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EFFECT OF EXPOSURE TO SOLAR RADIATION ON SOME PHYSIOLOGICAL AND HEMATOLOGICAL PARAMETERS IN SUCKLING JERSEY CALVES FED ASCORBIC ACID

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SUMMARY

Seven jersey calves, one week old, were assigned to two treatment groups. a control group (3 animals) with no L-ascorbic acid supplementation and a supplemented group (4 animals) receiving 2 gm/head daily of L-ascorbic acid for 3 wk period. Treatments were switched in a crossover design for another 3 wk period. At the end of each period animals were exposed to direct sunlight for 2 h. Respiration rate (Rr) and rectal temperature (Rt) were recorded. Heat tolerance was calculated using Road's coefficient and some blood constituents were measured, before and after exposure to sunlight. Direct sunlight exposure increased Rr ($P<.001$), Rt ($P<.001$) and serum glucose, in control ($P<.01$) and treated animals ($P<.07$), and increased total bilirubin ($P<.03$), in controls only, and GOT and GPT and decreased PCV % in both groups. However, L-ascorbic acid supplemented-animals had lower Rr (P.001), Rt and serum glucose. cholesterol, total bilirubin ($P<.01$), GOT ($P<.01$) and albumin ($P<.05$) concentrations. PCV % and heat tolerance were higher in supplemented than in control when the animals were exposed to direct sunlight. Dietary ascorbic acid may improve heat tolerance and blood profile of suckling jersey calves exposed to direct sunlight.

Keywords: jersey calves, ascorbic acid, body temperature, respiration rate, heat tolerance, blood.

INTRODUCTION

It is generally accepted that high environmental temperature is a constraint on the performance of farm animals. The impact of hot environments can be sever, particularly for young animals (Kobeisy, 1983). Therefore this trial addresses the question: what practices are available to protect suckling animals and consequently improve their performance under heat stress conditions ?. Recently Seed (1992) reviewed that ascorbic acid was effective in reducing laying hen mortality due to temperature and humidity stressors. Moreover it has been shown that ascorbic acid can improve egg quality and production and growth performance. Pardue and Thaxton (1986) showed also that at high ambient temperature (37 C°), ascorbic acid supplementation decreased body temperature of hens when compared to control. Thermal environments decreased plasma ascorbic acid levels due to enhanced metabolic turnovers and lower body pools (Stone, 1972, Brin, 1981 and Kallner, 1982), and consequently may require increased daily intakes of ascorbic acid. The decrease in ascorbic acid level in body pools impairs key biochemical functions, i.e. carnitine biosynthesis and histamine degradation (Jaffe, 1984). Dairy calves apparently do not produce endogenous ascorbic acid untill 4 mo of age (Wwgger and Moustgaard, 1982) and their food, milk, is a poor source of ascorbic acid (Abdel-Wahab, 1975). In addition. Kobeisy and Abd El-All (1993) found beneficial effects of dietary ascorbic acid on performance and blood profile of suckling buffalo calves. Therefore the objective of this study was to observe the effect of exposure to solar radiation on respiration rate, rectal temperature, heat tolerance and some blood parameters in suckling jersey calves fed ascorbic acid.

MATERIAL AND METHODS

The study was conducted during the summer months (june and july) in Animal Production Experimental farm of the Faculty of Agriculture, Assiut University. Maximum and minimum air temperature and relative humidity were 45.6°C, 23.45°C, 73.5% and 9%, respectivley. The trial inculaded two periods of 3 wk each. Seven jersey calves at the age of one wk were assigned to two treatments, a control group (A, 3 animals), with no L-ascorbic acid supplementation and a supplemented group (B, 4 animals) receiving supplemental dietary dietary L-ascorbic acid as 2 gm per animal per day for 3 wk period. In the second 3 wk period, treatments were switched in a crossover design. Similarly. Bianca (1963) and Khalil (1980) used 4 and 8 sheep to study the effect of sunlight exposure on some physiological parameters. The supplementary ascorbic acid was fed in two equal doses of 1.0 gm each at 08.00 and 16.00 h, it was dissolved in whole raw milk just before feeding. Calves were fed raw milk according to Ragab and Asker (1968) during the two experimental periods. At the end of each period, animals were exposed to direct sunlight for 2 h from 13.00 to 15.00 h. During the peroids of sun exposure the animals received naither food nor water.

