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Means of Alleviation the Negative Effects of Summer Heat Stress on Animals

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ABSTRACT

In tropical and subtrobical countries, climatic characteristic is the major constraint on animal productivity. Growth, milk production and reproduction are impaired as a result of the drastic changes in biological functions caused by heat stress Reduction of heat stress syndrome during hot summer season can be reduced or even eliminate those losses in farm animals. The process of minimizing or reducing these effects is called amelioration process. Amelioration of heat stress in heat stressed animals to improve its productivity has been attempted using different techniques including physical, nutritional and physiological means.

Keywords: *animals, heat stress, growth, milk yield, amelioration process;*

INTRODUCTION

Optimal climatic conditions for cattle, buffaloes, sheep, goats, rabbits and poultry would be something like an air temperature of 13 to 20°C, a wind velocity of 5 to 18 km/hr, relative humidity of 55 to 65% and a moderate level of sunshine (Marai and Habeeb. 1997).The summer in Egypt, is characterized by high ambient temperature (35-40^{o}C) and high relative humidity(50-75%). Solar radiation is high (4500KJ/M^{2}) throughout the year and for all Egyptian zones, with extermes observed during summer (Habeeb et al., 1994). Therefore, animals raised to such a sever climatic stress for almost 8 months of the year and become uncomfortable suffering extremely in production and reproduction (Habeeb et al., 1992). Exposure of animals to heat stress evokes a series of drastic changes in the biological functions, which include a decrease in feed intake, feed efficiency and utilization, disturbances in water, protein, energy and mineral balances, enzymatic activities, hormonal secretions and blood metabolites ending to impairment the productive and reproductive performance. Heat stress also lowers natural immunity making animals more vulnerable to disease. Heat stressed animals become uncomfortable and suffers extremely in production, reproduction and resistance to diseases and parasites (Habeeb et al., 2008). The decreases in growth and milk yield of the European cattle may reach one-half when introduced to tropical or sub-tropical environment (Habeb et al., 1997). The process of minimizing or reducing these effects is called amelioration process. Amelioration of heat stress in heat stressed animals to improve its productivity has been attempted using different techniques including physical, nutritional and physiological means.

Good management should aim to well-being, comfort and maintaining high productive and reproductive efficiency of the animals. Under hot climate conditions, the major objective is to facilitate overcoming heat stress, although such criteria is sometimes difficult because its occasional high costs, altogether with that most countries in which it occurs have severe financial constraints. Providing with suitable housing, feeding, disease and parasite control and heat stress alleviation practices, together with amelioration of the environment, can help heat stressed animals to express their genetic potentials in tropical and sub-tropical areas (Marai and Habeeb, 1997).

Alleviation of heat stressed animals can be applied by physical, physiological and nutritional techniques. The managemental practices concerned in hot climate, which will be the subject of the present article involve modification of the environment, reducing the animal's heat production and increasing its heat loss. Below, are some techniques that can be used to help the animal in dissipating the heat load and to correct the negative effects caused by heat stress? Such techniques arc classified to physical, physiological and nutritional techniques as follows.

MEANS OF AMELIORATION OF HEAT STRESS CONDITIONS ON FARM ANIMAL

Physical Technique

Physical technique includes shading and cooling methods. Any cooling system that is to be effective must be into consideration the intense solar radiation, high ambient temperature and the typically high daytime relative humidity. These challenging conditions tax the ability of any cooling system to maintain a normal body temperature for the animals.

Table1. *Averages of ambient temperature and relative humidity during winter and summer natural conditions of the farm under the two types of shed*

Experimental period (Days)	Without shading	With wood shading	With reinforced concrete shading	Overall mean for periods
Rectal temperature (°C)				
From 1 - 7	39.8 ±0.29	38.8±0.30	39.9 ±0 20	39.5±0.20
8-30	39.5 ±0.25	38.5±0.30	39.7±0.20	39.2±0.20
31-60	39.2 ±0.24	38.6 ±0.20	39.5±020	39.1 ±0.10
1-60	39.5 ±0.15^{a}	38.6 ±0.10^{b}	39.7±0.10^{a}	
Respiration rate (rpm)				
From 1- 7	85±1.80	58 ±2.90	78 ±1.30	74 ±3.10
8-30	75 ±1.80	67 ±1.50	70 ±1.30	71 ±1.40
31-60	78 ±1.50	69 ±1.20	73 ±1.20	73 ±1.40
1-60	80 ±1.30^{a}	65 ±1.50^{b}	74 ±1.00°	
Daily body gain (g)				
From 1- 7	571 ±11	814 ±13	659 ±19	681 ±14^{B}
8-30	609 ±10	826 ±10	717 ±10	717±10^{A}
31-60	600 ±10	800 ± 9	733±11	711±10^{A}
1-60	593 ±12^{c}	813±14^{a}	703±28^{b}	
Daily roughage intake (Kg/8 calves)				
From 1-7	5.6±0.0	8.8±0.0	6.5 ±0.0	7.0 ±0.0
8-30	5.6±0.3	8.8 ±0.6	6.5 ±0.6	7.0 ±0.3
31-60	5.7 ±0.3	8.8 ±0.6	6.5 ±0.6	7.0±0.2
1-60	5.6 ±0.2^{c}	8.8±0.3^{a}	6.5 ±0.0^{b}	
T3 hormone (ng/dl)				
At the 7th day	100 ±1.4	115 ±0.9	103 ±0.9	106 ±1.5^{C}
At the 30th day	125 ±1.3	145±1.3	127±0.7	132 ±2.0^{B}
At the 60th day	155 ±1.3	170 ±1.5	158 ±1.8	161 ±1.6^{A}
Overall mean	126 ±4.7^{c}	143±4.8^{a}	129 ±4.8^{b}	
Cortisol hormone (ng/ml)				
At the 7th day	25 ±0.8	25±0.9	26±1.2	25±0.5^{B}
At the 30th day	40 ±1.3	36 ±1.6	40 ±1.3	38 ±0.8^{A}
At the 60th day	23±0.8	10 ±0.7	20 ±0.8	18 ±1.2^{C}
Overall mean	29 ±1.6^{a}	23 ±2.3^{b}	29 ±1.7^{a}	

Shading

Shading is used to protect animals from direct and indirect solar radiation. Shade is the simplest and relatively inexpensive tool. Numerous types of shading are used such as trees, metal or synthetic materials. Shade is the simplest and a relatively inexpensive tool for combating heat (Yousef *et al.*, 1996 and 1997). Using the wood roofed sheds for protection the lactating cows from the direct solar radiation of the hot summer season caused a significant decline in the ambient temperature from 37.2°C under direct solar radiation outside the yard to 31.2°C under wood sheds (Yousef et al., 1996). The reduction in the ambient temperature lowered the heat load on the cows as indicated from the improvement in their milk yield, milk components and food intake and decreasing their rectal temperature and respiration rate. The use of wood roofed shed during summer season ameliorated the heat load exerted on animals since the milk yield, feed intake and blood components and hormonal levels increased significantly and rectal temperature and respiration rate decreased significantly as compared with those under solar radiation

(Yousef et al., 1996). Using the wood for roofing sheds to protect the animals from direct solar radiation of the hot summer season decreased the ambient temperature under the shed by about 5°C as compared to un-shaded conditions in the same season while using the reinforced concrete for roofing sheds decreased significantly the ambient temperature under the shed but by 2.5°C only as compared to un-shaded summer condition (Table 1) (Yousef et al., 1997).Therefore, calves maintained under wood roofed shed during summer showed a significant lower rectal temperature, respiration rate and concentration of plasma cortisol as compared to the calves exposed to summer direct solar radiation and the calves protected with wood shed during summer time had greater weight gain and roughage feed intake accompanied with lower values in rectal temperature, respiration rate and cortisol level than those of calves protected with reinforced concrete shed (Table 2) (Yousef et al., 1997).

