 ± 1.79 [ab]	46.26 ± 1.60[a]	46.55 ± 1.60 [a]	**
Total gain, Kg	18.30 ± 1.06 [b]	21.20 ± 1.19 [ab]	24.62 ± 1.06[a]	22.93 ± 1.06 [a]	**
Average daily gain (g/day)	203.3 ± 11.8 [b]	235.6 ± 13.2 [ab]	273.6 ± 11.8 [a]	254.8 ± 11.8 [a]	**
Cumulative feed intake (kg)	100.4 ± 4.63 [b]	123.97 ± 5.18 [a]	115.74 ± 4.63[ab]	126.31 ± 4.63 [a]	**
Feed conversion efficiency (1)	5.15 ± 0.28	5.47 ± 0.313	5.42 ± 0.28	5.53 ± 0.28	ns
Cumulative water intake (liter)	244.8 ± 21.1[c]	549.9 ± 23.6[a]	516.72 ± 21.1[b]	558.6 ± 21.1 [a]	**
Water efficiency (2)	12.51 ± 0.82[b]	24.22 ± 0.91 [a]	24.06 ± 0.82 [a]	24.44 ± 0.82 [a]	**
Water consumption (3)	2.44 ± 0.05[b]	4.44 ± 0.05 [a]	4.46 ± 0.05 [a]	4.43 ± 0.05 [a]	**

(1) (kg feed intake/Kg weight gain), (2) (water intake/ Kg weight gain), (3) (liter/kg feed intake).
G1:Vit C supplementation., G2: Drinking chilled water, G3: Vit C + Chilled water.

Stermer *et al.* (1986) found that cows consumed more water of 22°C ($P<0.05$) than water of the other tested temperatures (10, 16 and 28°C). However, the 10°C water succeeded to reduce body temperature. **Lofgreen *et al.* (1975)** theorize that drinking cold water provides sufficient cooling that allow beef cattle to increase their feed intake significantly. **Cloete *et al.* (2000)** reported that ewes maintained in control paddocks consumed 26 % more ($P<0.05$) water during the experimental period than contemporaries in shaded paddocks (3.878 ± 0.222 vs. 3.076 ± 0.222 l/ewe/day, respectively). The daily water intake of Suffolk sheep with access to tree shade in a Mediterranean climate was 33% (7.5 vs. 11.3 l/head) lower ($P < 0.05$) than for sheep with no shade **(Olivares and Caro, 1998)**. **Savage *et al*. (2006)** observed that under warm climatic condition animals preferred to drink more water at 30°C than at 20°C, DMI was higher ($P<0.05$) in cold room (1578 g) than hot room (1136 g), change in live weight of sheep between the hot room and the cold room was not significant, total daily water intake of sheep was higher ($P<0.05$) in hot room (8275 g) than cold room (5826 g). **Baker *et al.* (1988)** found that cows drink water at 10ºC consumed 3.67 kg DM/100 kg of body weight compared with 3.36 kg DM/100 kg for the control. **Huuskonen *et al.* (2011)** reported that, calves offered warm water drank 7 and 8% more water than those offered cold water during post-weaning period and overall the experimental period, respectively. Feed intake fell by 12% after temperature increased from 25 to 29 °C ($P\leq0.001$) and fell by 38% at 39 °C and 80–90% relative humidity. Water intake increased with increases in chamber temperatures, being double at a chamber temperature 39 °C compared with intakes at temperatures 25 °C, even when relative humidity levels reached 90% **(Thanh and Shichang, 2010)**.

CONCLUSION

It could recommended, to modify heat stress of summer on sheep to supplement with ascorbic acid, especially at level 2.5 g/head/day, and/or drinking cold water to alleviate heat stress.

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AMELIORATIVE EFFECT OF ASCORBIC ACID ADMINISTRATION AND CHILLED DRINKING WATER ON RAM LAMBS EXPOSED TO HEAT STRESS DURING SUMMER SEASON.

تأثير إضافة حامض الأسكوربيك ومياه الشرب المبردة على أداء الحملان عند تعرضها للإجهاد الحرارى خلال فصل الصيف.