Respiration rate and rectal temperature were recorded immediately before (13.00 h) and after (15.00h) exposure to direct sunlight. Respiration rate was measured by counting the flank region and rectal temperature by clinical thermometer. Heat tolerance indices for both treatment groups of animals at the end of each period were calculated by Rhoad's coefficient. Coefficient of heat tolerance -100-(18 Tr- 38.3), where. Tr-rectal temperature in °C (Road, 1944; Bianca, 1963).

Blood samples were taken from each animal before and after sun exposure, and immediatly transfered to two vials, one dry clean and sterilized while the other containing EDTA. Serum was then separated by centrifugation at 3000 rpm for 15 min and stored at-20°C untill analysed.

Serum glucose was determined using kits supplied by Stanbio Laboratory Inc. (Texas, USA). Total protein, urea nitrogen, total bilirubin, glutamic oxaloacetic (GOT) and glutamic pyrovic (GPT) transaminase concentrations were determined using kits supplied by Diamond Diagnostics (Egypt). Serum albumin was determined using a kit supplied by bioMerieux (Bains. Prance). Serum cholesterol was determined using a kit supplied by Medical Marketing Service (Germany).

Statistical analysis was carried out acording to Harvey (1987) computer program.

RESULTS AND DISCUSSION

Respiration Rate. Rectal Temperature and Heat Tolerance:

Respiration rate and rectal temperature are given in table 1. In both treatment groups, direct sunlight exposure increased ($P<.001$) Both respiration rate and rectal temperature. However, L-ascorbic acid supplementation decreased both respiration rate ($P<.001$) and rectal temperature of animals exposed to direct sunlight/heat stress when compared to controls. Rushevskaya and Davydov (1976) showed polypnea in 3-4 month animals exposed to high air temperature (31°C), combined with solar radiation. Studies on the effects of ascorbic acid on the thermal and respiratory responses of suckling calves exposed to direct sunlight/heat stress are laking. However in poultry, Ahmed et. al., (1967), and Pardue and Thaxton (1986) reported significantly lower body temperature in ascorbic acid supplemented-hens when compared to nonsupplemented hens at 35°C and 37°C environmental temperatures, repectively. Attia (1976) showed that ascorbic acid supplementation sequentially lowered body temperature increases in 7-and 13-month-old hens transfered from 15 to 32°C. The decrease in body temperature of ascorbic acid supplemented-animals during sun exposure might be due to the decrease in O_2 consumption rate, consequently decreased heat production. Pardue and Thaxton (1986) found that O_2 consumption was lower in ascorbic acidsupplemented hens than controls when the highest body temperature occured.

The relatively low respiration rate in ascorbic acid-supplemented animals, after sunlight exposure, might be due to the animals maintain their respiration efficiency by increasing the depth of air changing rather than increasing their respiration rate. The result seem to agree with the finding of Esa (1992) who found that dietary ascorbic acid decreased ($P<0.05$) respiration rate of hens during exposure to high summer temperature.