Table2. *Averages of ambient temperature and relative humidity during winter and summer natural conditions of the farm under the two types of shed*

Experimental period (days)	Winter climate	Summer climate		
		Without shading	With shading	
			Wood	Reinforced concrete
Ambient temperature (C°)				
From 1-7	14.8 ±0.9	36.6 ±0.5	32.5 ±0.6	34.8 ±0.7
8-30	15.3 ±0.7	36.9 ±0.8	32.6 ±0.9	34.9 ±0.9
31-60	15.2 ±0.8	37.1±1.0	31.0 ±0.5	33.6 ±0.8
1-60	15.1d±0.5	36.9a±0.5	32.0c±0.4	34.4b±0.6
Relative humidity (%)				
From 1-7	64.5 ±2.5	48.8 ±2.1	47.5 ±2.5	47.9 ±2.2
8-30	65.0 ±2.8	47.3 ±2.9	45.9 ±2.8	46.5 ±2.9
31-60	65.0 ±2.2	47.8 ±2.5	46.8 ±2.1	45. P ±2.1
1-60	64.8a±2.0	479b±1.8	46.7b±1.8	46.8b±1 6

a, b, c Means with the same letter in the same raw for each parameter are not significantly (P<0.05) different due to treatment

A, B, C Means with the same letter in the same column for each parameter are not significantly (P<0.05) different due to period

The shed should be placed on a top of a hill if possible, opened on all sides and with wire or cable fences, the roof should be 3.5 to 4.0 meters high with its long dimension east-west to prevent exposure to high sun radiation. The roof slopes should be south-north to avoid vertical sun heat. The roof can be made of a 10 to 15 centimeters layer of hay held in place by wire above and below that realizes insulating and cool effects. Such roof does not permit penetration of heat from the sun through to radiate into the animals, as well as, little radiant animals is reflected back from its underside (El-Sobhy, 2005). In addition, hot air under the shade can rise up through the loose hay. If solid insulating material or wood shads roofs are used, the top should be painted white or shiny to reflect as much heat as possible, and the underside should be dull and dark to avoid reflecting animal heat it receives. The pens should be constructed of wire or cables to offer less resistance to air movement. The adequate surface area from shade per animal is 3.7 - 5.6 square meters for cattle and 1.86-2.79 square meters for sheep to be kept loose in the shed. Vegetation should surround the pens. Shade trees (with falling leaves during winter) should be scattered around and within the yards of the sheds, and such sheds should be scattered in the pasture or range. If livestock owners are compelled to build for housing their animals, they have to use insulating materials for the outer walls with adequate ventilation openings and the roofs should erect 60 centimeters more than the outer walls to protect the walls from direct sun heat (Marai and Habeeb, 1997).

One of the first steps that should be taken to moderate the stressful effect of a hot climate is to protect the animals from direct and indirect solar radiation. It was estimated that total heat load could be reduced from 30 to 50% with a well-designed shade (El-Sobhy, 2005). Shade is the simplest and a relatively inexpensive tool for combating heat (Yousef *et al.*, 1997). Cows in a shaded versus no shade environment had lower rectal temperature (38.9 and 39.1° C) and reduced respiratory rate (54 and 82 breath/ min) and yielded 10% more milk when shaded (Roman-Ponee *et al.*, 1977). Numerous types of shading are available, from tree to metal and synthetic materials. The limited success of shading in preventing the depression of productivity of farm animals is due to that it does not reduce spherical radiant temperature down to air temperature no does it affect air temperature (Flamenbaum *et al.*, 1986). Various cooling techniques have been reviewed by Collier *et al.* (2006), but shade successfully decreased the physiological effect of heat stress on cattle (Mitlohner *et al.*, 2001, 2002)

Shading using tree, Shading using metal and synthetic materials Shading using wood, Shading using asbestos, Shading using metal and synthetic materials Shed for tropical animals provides shade and good ventilation. Shade had the greatest success in maintaining animal performance and physiology under heat stress conditions; animal behavior, spatial utilization, and elimination patterns affected all other measured variables. Teama *et al.* (2012) found that averages of air temperature and relative humidity values at 0600hr and at 1600hr decreased significantly during summer season due to shading and daily gain, blood components and hormonal levels improved in young native calves during summer season due to shading (Tables 3 and 4).

Table3. *Summer monthly averages of air temperature (T, °C) and relative humidity (RH, %) values at two times daily under with and without shading during hot summer season.*

Summer months	With shading				Without shading			
	At 0600hr		At 1600hr		At 0600hr		At 1600hr	
	T (°C)	RH(%)	T(°C)	RH(%)	T(°C)	RH (%)	T (°C)	RH (%)
May	32	67	36	57	31	73	41	52
June	33	62	38	60	33	75	43	53
July	30	71	35	56	29	86	39	62
Mean	31.6	66.6	36.3	56.6	31.0	78.0	41.0	55.66

a, b Means with the different superscripts in the same row differ significantly (P<0.05).

Table4. *Daily gain and blood components in young calves under with and without shading during summer season*

Items	With shading	Without shading	Significance (p≤)
Daily gain (kg)	0.890^a±0.03	0.680^b±0.03	0.001
Total protein (g/dl)	7.91^a±0.2	7.0^b±0.2	0.01
Albumin (g/dl)	5.04±0.18	5.1±0.18	0.76
Globulin (g/dl)	2.88^a±22	1.89^b±2	0.004
Immunity γ-globulin (g/dl)	1.0±0.06	0.95±0.1	0.10
Total antioxidants (mM/l)	0.65^b ±0.11	1.06^a±0.11	0.001
Catalase enzyme activity (u/l)	910.8^a±2	799.6^b±2	0.001
T_3 (nmol/l)	5.73^a±0.27	3.73^b±0.27	0.001
T_4 (nmol/l)	100.74^a±7.5	78.50^b±7.5	0.04

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Cooling Methods

Cooling method includes air movement (fans) and air conditioning which appear to be effective in areas of low or high humidity and cool the air while raising the relative humidity. Although shade reduce heat accumulation from solar radiation there is no effect on air temperature or relative humidity and added cooling is necessary for animals in hot summer climate and should be avoided crowding animals into a small area, because it lead to restricts air flow and aggravates heat stress (Gerald and Charles, 1999). A number of cooling options exist based on combinations of the principles of convection, conduction, radiation and evaporation. It can carry away animals in the form of radiation, conduction and convection. Moisture in the form of vapor it also helps in cooling of the surroundings (barn walls and roofs, fences, earth...etc) which in turn helps keeping the animals cooler (Brouk *et al.*, 2002). Dairy cows cooled by fans and air movement (fans) appear to be effective in areas of low or high humidity and cool the air while raising the relative humidity(Shearer *et al.*, 1999), Increasing air movement promotes evaporation, makes cooling by perspiration more effective and helps removal heat dissipated by animals in the form of radiation, conduction and convection. It can carry away moisture in the form of vapor. It also helps in cooling of the surroundings (barn, walls and roofs, fences, earth.. etc) which in turn helps keeping the animals cooler. Air conditioning techniques are considered as method of modification of the environment as well