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أجريت هذه الدراسة بمزرعة الإنتاج الحيوانى التابعة لكلية الزراعة جامعة الأزهر فرع أسيوط، خلال الفترة من بداية شهر مايو حتى نهاية شهر اغسطس لعام ٢٠١١ م، بهدف دراسة تأثير تخفيف العبء الحرارى بإضافة حامض الأسكوربيك وتقديم مياه الشرب المبردة على أداء الحملان وبعض الصفات الفسيولوجية عند تعرضها للإجهاد الحرارى خلال فصل الصيف.

أستخدم فى هذه الدراسة عدد (٢٠) حمل خليط (كيوس x أوسيمى) لها نفس العمر ومتوسط الوزن ٢٢,٢٠ + ٠,٩٩ كجم تقريبا وقسمت عشوائيا الى أربع مجموعات متساوية (٥ حملان / مجموعة) كالاتى :

١) مجموعة الكنترول غذيت على العليقة فقط مع ماء غير مبرد وبدون إضافة فيتامين C.
٢) المجموعة الثانية غذيت على العليقة + ماء الشرب البارد (١٠- ١٥ درجة مئوية) وبدون إضافة فيتامين C.
٣) المجموعة الثالثة غذيت على العليقة + ماء غير مبرد + أضافة فيتامين C بمعدل ٢,٥ جم/ للرأس/ يوم.
٤) المجموعة الرابعة غذيت على العليقة + ماء مبرد (١٠– ١٥ درجة مئوية) + حامض الاسكوربيك بمعدل ٢,٥ جم/للرأس/يوم.

تم وزن جميع الحملان قبل بداية التجربة ثم تم وزنها مرة كل اسبوعين باستخدام موازين رقميه، وتم تسجيل درجة الحرارة بإستخدام الترمومتر والرطوبة بالهيجروميتر مرتين على الاقل يوميا كما تم حساب دليل الحرارة والرطوبة THI. بعد البدء فى المعاملة بحوالى اسبوع تم قياس درجة حرارة المستقيم والاذن باستخدام الترمومتر الرقمى وكذلك معدل التنفس والنبض مرتين يوميا فى السادسة صباحا والواحدة ظهرا مرة إسبوعيا. كما تم ايضا تسجيل كمية المأكول من الغذاء مرة اسبوعيا، وتسجيل كميه الماء المستهلكة لكل الحملان بإستخدام أطباق بلاستيك ومسطرة مدرجة. تم أخذ عينات الدم مرة كل إسبوعين وتم فصلها بالطرد المركزى وتقدير الجلوكوز ثم حفظ البلازما بالتجميد على -٢٠ درجة مئويه لحين التحليل بجهاز الاسبكتروفوتوميتر لتقدير (البروتين، والالبيومين، الكوليسترول، الكالسيوم، الفوسفور، انزيمات الكبد الناقلة لمجموعات الامين AST, ALT) وتم حساب الجلوبيولين ونسبة الالبيومين الى الجلوبيولين.

ومن النتائج المتحصل عليها وجد ان هناك زيادة معنوية فى مستوى الالبيومين والبروتين والجلوكوز، الكوليسترول والكالسيوم فى المجاميع المعاملة بينما إنخفض مستوى إنزيمات الكبد معنويا عن مجموعة الكنترول. أيضا كانت هناك إختلافات معنوية فى كمية الغذاء المأكول، ووزن الجسم ومعدل النمو اليومى وكمية المياه المستهلكة. كانت هناك اختلافات معنوية فى درجة حرارة المستقيم ومعدل التنفس ومعدل النبض بين مجموعة الكنترول والمجاميع المعاملة بينما لم يكن هناك اى اختلافات معنوية فى درجة حرارة الاذن نتيجة المعاملة بحامض الاسكوربيك او شرب الماء البارد.

ومن هذه الدراسة يمكن استنتاج أن اضافة حامض الاسكوربيك بمعدل ٢,٥ جم/للراس/يوم يقلل من التأثير السلبى للاجهاد الحرارى الذى تتعرض له الاغنام خلال فصل الصيف. أيضا تقديم الماء النظيف باردا على درجة حرارة من ١٠- ١٥ درجة مئوية أمر بالغ الاهمية للوقاية من حدة الاجهاد الحرارى خلال فصل الصيف خاصة تحت ظروف صعيد مصر.