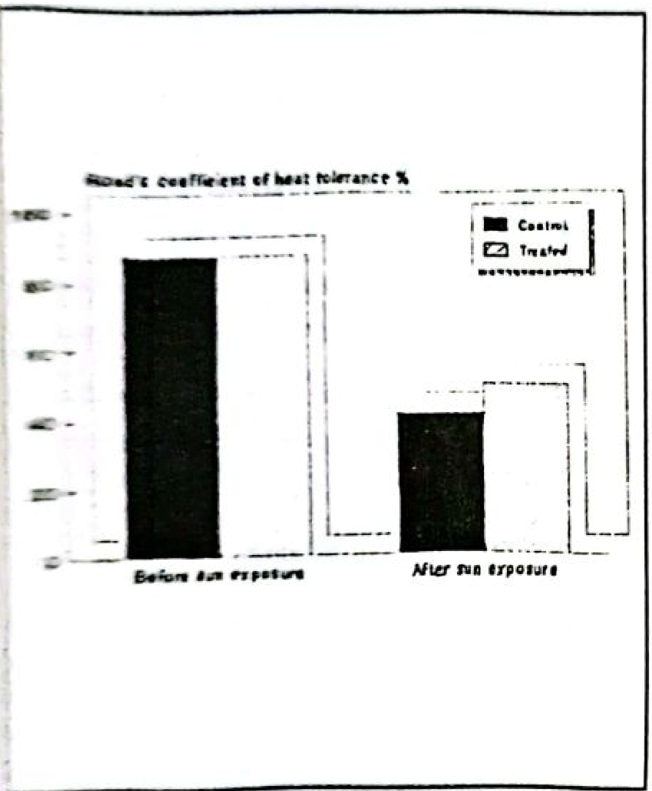

Fig. (1): Effect of dietary ascorbic acid on heat tolerance of suckling calves.

Dietary ascorbic acid improved heat tolerance of animals when exposed to direct sunlight. Road's coefficient of ascorbic acid supplemented-animals was higher than that of controls (49,34 vs. 41.11) after sun exposure, while it had nerly similar values in both treatments before sun exposure (Fig. 1).

Blood Constituents:

Ascorbic acid supplementation increased ($P<.05$) packed cell volume (PCV, %), erythrocyte mass, from 33.14 to 37.14 % (Table 1). Similarly, high PCV was found by Kobeisy and ABD El-All (1993) in suckling buffalo calves and by Miski (1976) in growing chickens fed ascorbic acid. The significant increase of PCV % of ascorbic acid supplemented-animals when compared to nonsupplemented animals supports the findings that ascorbic acid is important in the prevention of anemia (Levander and Cheng, 1980: Calabrese, 1980). Sun exposure decreased PCV% in control and supplemented animals. Similar result was found in nonsupplemented dairy catle by Pinero et al. (1971). Hassan and roussel (1975) and Lee et al. (1976). Such phsiological response was associated with the decrease in cellular O_2 requirement during heat stress, to decrease the endogenous heat production and consequently minimize the effect of exogenous heat input (Lee

Table(1): Respitatory rate,Rectal temerature and packed cell volume(PCV) in jersey calves as influenced by sun exposure and ascorbic acid supplementation

	Respiration rate (r/min.)			Rectal temperature °C			Packed cell volume (PCV%)		
	Treatment ^{a,b}			Treatment ^{a,b}			Treatment ^{a,b}		
	A	B	S.E.	A	B	S.E.	A	B	S.E.
befor exposure	42,68^{g}	45,10^{g}	5.55	38.99^{g}	39.00	0.20	34.00	38.71	2.02
after exposure	189,14^{eh}	157,71^{fh}	5.55	41.57^{h}	41.11^{h}	0.20	32.29	55.57	2.02
Mean	116.00^{c}	101.43^{d}	3.92	40.2^{8}	40.06	0.14	33.141	37.14^{j}	1.43

a-values are least-squares means and S.E.=standard error

b-Treatments: A=Control;B=2gm L-ascorbic acid,animal^{-1},day^{-1}

c,d(P<0.1);e,f(P<0.001);g,h(P<0.001);i,j(P<0.05).

et al., 1976). Although, this result might suggest that suckling animals were not able to form new red blood cells in order to maintain the PCV % as replacement for the damaged red blood cells caused by exposure to direct sunlight/heat stress.

response will be very important during resist[illegible] It delays. 1) the adrenal cortical exhaustion, [illegible] 2) the depletion of energy reserves, both allow[illegible] animals to survive (Seed. 1992).