Sprinkling (spraying)

The importance of sprinkling in dissipating heat load is due to the high thermal capacity of water (1 cal/gm/ ºC) and its high heat of evaporation (580 cal/gm) (Kamal *et al.,* 1989). Sprinkling the animal with water would help in dissipating heat from the skin of the animal through conduction and then evaporation of the water layers coating it (Brouk *et al.,* 2002). However, evaporative cooling was predicted to improve milk yield for cows (Hahan and Osburn, 1970). Water spray used to cool dairy cows (Kamal *et al.,* 1989) Wallowing in water mud are the most common methods for cooling (Gerald and Charles, 1999). Habeeb et al. (2001) studied the role of niacin and sprinkling in improving milk yield composition and biochemical functions of the heat stressed Friesian cows. The authors reported sprinkling the heat stressed lactating cows with tap water caused significant increase in milk yield (16.7%), milk protein (6.7%) and milk fat (6.0%) contents and significant decrease in ash content (15.3%). Lactose content did not differ among treatments. Sprinkling lactating cows exposed to summer heat stress with tap water increased overall mean of T_3 level (36.8%) and decreased cortisol level (13.6%). Sprinkling treatment increased significantly total protein, albumin and globulin concentrations and decreased significantly urea-N and creatinine concentrations in the blood serum of the heat stressed Friesian cows. Sprinkling technique alleviated heat stress on animals as indicated by liver function parameters (Table 6). Data showed that activities of alanine and aspartic-rransaminase as well as alkaline and acid-phosphatase were significantly declined due to sprinkling. The decline percentages were 24.4, 30.0, 17.6 and 28.6%, respectively compared with those not sprinkled. The increase in daily milk yield, milk composition and most blood components in the heat stressed cows due to sprinkling may be attributed to that sprinkling cooled the animal's surface directly by conduction and evaporation (2427 joules dissipated per g water evaporated). The result was reducing the heal load of summer season by increasing the heat loss through skin vaporization. This reduction in heat load improved the appetite of the animal to increase feed intake and consequently proteins utilization either from feed or from digested rumen microorganisms, are increased (Habeeb *el al.*, 1989). The increase in milk yield and composition may be also due to the role of sprinkling in alleviating the thermal hormonal alterations which depress the milk yield under heat stress, i.e., increase T_3 level and decrease cortisol level in sprinkled animals compared with not sprinkled. Consequently, the energy used for cooling processes may be spared for production functions. Moreover, sprinkling aids animals to reach a steady physiological state as indicated by restoration in blood components as well as reduction in serum transaminases enzyme activities.

With regard to the effect of sprinkling on physiological thermoregulatory parameters, Habeeb *et al.* (1995) reported that sprinkling ameliorate the stressful conditions on heat stressed animals resulting the decrease in rectal temperature and respiration rate. Marai and Habeeb (1997) reviewed the management practices to ameliorate the effects of heat stress on farm animals under subtropical conditions. Sprinkling the heat stressed cows with tap water 3 times daily increased significantly the values of haemoglobin and packed cell volume and did not affect on erthrocyte and leucocyte counts. Similar results obtained in Friesian lactating cows (Habeeb *et al.* 1989) and in rabbits (Habeeb *et al,* 1994) due to either internal (drinking cooled water) or external (sprinkling) cooling techniques. In lactating Friesian cows, Zeidan et al (2001) showed that sprinkled technique alleviate the heat load which imposed on the animals exposed to the high air temperature of the summer season resulting in decrease each of rectal temperature, respiration rate and pulse rate. Sprinkling also caused significant increase in the hemoglobin and packed cell volume (%) values. Marcillac-embertson *et al.* (2009) indicate that corral pen management in the form of installation of shade and sprinklers can affect heat stress in cattle, but may lead to environmental effects.

Sprinkling the heat stressed animals with tap water alleviate the heat stress on respiratory and cardiovascular systems resulting the significant decreases in respiration and pulse rates. Sprinkling also cooled the animal's surface directly by conduction and evaporation resulting the reducing in rectal temperature of the treated animals as compared to not sprinkled animals. The decreasing in rectal temperature, respiration rate and pulse rate and the increasing in haemoglobin and packed cell volume values in the sprinkled animals may be due to increasing the heat loss through skin vaporization and at the same time, alleviating thermal hormonal alterations. The vaporization of 1ml of water requires 2.43 joules to convert into vapor and this is the amount of heat lost when 1 ml of sweat evaporates from the skin.

Drinking Cool Water

Water is one of the most important nutrients required for the maintenance of life and is involved in many physiological functions essential for maximum performance of farm animals. Water requirements vary and are regulated by many factors such as intake of dry matter, environmental temperature and loss of water from the body tissues (Habeeb *et al.*, 2012b). Livestock need a plentiful supply of good and clean water for normal rumen fermentation and metabolism, proper flow of feed through the digestive tract, good nutrient absorption, normal blood volume and tissue requirements (Reid and Bird, 1990). The exposure of animals to elevated ambient temperatures induces an increase in the dissipation of excess body heat, in order to negate the excessive heat load. Dissipation of excess body heat is excluded by evaporation of water from the respiratory tract and skin surface via panting and sweating. Milam et al. (1986) reported that chilled water has been suggested as a potential means of reducing the effects of heat stress through reduction of core body temperature. It would be advantageous to provide tepid water to cows, reducing the effect of heat stress observed with warm water (Bewley et al., 2008). Cooling ponds and drinking cool water are also methods used to reduce heat load on farm animals. Lanham *et al.* (1986) showed that 20 minutes after drinking 10°C or 28°C water, respiratory frequency of lactating Holstein cows decreased 17 breaths/min to 38.6 breaths/min and 3.4 breaths/min to 52.4 breaths/min

With regard to drinking water, ample fresh cool water must be found within each shed and the water troughs and the animals while watering should be shaded by a suitable shelter from the direct sun heat, and the water pipes should be placed at 20-25 centimeters depth from the ground surface to keep the water cool in the hot climate (El-Sobhy, 2005). The beneficial effect of drinking cool water in reduction of the heat load is due to the heat dissipated by conduction as a result to the difference between the drinking cool water and urine temperatures. Moreover, the increase in body water due to the increase in water intake under hot climate helps dissipation of heat by increasing evaporative heat loss through sweating and respiration and by conduction (Daader, *et al.*, 1989; Habeeb, *et al.*, 1994 and Abdel Samee, *et al.*, 1998). Modifications of corral management (i.e., construction of shade or sprinklers, or both) can alter thermal load, behavior, and environmental effect of cattle. Various cooling techniques have been reviewed by Collier *et al.* (2006), but water application successfully decreased the physiological effect of heat stress on cattle (Mitlohner *et al.*, 2001). Treatments to lower body temperature include cold water submersion, cold water enemas, ice applications and in the case of sheep cold water applied to body parts with little wool (head and lower legs). Most researches were carried out to study the effect of water temperature on DM, energy or CP and CF digestibility and N balance, especially on heat stressed lactating dairy cows. Exposure to high ambient temperature augments the efforts to dissipate body heat, resulting in the increase consumption of water and a decline in feed intake (Huuskonen et al., 2011). A higher heat increment is caused by the specific dynamic action that accompanies the metabolism of feed (Daader et al 1989). The probable explanation for the beneficial effect of cold water is to provide sufficient cooling to allow an increased feed intake. Lofgreen et al (1975) reported that British cattle in a hot environment consumed more feed, gained more weight, and improved energy utilization and efficiency of conversion of feed to gain when given access to water cooled to 65F (18.3 ^{o}C) compared to 90F(32.2^{o}C).

The treatment of the heat stressed Friesian calves with drinking cool water and sprinkling led to highly significant increase in the average LEG by 200 g daily for each calf of which 56% was solids (113g) when compared to control group. The treatment increased also DM intake and caused highly significant improvements in DM, energy and protein efficiencies by 26, 33 and 35%, respectively. When calculating the efficiency on SBG basis, the corresponding improvements were 56, 40 and 66%, respectively ((Habeeb et al., 1995). The cooling treatment caused a significant increase in concentrations of thyroid hormones. T_4 and freeT_4 index were higher in treated calves as compared with the control summer by 82 and 62%. At the same time, cooling the calves increased blood components as well as hemoglobin values. It was also found that the treatment was associated with significant reductions in rectal temperature and respiration rate, as well as, transaminase enzyme activities. In addition, the treatment showed that the water retained was decreased in the treated calves as indicated from the increase in daily SBG (Marai et al., 1997). Drinking cool water cooled the animal's body core by conduction as a result to the difference between drinking cool water and urine temperatures (Habeeb et al., 1989). At the same time, sprinkling cooled the animal's surface directly by conduction and evaporation (2427 J dissipated per g water evaporated). The result was reducing the heat load of summer by increasing the heat loss through urine excretion and skin vaporization. This reduction in the heat load improved the appetite of the animal which caused an increase in feed consumption and consequently in body weight gain and feed utilization. In addition, the cooling treatment alleviated the thermal hormonal alterations, especially T_4 and other factors which depressed the growth under summer heat stress. Consequently, the energy used for cooling process may be spared for production functions (Kamal et al., 1972). The reduction in the summer heat load due to cooling also aided the animal to reach a steady physiological state as indicated by restored blood parameters, decreased rectal temperature and respiration rate, as well as, transaminase enzyme activities (Habeeb et al., 1995).

Table5. *Effects of diet supplementation and body cooling with sprinkling and drinking cool water on daily gain, solids gain, feed intake and feed efficiency of heat stressed Friesian calves.*

Growth performance and feed utilization parameters	Summer experiment (60 days)		
	Control without treatment	Supplemented daily with urea (787g) + mineral and vitamin mixture (500 g)	Sprinkling 7 times with tap water and drinking cool water (10°C)
Initial LBW (kg)	247.8[a] ± 27	248.6[a] ± 21	248.0[a] ± 18
Final LBW (kg)	281.8[b]±27	292.6[a]±13	294.0[a]±19
Daily live body gain, LBG (g)	567[b]±35	733[a]±54	767[a]±20
Relative	68	88	92
Solids body gain, SBG (g)	171[b]±9	281[a]±10	284[a]±8
Relative	54	90	90
Daily feed intake concentrate (kg)	5.25[a]	5.25[a]	5.25[a]
Daily feed intake roughage (kg)	2.15[b]	2.58[a]	2.60[a]
Dry Matter, DM (kg)	6.8[b]±0.1	7.2[a]±0.1	7.2[a]±0.02
Relative DM	92	97	97
Net energy intake[1], NE (MJ)	37. 5[b]	38.0[a]	38.0[a]
Digestible crude protein, DCP(g)	535	535	535
Supplement DCP[2] (g)	—	180	—
Nutrafos 1 (g)	—	50	—
DM efficiency			
kg LBG/kg DM intake	0.084[b]	0.102[a]	0.106[a]
Relative	75	91	95
kg SBG/kg DM intake	0.025[b]	0.039[a]	0.039[a]
Relative	60	93	93
Net energy efficiency:			
kg LBG/MJ NE intake	0.015[d]	0.019°	0.020[b]
Relative	71	91	95
kg SBG/MJ NE intake	0.005[b]	0.007[a]	0.007[a]
Relative	63	88	88
Protein efficiency:			
kg LBG/kg DCP intake	1.06[b]	1.03[b]	1.43[a]
Relative	68	66	92
kg SBG/kg DCP intake	0.32[c]	0.39[b]	0.53[a]
Relative	54	67	90

[1] *Net energy intake = SE intake x 3.761 x 4.184 MJ x 0.80*

[2]*Intake for each animal in summer was 78.7g urea and each 1 g urea gives (3.46 x 6.25) 2.875 g crude protein, i.e. 180 g DCP was supplemented (assuming that digestibility of urea was 80%).*

a. b Means with the different superscripts in the same row differ significantly (P<0.05).

When comparing between diets supplemented calves and cooling treatment, there was no differences in actual gain (SBG) and voluntary feed intake and consequently in feed DM efficiency values. But cooling treatment caused significant reductions in rectal temperature and respiration rate and decreased the SCOT and SGPT activities, while the opposite was found in supplemented calves. From the economic point of view, the cooling treatment was lower in costs and higher in income than the diet treatment. The estimated profit gain values (difference between costs and income/costs) were 3.3 and 2.3 as much as the costs in the two treatments, respectively, during the experimental period. In conclusion, the cooling treatment was more effective than feed supplementation in alleviating the heat load under subtropical conditions and could be recommended to be used when water is available. In case there is lack of water such as in desert lands, more nitrogen, minerals and vitamins could be administered for calves to alleviate heat stress (Habeeb et al., 1995) (Table 5). The treatment of the heat stressed lactating Friesians (at 90 to 120 days post-partum) with drinking cool water (10 - 15 °C) *ad libitum* and sprinkling with tap water (25°C) 10 min every hour five times daily from 10 a.m. to 4 p.m. for 15 days improved daily milk yield by 14% and restoration tendency in cortisol by 27%, glucose by 12%, total lipids by 21%, cholesterol by 18% and total proteins by 4%. Some blood metabolites and physiological parameters decreased significantly. The decrease was 6% in SGOT and 11% in SGPT, 3% in rectal temperature and 34% in respiration rate (Habeeb et al., 1995) (Table 6).

Table6. *Milk yield and blood constituents of heat-stressed Friesian cows as affected by sprinkling and drinking cool water technique*

Milk yield and blood constituents	Control (Hot summer season)	Drinking cool water (10-15°C) and sprinkled with tap water (25 °C) during hot summer season	Significances
Milk yield (kg/day)	8.22	9.38	P<0.01
Plasma cortisol (ng/dl)	0.56	0.71	P<0.01
Plasma glucose (mg/dl)	52.16	58.70	P<0.05
Serum total lipids (mg/dl)	297.78	359.39	P<0.01
Serum total cholesterol (mg/dl)	147.02	173.35	P<0.01
Serum total proteins (g/dl)	6.40	6.69	P<0.05
Serum GOT (unit/dl)	74.75	70.13	P<0.05
Serum GPT (unit/dl)	19.50	17.44	P<0.05
Rectal temperature (°C)	39.83	38.69	P<0.05
Respiration rate(resp. /min)	98.50	65.00	P<0.01
Pulse rate (pulse/min)	66.10	67.32	Not significant

Table7. *Effects of diet supplementation and body cooling with sprinkling and drinking cool water on thyroid, liver and kidney functions, blood components and picture and thermoregulatory parameters of heat stressed Friesian calves.*