Table(2): Serum glucose,cholesterol and total bilirubin in jersey calves as influenced by sun exposure and ascorbic acid supplementation

	Glucose mg/dl			Cholesterol mg/dl			Total bilirubin mg/dl		
	Treatment a,b			Treatment a,b			Treatment a,b		
	A	B	S.E.	A	B	S.E.	A	B	S.E
befor exposure	64.6Bc	67.37e	7.30	126.42g	89.34h	11.98	10.11g	9.16	2.00
after exposure	100.14d	86.92f	7.30	119.19	103.63	11.98	16.50hk	7.571	2.00
Mean	82.41	77.15	5.16	122.81	96.48	8.47	13.31i	8.37j	1.42

a-values are least-squares means and S.E.=standard error

b-Treatments: A=Control;B=2gm L-ascorbic acid,animal^{-1},day^{-1}

c,d(P<0.1);e,f(P<0.07);g,h(P<0.03);i,j(P<0.02)k,l(P<0.01)

Direct sunlight exposure for 2h increased serum glucose in all animals (Table 2). High bood glucose is a normal physiological response to heat stress, because of increased secretions of adrenalin (during alarm reaction stage) and cortisol (during resistance stage of General Adaptation Syndrome), to heat stress (Selye, Hadley. 1984; Seed, 1992). In addition, catecholamines are inhibitory (through an action on β-adrenoceptors of pancreatic β cells) to insulin secretion and stimulatory to glucagon secretion (through an action on γ--adrenoceptores of pancreatic A cells) (Hadley, 1984), both of actions increased blood glucose. Sun exposure increased Serum glucose by 54.82 % (P<.01) in control animals, but only by 29.02 % (P<.07) in ascorbic acid supplemented-animals (Table 2). Such effect was probably due to ascorbic acid supplementation decreased, to some extent, adrenal cortical hormones and consequently gluconeogensis during heat stress. Ascorbic acid supplementation decreased the level of corticosterone in vivo (Schmeling and Nockels, 1978; Pardue et. al., 1985) and in vitro (Sulimovici and Boyd. 1968; Shimizu, 1970; Carballeira et. al., 1974). Such physiological

Serum cholestrol was not significantly affected [illegible] direct sunlight exposure. Dietary ascorbic ac[illegible] lowered (P<.03) serum cholesterol concentrati[illegible] by about 27% (Table 2). Similarly. the reducti[illegible] of blood cholesterol concentration by feedi[illegible] ascorbic acid has been demonstrated in buffal[illegible] calves during winter season (Kobeisy and Ab[illegible] El-All, 1993), in rats and rabbits given a hig[illegible] cholesterol diet (Sokolof et al., 1967), [illegible] propylthiouracil (PTU) - treated chick[illegible] (Takahashi et. al., 1991) and in guinea pig[illegible] (Banerjee and Bandyopadhyay, 1963). I[illegible] addition, Sedov (1956) found that one-half gra[illegible] of ascorbic acid given to patients wi[illegible] yypercholesterolemia caused an abrupt decreas[illegible] in serum cholesterol concentration and Myasnik[illegible] (1958) succeeded in decreasing blood cholester[illegible] level in patients having persiste[illegible] hypercholesterolemia by administration of 1.0 g[illegible] ascorbic acid per day. Indeed, the possible role [illegible] ascorbic acid as a hypocholesteremic age[illegible] appears to be essential for the maintenance of the physiological integrity of arterial grou[illegible] substance. Hanck and Weiser (1977) foun[illegible] inverse relationship between L-ascorbic ac[illegible] intake and human mortility rates. possibly due [illegible] ascorbic acid decreased both blood cholesterol and triglycerides. Harber (1993) stated that the slaim that increasing mortality from heart disease in the US was associated with increased consumption of saturated fatty acids, and cholesterol. is another 20 the century myth.