Hormones and blood components	Control without treatment	Supplemented daily with urea (787g) + mineral and vitamin mixture (500 g)	Sprinkling 7 times daily with tap water and drinking cool water (10°C)
T_4 (ng/1)	$71^c \pm 3.0$	$99^b \pm 8.0$	$129^a \pm 8.0$
T_3-uptake (%)	$29^a \pm 0.3$	$28^{ab} \pm 0.8$	$26^b \pm 1.0$
Free T_4 index	$21^b \pm 1.0$	$28^a \pm 3.0$	$34^a \pm 3.0$
Relative	75	100	121
Glucose (mg/1)	$600^c \pm 21$	$691^b \pm 10$	$802^a \pm 9$
Total protein(g/1)	$74^b \pm 5$	$87^a \pm 3$	$89^a \pm 4$
Total lipids (g/1)	$3.7^b \pm 0.2$	$4.3^a \pm 0.2$	$4.2^a \pm 0.2$
Haemoglobin (g/1)	$102^b \pm 1$	$111^a \pm 1$	$110^a \pm 1$
Haematocrit (ml/1)	$369^a \pm 4$	$365^a \pm 8$	$325^b \pm 1 1$
SCOT (unit/1)	$758^b \pm 13$	$903^a \pm 16$	$690^c \pm 8$
SGPT (unit/1)	$228^b \pm 6$	$254^a \pm 5$	$185^c \pm 3$
Urea- N (mg/1)	$131^c \pm 10$	$173^a \pm 10$	$155^b \pm 10$
Creatinine (mg/1)	$17^b \pm 0.8$	$20^a \pm 0.5$	$20^a \pm 0.4$
Rectal temp. (°C)	$39. 9^b \pm 0.03 \pm 0.03$	$40.1^a \pm 0.03$	$39.3^c \pm 0.02$
Respiration rate (rpm)	$101^a \pm 1.5$	$107^a \pm 0.6$	$60^b \pm 2$

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

This increase in daily milk yield in the heat stressed cows due to sprinkling and drinking cool water may attributed to the probable role of physical treatment in alleviating the thermal hormonal alterations and other factors that result in low milk yield. In addition, the energy used for cooling processes may be spared for production functions. The observed increase in the blood components as a function of drinking cool water and sprinkling under hot climate may be attributed to the direct effect cooling process which aided animals to reach a steady physiological state with respect to haemodilution normally occurring in heat stressed cattle. It is also possible that this cooling treatment improved the appetite of animals, thus causing an increase in protein intake, either from feed or from digested rumen microorganisms and consequently an increase in milk production. In conclusion, it seems that the sprinkling and drinking cool water technique is a simple safe and an economical and practical method for decreasing the heat stress effects on animals and consequently improved milk production in the subtropics (Table 7) (Habeeb et al., 1995).

Most researches were carried out to study the effect of water temperature on dry matter, energy or crude protein and crude fiber digestibility and N balance, especially, on heat stressed lactating dairy cows (OACC, 2007 and Bewley et al., 2008). Habeeb et al. (2012) showed that drinking cool water or cold water decreased the heat load of summer season on pregnant Ossimi ewes. The respiration rate and temperatures of rectal, skin and ear values decreased significantly while daily feed intake, dry matter intake and water intake values increased significantly due to treatments when compared to those drank warm water. Total proteins, globulin, and glucose concentrations in the serum of ewes drinking cool or cold water were higher significantly than those in ewes drinking warm water. Enzymes activities of the liver, GOT, GPT and γGT, as well as concentrations of creatinine, urea-N, total cholesterol and triglycerides were lower significantly in ewes drank cool or cold water than those drank warm water. Estradiol, progesterone and parathormone levels in ewes drank cool or cold water were significantly higher than its levels in ewes drank warm water. The opposite was found in cortisol levels, since ewes drank cool or cold water have cortisol levels lower than its levels in ewes drank warm water. Drinking cool and cold water increased average of kid's weight at birth from 3.2 kg in ewes drank warm water to 4.10 and 3.60 kg, respectively. In addition, litter size at birth and at weaning as well as litter weight at birth improved significantly in ewes drinking cool and cold water as compared to ewes drinking warm water. In the same time, the percentage of mortality at birth improved from 0.90 in ewes drank warm water to 0.65 and 0.74 in ewes drank cool and cold water, respectively. Habeeb et al. (2012) concluded that internal cooling technique (drinking cool or cold water) acts through the difference between the cool drinking water and warm urine execration temperature which help in heat dissipation by conduction and also aids in evaporative cooling from the body surface (Habeeb et al., 2012) (Tables 8 and 9).

Table8. *Thermoregulatory parameters in pregnant Ossimi ewes as affected by temperature of drinking water during summer of Egypt*

Parameters	Experimental period	Control	Treatments	
		Drinking warm water(30±2 °C)	Drinking cool water (20±2 °C)	Drinking cold water(10±2 °C)
Respiration rate	After 2 weeks	44.20^{a} ± 1.1	30.30^{b}±1.1	30.50^{b}±1.2
	After12weeks	64.7^{a} ± 1.0	45.6^{b}±1.2	46.2^{b}±1.1
Rectal temperature	After 2 weeks	39.5^{a} ±0.08	38.2^{b}±0.06	38.1^{b}±0.06
	After12weeks	39.9^{a} ±0.06	38.5^{b}±0.06	38.5^{b}±0.06
Skin temperature	After 2 weeks	37.5^{a} ±0.05	34.1^{b}±0.05	35.2^{b} ±0.05
	After12weeks	37.5^{a} ±0.04	33.5^{b}±0.04	34.6^{b} ±0.05
Ear temperature	After 2 weeks	38.2^{a} ± 0.04	37.4^{b}±0.04	37.4^{b} ±0.04
	After12weeks	38.1^{a} ± 0.04	37.3^{b}±0.04	37.4^{b} ±0.04

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Table9. *Feed and water intake of pregnant Ossimi ewes as affected by temperature of drinking water during summer of Egypt*

Parameters	Experimental period	Control	Treatments	
		Drinking warm water(30±2°C)	Drinking cool water (20±2°C)	Drinking cold water (10±2°C)
Average of total feed intake (kg/day)	After 2 weeks	1.62[b]±0.02	1.93[a]±0.02	1.91 [a] ±0.02
	After12weeks.	1.66 [b]±0.02	1.90[a]±0.02	1.90 [a] ±0.02
Average of water intake (l/day)	After 2 weeks	1.83[c]±0.03	3.10[a]±0.03	2.53[b]±0.03
	After12weeks.	2.03[c]±0.03	3.25[a]±0.03	2.83[b]±0.03
Dry matter intake (g/kg LBW/day)	After 2 weeks	28.8 [a] ± 0.5	34.5 [b] ± 0.4	34.0 [b] ± 0.3
	After12weeks.	29.5 [a] ± 0.6	33.8 [b] ± 0.5	33.8 [b] ± 0.4

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Drinking cool water under hot climate may be lead to the direct effect of cooling process which aided animals to reach a steady physiological state with respect hemodilution normally occurring in heat stressed animals. It is also possible that this cooling treatment improved the appetite of animals and causing an increase in feed intake, especially, protein either from feed or from digested rumen microorganisms and consequently an increase in blood substrates, minerals and vitamins. Conclusively, it seems that the drinking cool water is an ideal mean and easier technique for improving the productive performance of rabbits under summer season (Habeeb et al., 2010c). Marai et al. (2007) found that daily body weight gain of rabbits was affected adversely during the hot period of the summer season in Egypt and drinking cool water during summer improved body weight gain.

Plasma testosterone, vitamins B9 (folic acid), B_{12} (cyanocobalamin), zinc and selenium concentrations increased significantly and cortisol decreased significantly in bucks of rabbits drank cool water or injected with vitamin B-complex after both 2 and 10 weeks of treatment as compared with drank tap water. Plasma testosterone concentration increased significantly (P<0.001) in bucks drank treated water after both 2 and 10 weeks of treatment as compared with those drank tap water by 8.10 and 12.30 %, respectively. Testosterone level also increased significantly (P<0.001) by injection of Tri-B vitamins in rabbits buck by 13.78 and 17.93% after 2 and 10 weeks of treatment, respectively. Plasma cortisol concentration decreased significantly (P<0.001) in bucks drank treated water after both 2 and 10 weeks of treatment by 24.31and 14.82 %, respectively. Injection of Tri-B vitamins in rabbits buck decreased cortisol level by 46.17 and 29.123 % after 2 and 10 weeks of treatment, respectively. With drinking cool water during summer season, cortisol levels decreased (P<0.001) by 31.17and 23.15 % after 2 and 10 weeks of treatment, respectively. Plasma cortisol levels decreased in injected rabbits by 52.94 and 32.23%, after 2 and 10 weeks of treatment, respectively. Drinking bucks with treated water increased significantly (P<0.001) cyanocobalamin concentrations by 39.70 and 46.21%, for 2 and 10 weeks, respectively. Injection of Tri-B vitamins into bucks also increased significantly (P<0.001) plasma cyanocobalamin concentration by 56.08 and 47.96 %, respectively Drinking treated water for 2 and 10 weeks increased significantly (P<0.001) folic acid concentrations as compared with rabbits drank fresh water by 108.19 and 68.97%, respectively. Injection of Tri-B vitamins into bucks also increased significantly (P<0.001) plasma folic acid concentration by 112.57 and 63.58 %, respectively. After two weeks or ten weeks from drinking treated water, zinc concentration increased significantly by 21.43 and 21.52 %, respectively. Injection Tri-B vitamins into buck also increased zinc concentration significantly by 30.00 and 31.65 %, respectively. Drinking treated water increased significantly selenium concentration by 13.63 after 2 weeks and 13.36% after 10 weeks. Injection of Tri-B vitamins into bucks also increased significantly plasma selenium concentration by 27.27 and 21.12 %, respectively (Table 10) (Habeeb et al., 2010c).

Table10. *Plasma testosterone, cortisol, vitamins B9, B12, zinc and selenium concentrations in New Zealand White rabbit bucks as affected by drinking cool water or Injection with Tri-B under hot summer season of Egypt.*

Parameters	Experimental weeks	Hot summer season without treatment	Drinking cool water during hot summer season	Injection with Tri-B vitamins during hot summer season
Testosterone (ng/ml)	After 2 weeks	113.40[c]±2.2	123.70[b]±2.2	129.00[a]±2.2
	After 10 weeks	115.39[b]±2.2	129.37[a]±2.2	134.67[a]±2.2
Cortisol (ng/ml)	After 2 weeks	12.20[a]±0.22	8.41[b]±0.22	5.75[c]±0.22
	After 10 weeks	10.02[a]±0.22	7.70[b]±0.22	6.79[b]±0.22
Vitamin B12 (pg/ml)	After 2 weeks	17.91[b]±1.5	24.07[a]±1.5	26.33[a]±1.5
	After 10 weeks	21.52[b]±1.0	28.21[a]±1.0	29.45[a]±1.0
Vitamin B9 (ng/ml)	After 2 weeks	17.91[b]±1.5	24.07[a]±1.5	26.33[a]±1.5
	After 10 weeks	21.52[b]±1.0	28.21[a]±1.0	29.45[a]±1.0
Zinc (ppm)	After 2 weeks	6.20[b]±0.40	8.20[a]±0.30	8.40[a]±0.70
	After 10 weeks	7.60[b]±0.70	9.60[a]±0.70	9.80[a]±0.70
Selenium (ppmx10^{-2})	After 2 weeks	1.90[c]±0.10	2.30[b]±0.10	2.70[a]±0.10
	After 10 weeks	2.21[b]±0.11	2.42[a]±0.11	2.64[a]±0.11

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Habeeb et al. (2010c) concluded that drinking cool water during summer and injection of Tri-b intramuscular two times weekly are considered the best two amelioration techniques to improve these levels in plasma of rabbits and consequently improved growth and feed performance, especially, under stressful conditions of Egypt. In the same time, the drinking cool water during summer season is useful, simply and more practical technique for amelioration the heat load on animals (Habeeb et al., 2012) (Tables 11, 12, 13 and 14) .Conclusively, drinking cool water is method used to reduce heat load on farm animals.The importance of the drinking cool water under hot climate may be attributed to the direct effect of cooling process which aided animals to reach a steady physiological state with respect hemodilution normally occurring in heat stressed animals. It is also possible that this cooling treatment improved the appetite of animals thus causing an increase in feed intake, especially, protein either from feed or from digested rumen microorganisms and consequently an increase in blood substrates, minerals and vitamins. It is concluded that drinking cool water is an ideal mean and easier technique for improving the productive performance of animals under summer season (Habeeb et al 2012).

Table11. *Liver functions of pregnant Ossimi ewes as affected by temperature of drinking water during summer of Egypt.*

Parameters	Experimental period	Control	Treatments	
		Drinking warm water (30±2 °C)	Drinking cool water (20±2 °C)	Drinking cold water (10±2 °C)
Total proteins(g/dl)	After 2 weeks	5.81[b]± 0.08	6.41[a]±0.07	6.24[a]±0.08
	After12 weeks.	5.99[b]± 0.06	6.81[a]±0.08	6.74[a]±0.08
GOT(u/ml)	After 2 weeks	49.28[a]±3.3	31.50[c]±2.7	36.43[b]±2.6
	After12 weeks.	59.38[a]±3.5	41.58[c]±3.6	46.93[b]±2.7
GPT(u/ml)	After 2 weeks	30.06[a]±2.1	22.08[b]±1.4	23.56[b]±1.2
	After12 weeks.	39.66[a]±2.3	29.00[b]±1.9	29.50[b]±1.4
γGT(u/l)	After 2 weeks	41.24[a]± 1.5	31.00[b]±1.7	34.90[b]±1.6
	After12 weeks.	47.60[a]±1.7	40.80[b]±1.8	42.00[b]±2.1

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Table12. *Concentrations of some steroid hormones in pregnant Ossimi ewes as affected by temperature of drinking water during summer of Egypt*

Parameters	Experimental period	Control	Treatments	
		Drinking warm water (30±2 °C)	Drinking cool water (20±2 °C)	Drinking cold water (10±2 °C)
Estradiol$_{17ß}$ (pg/ml)	After 2 weeks	170.0[b]±7.3	220.0[a]±8.3	210.0[a]±8.3

	After12weeks.	220.0^{b}±8.3	248.0^{a}±9.6	244.0^{a}±8.8
Progesterone (ng/ml)	After 2 weeks	5.35^{c}± 0.5	8.42^{a}± 0.5	7.11^{b}± 0.6
	After12weeks.	8.25^{c}± 0.4	12.40^{a}±0.7	10.11^{b}± 0.6
Cortisol (ng/ml)	After 2 weeks	14.85^{a}±1.0	9.51^{b}±1.2	8.30^{b}±1.1
	After12weeks.	19.15^{a}±1.1	13.11^{b}±1.1	12.40^{b}± 0.9
Parathormone (pg/ml)	After 2 weeks	16.12^{b}±1.5	22.87^{a}±1.7	22.84^{a}±1.1
	After12weeks.	12.12^{b}±1.4	16.87^{a}±1.5	15.84^{a}±1.6