Serum total bilirubin was lower (P<.02) in ascorbic acid supplemented animals than controls (8.37 vs. 13.31 mg/dl). Exposures of nonsypplemented animals to direct sunlight resulted in a reagid increase (P<.03) in serum totla bilirubi concentration (16.5vs. 10.11 mg/dl). In ascorbic acid supplemented animals, total bilirubin was not significantly decreased (9.16 vs

and globulin (Table 3). Similar result was found in buffalo calves fed ascorbic acid by Kobeisy and Abd El-All (1993). Sun exposure increased both total protein and albumin (P<0.05) concentrations in control animals and globulin tended to be higher in ascorbic acid supplementted-animals. Khalil et. al., (1990) found that total protein increased after 9 hr exposure to solar radiation. Urea-nitrogen was not signifacantly affected by either ascorbic acid supplementation or sun exposure (Table 3). Kobeisy and Abd El-All (1993) found insignificant differences in serum urea nitrogen concentration between control and ascorbic acid supplemented buffalo calves during winter season.

Table(3): Serum total Protein, albumin, globulin and urea nitrogen concentration in jersey calves as influenced by sun exposure and ascorbic acid supplementation.

sun exposure	Total Protein g/dl			Albumin g/dl			Globulin g/dl			Urea Nitrogen mg/dl-		
	Treatment [a,b]			Treatment [a,b]			Treatment [a,b]			Treatment [a,b]		
	A	B	S.E.	A	B	S.E.	A	B	S.E.	A	B	S.E.
before	8.17	8.09	.64	3.99e	4.06	.13	4.18	4.03	.64	19.94	20.19	.97
after	8.45	8.09	.64	4.34fc	3.95d	.13	4.11	4.13	.64	18.75	19.95	.97
Mean	8.31	8.09	.46	4.17	4.01	.09	4.14	4.08	.45	19.35	20.19	.68

a-values are least-squares means and S.E.=standard error
b-Treatments: A=Control;B=2gm L-ascorbic acid,animal^{-1},day^{-1}
c,d(P<0.5);e,f(P<0.07).

7.57 mg/dl). Exposure to direct sunlight increased the rate fo destruction of red blood cells which produced heme, cosequently converted to billverdin and then reduced to bilirubin (Lee et.al., 1976; Reece, 1991). The decrease of serum totla bilirubin of ascorbic acid supplemented-animal compared to controls may be due to, ascorbic acid protect erythrocyte membrance for autooxidation, such as found in lukocyte by Anderson (1981), or probably due to their role in decreasing the synthesis of glucocorticoids (Schmeling and Nockels, 1978; Pardue et.al., 1985). The High corticosteriods concentrations may increase degradation of RBC (Hadley, 1984).

Ascorbic acid supplementation had no significant effect on total protein and their fractions, albumin

Serum glutamic oxaloacetic (GOT) and glutamic pyrovic (GPT) transaminase concentrations responded similarly to 2h sun exposure (Tabel 4). Exposure to direct sunlight increased both serum GOT and GPT concentrations. Khalil and Abd-Elhakim (1990) found similar results in poultary. Ascorbic acid supplementation decreased significantly (P<.02) serum GOT concentration. While GPT was not significantly afected by ascorbic acid treatment . The rise in GOT level indicates an increased cardiac acrtivity and output as a result of sun exposure (Khalil and Abd-ElHakim, 1990) and this also support the present result that ascorbic acid supplemented animals may be more tolerant to sun exposure than nonsupplemented animals.

Table(4): Serum GOT and GPT in jersey calves as influenced by sun exposure and ascorbic acid supplementation

sun exposure	GOT, u/l			GPT. u/l		
	Treatment [a,b]			Treatment [a,b]		
	A	B	S.E.	A	B	S.E.
befoer sun exposure	29.71[e]	24.14	6.16	8.85	10.49	1.16
after sun exposure	56.42[cf]	32.86[d]	6.16	10.62	11.06	1.16
Mean	43.07[g]	28.50[h]	4.36	9.73	10.78	0.82

a-Values are least-squares means and S.E.=standard error

b-Treatments: A=Control;B=2gm L-ascorbic acid,animal^{-1},day^{-1}

c,d(P <.01); c,f (P<0.5);g,h(P<0.02).

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