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Table13. *Kidney functions (creatinine and urea-N), some lipids profile parameters (cholesterol and triglycerides) and glucose concentrations in pregnant Ossimi ewes as affected by temperature of drinking water during summer of Egypt*

Parameters	Experimental period	Control	Treatments	
		Drinking warm water (30±2 °C)	Drinking cool water (20±2 °C)	Drinking cold water (10±2 °C)
Creatinine (mg/dl)	After 2 weeks	1.13^{a}±0.03	0.80^{b}±0.03	0.91^{c}±0.02
	After12weeks.	1.80 ^{a}±0.02	1.20 ^{b}±0.01	1.19 ^{b}±0.01
Urea (mg/dl)	After 2 weeks	28.31^{a}±2.0	20.80^{b}±1.9	21.50^{b}±2.2
	After12 weeks.	35.90 ^{a}±2.1	30.00 ^{b}±1.5	29.50 ^{b}±1.4
Cholesterol (mg/dl)	After 2 weeks	101.47^{a}±2.9	87.42^{b}±4.8	87.41^{b}±3.8
	After12 weeks.	98.40^{a}±2.8	82.22^{b}±3.8	80.61^{b}±4.8
Triglyceride (mg/dl)	After 2 weeks	77.40^{a}±2.8	65.20^{b}±2.6	67.90^{b}±2.5
	After12 weeks.	66.43^{a}±3.1	60.80^{b}±2.8	60.90^{b}±2.7
Glucose (mg/dl)	After 2 weeks	64.99^{b}±2.1	73.41^{a}±1.8	75.27^{a}±1.7
	After12 weeks.	50.09^{b}±1.5	63.41^{a}±2.3	61.27^{a}±2.1

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Clipping or Wool shearing process

Shearing or clipping is the process by which the woolen fleece of a sheep is cut off. Shearing, generally, takes place in the spring when the temperature is warmer to allow the sheep to have a full wool coat during the winter and they have adequate wool growth to keep the animal cool and avoid sunburned sheep in the summer. Lack of shearing caused too much wool and the extra wool weight can result in heat exhaustion or heat stroke during hot weather conditions. Shearing is necessary to prevent the animal from overheating either when indoors, or outside during hot summer months. When shorn, sheep are also much less prone to fly strike (Finocchiaro et al., 2005). However, if body heat production in sheep is suddenly increased, it can have difficulty in losing sufficient heat to maintain a constant body temperature and may become heat stressed. Conversely, a sheep which has been shorn is susceptible to extremes of climatic temperature and can easily become either cold stressed or heat stressed if exposed to extreme weather conditions (Rushen et al., 2008). Evaporation becomes the most important avenue for heat dissipation, since sweating in unshorn sheep is much less important than respiratory evaporation due to the presence of a wool coat. Under long periods of exposure to heat during summer season, animals try to produce less body heat by the decreases in feed intake (Marai et al., 2007).

Significant reductions in skin and rectal temperatures and respiratory rates have been shown by clipping animals (Habeeb et al., 2009). In range and housed conditions, shorn animals show an increase in growth rate. However, the direct exposure of their clipped skins to solar radiation may hurt the skin. In such case, suitable covering for the skin can be obtained by partial clipping of the coats of the animals.

Table14. *Ossimi litter size and weight at birth and at weaning drinking water with different temperatures at late pregnancy period during hot summer of Egypt.*

Parameters	Control	Treatments	
	Drinking warm water(30±2 °C)	Drinking cool water (20±2 °C)	Drinking cold water(10±2 °C)
Litter size at birth (kg)	1.00^{b}±0.002	1.20^{a}±0.002	1.30^{a}±0.002
Litter weight at birth (kg)	5.34^{b}±0.34	5.94^{a}±0.62	6.10^{a}±0.35
Kid weight at birth (kg)	3.20^{c}±0.06	4.10^{a}±0.06	3.60^{b}±0.06
Mortality at birth (%)	0.90^{a}±0.001	0.65^{c}±0.001	0.74 ^{b} ±0.001
Litter size at weaning (kg)	5.10^{c}±0.58	6.31^{a}±0.60	5.84^{b}±0.60

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Exposure to high ambient temperatures augments the efforts to dissipate body heat, resulting in the increase of respiration rate, body temperature and consumption of water, and a decline in feed intake. At the same time, such exposure of animal to heat stress evokes a series of drastic changes in the biological functions, which include a decrease in feed intake efficiency and utilization, disturbances in water, protein, energy and mineral balances, enzymatic reactions, hormonal secretions and blood metabolites (Habeeb et al., 1992). Marai et al. (2007) reported that the exposure of sheep to elevated ambient temperatures induces an increase in the dissipation of excess body heat, in order to negate the excessive heat load. Dissipation of excess body heat is performed by evaporation of water from the respiratory tract and skin surface via panting and sweating, respectively. However, evaporation by panting in sheep becomes the most important avenue for heat dissipation, as sweating in woolen sheep is much less effective due to the presence of the wool coat. Johnson (1987) reported that when the environmental temperature rises to 36 ◦C, the ears and legs of sheep dissipate a high proportion of the heat, as these areas contribute about 23% of the body surface area and when the physiological mechanisms of the animal fail to negate the excessive heat load, the rectal temperature increases. Thompson (1985) reported that sheep loose approximately 20% of total body heat via respiratory moisture in a neutral environmental temperature (12˚C) and the moisture loss increases and accounts for approximately 60% of the total heat loss at high ambient temperature (35˚C). Gimenez and Rodning (2007) reported that shearing the ewe flock and rams 2 to 4 weeks before breeding can help reduce heat stress.

Effect of wool shearing process during hot summer season on some physiological, nutritional and growth performance was studied by Habeeb et al. (2008 a, b) and found that shearing lambs during summer season increased significantly the mean values of DM, OM, CP, CF and NEF digestibility percentages, improved significantly the nutritive values of ration (TDN and DCP), decreased significantly water intake, increased DM intake and body weight gain and improved feed conversion-rate. Furthermore, the mean values of T_4 and T_3, total proteins, and globulin increased significantly in plasma for shorn lambs. On the other hand, unshorn lambs had higher mean values in cortisol hormone than shorn ones. Results revealed also that shorn lambs had significant lower values of rectal, dorsal skin, internal and external ear temperatures as well as respiration rate and heart rate compared to the unshorn shearing lambs. The unshorn lambs exposed to increase the heat load as a result to decrease the heat dissipation by sweating due to the presence of wool coat. The heat load imposed on unshorn lambs caused the decrease of its feed intake and growth performance when compared to those shorn lambs. Providing shearing resulted in reducing the adverse effects of heat stress in summer and in turn improved the metabolic media of shorn lambs to increase their productivity. In addition, providing shearing resulted in alleviating the burden of summer heat stress and consequently improved the heat tolerance of lambs raised under semi arid conditions of the desert and resulted in reducing the adverse effects of heat stress in summer and in turn improved the metabolic media of shorn lambs to increase their levels in total proteins, globulin, T_4 and T_3 (Habeeb et al., 2008 a, b)

Habeeb et al. (2009) concluded that under hot weather, shearing sheep must be carried out. It is very important that sheep be sheared before summer heat begins. This will help them get through the summer months without causing further stress. If we can't sheer the lambs before summer, the animals will exposure to severe heat stress which is accompanied by changes in the biological functions including the depression in feed intake and utilization, disturbance in the metabolism of protein, energy and water balances, as well as thyroid and adrenal hormonal secretions and immunity function (Habeeb et al., 2009) (Tables 15, 16, 17 and 18) .

Table15. *Effect of shearing process during hot summer season on voluntary intake, nutrient digestibility and nutritive values in experimental lambs*

Dry matter intake (DMI)	**Un-sheared lambs**	**Sheared lambs**
DMI from CFM (g/kg LBW)	$26.1^b \pm 0.3$	$28.9^a \pm 0.3$
DMI from wheat straw (g/kg LBW)	3.5 ± 0.6	3.3 ± 0.4
Total DMI (g/kg LBW)	$29.6^b \pm 0.6$	$31.2^a \pm 0.5$
Percentage of apparent digestibility		
Dry matter	$70.5^b \pm 0.90$	$79.3^a \pm 0.74$
Organic Matter	$71.5^b \pm 0.88$	$79.3^a \pm 0.78$

Crude Protein	$68.3^b \pm 1.00$	$74.9^a \pm 1.08$
Crude Fiber	$50.1^b \pm 1.91$	$58.8^a \pm 1.50$
Ether Extract	69.0 ± 2.05	72.3 ± 1.36
Nitrogen free extract	$77.5^b \pm 0.74$	$83.8^a \pm 0.52$
Percentage of nutritive values		
Total digestible protein	$67.90^b \pm 0.70$	$74.22^a \pm 0.71$
Digestible crude protein	$9.13^b \pm 0.18$	$10.03^a \pm 0.23$

a, b ...Means in the same row having different superscripts per each item differ significantly (P<0.05) .

Table16. *Effect of shearing process during hot summer season on daily body weight gain, water intake and feed conversion in experimental lambs*

Items	Un-sheared lambs	Sheared lambs
Total gain (kg)	$13.14^b \pm$ 1.08(SE)	$19.39^a \pm 1.69$
Average daily gain (g)	$117.35^b \pm$ 9.61(SE)	173.09^a ±15.07
Feed conversion (DMI/gain)	9.45^a(SE)	7.21^b
Water intake (l /day)	$4.40^a \pm$ 0.4(SE)	$2.82^b \pm 0.3$

a.b Means with the different superscripts in the same row differ significantly (P<0.05).

Nutritional Technique

Regarding feeds and feeding, proper requirements should be offered to animals all the year round. Protein content often averages 2-4 percent in deceptively lush-looking grown in there areas. Such forage is usually mature and dry out with a high stem: leaf ratio (due to falling of the leaves while drying).- Digestion of highly lignified fibrous feeds increases the heat output and heat load at a time the animal is already under considerable heat stress.

Animals efficient in feed conversion have more ability to withstand heat stress effects, since they produce less heat while digestion of such feeds. Arranging feeding with minimum lignified feeds and / or containing ingredients with low fibre-high energy content produces less metabolic heat is beneficial in such areas (Beede and Collier, 1986). As a general rule, feeds should be administered during the coolest periods of the day, i.e. at early morning, late in the evening or by night, under hot climate conditions. In extremely hot days, it is preferred to keep the animals in the sheds.

Table17. *Effect of shearing process during summer season on water intake, respiratory frequency and skin, ear and rectal temperatures in Ossimi male lambs*

Item	Un-sheared lambs	Sheared lambs
Respiratory frequency (breaths/min)	$50.0^a \pm 3.5$	$32.8^b \pm 2.8$
Heat rate (beats min^{-1})	$100^a \pm 3.5$	$80^b \pm 2.8$
Skin temperature (°C)	$38.5^a \pm 0.2$	$37.2^b \pm 0.1$
Ear temperature (°C)		
Internal	37.6±0.2	37.5±0.2
External	37.8± 0.2	37.8±0.1
Rectal temperature (°C)	$40.40^a \pm 0.01$	$39.00^b \pm$ 0.01

a, b ...Means in the same row having different superscripts per each item differ significantly (P<0.05)

Table18. *Effect of shearing process during hot summer season on immunity, kidney and thyroid functions and cortisol level in Ossimi male lambs*

Item	Un-sheared lambs	Sheared lambs
Immunity function:		
Total proteins (g/dl)	$6.79^b \pm 0.20$	$7.75^a \pm 0.26$ (+14.1%)
Albumin(g/dl)	3.77 ± 0.04	3.80 ± 0.02
Globulin (g/dl)	$3.02^b \pm 0.08$	$3.95^a \pm 0.06$ (+30.8)
Kidney function:		
Urea-N(mg/dl)	29.90 ± 2.44	33.00 ± 2.90
Creatinine (mg/dl)	1.06 ± 0.02	1.09 ± 0.01
Thyroid function:		
T_4 (nmol/l)	$77.33^b \pm 5.72$	$108.10^a \pm 7.85$ (+39.79%)
T_3 (nmol/l)	$1.48^b \pm 0.17$	$2.74^a \pm 0.37$ (+85.14%)
T_4 / T_3 ratio	52.25^a	39.45^b
Cortisol (ng/ml)	$14.20^a \pm 0.52$	$9.40^b \pm 0.41$(-33.8%)

a, b ...Means in the same row having different superscripts per each item differ significantly (P<0.05).

a, b,…Means for each parameter in the same raw with different superscript are significantly different (P<0.05)

Supplementing of heat stressed animals with protein, fat and/or mineral resources, is required to correct their negative balances, since heat stress induces a significant decrease in the dry matter intake and a significant increase in protein and lipids catabolism and decrease in live body weight, in addition to increase in excretion of urine and sweat containing minerals. Supplementation with ingredients that include crude protein or NPN (like urea) can be used to correct the negative nitrogen balance (Habecb et al., 1989). Palm oil can be used to increase the gross energy intake and consequently increase the performance. Mineral resources supplementation corrects minerals negative balances (El-Masry et al., 1989).

Supplementation of heat stressed animals with protein, fat, vitamins and mineral resources is required to correct their negative balances, since heat stress induces a significant decrease in the DMI and a significant increase in excretion of urine and sweat containing minerals (Omnisky *et al.*, 2002). There are several key areas of nutritional management which should be considered during hot weather. These include supplementation with ingredient that include crude protien or protein nitrogen like urea (Habeeb *et al.*, 1989). Regarding feeds and feeding, proper requirements should be offered to animals all the year round (El-Sobhy, 2005). Protein content often averages 2-4 percent in deceptively lush-looking grown in their areas. Such forage is usually mature and carries out with a high stem: leaf ratio (due to falling of the leaves while drying). Digestion of highly lignified fibrous feeds increases the heat output and heat load at a time the animal is already under considerable heat stress. Animals efficient in feed conversion have more ability to withstand heat stress effects, since they produce less heat while digestion of such feeds. Arranging feeding with minimum lignified feeds and/or containing ingredients with low fiber-high energy content will that produce less metabolic heat is beneficial in such areas (Beede and Collier, 1986). As a general rule, feeds should be administered during the coolest periods of the day, i.e. at early morning late in the evening or by night, under hot climate conditions. In extremely hot days, it is preferred to keep the animals in the sheds. Palm oil can be used to increase the gross energy intake and consequently increase the performance. Mineral resources supplementation correct minerals negative balances (El-Masry *et al.*,1989) and consequently improved milk production (Kamal *et al.*, 1989). A sharp increase in the secretion of potassium cation through sweat occur during hot climate conditions so feeding diets that have a high dietary cation-anion differences improved DMI and milk yield and regulation of acid base balance (West *et al.*, 1991).

Probiotics or direct fed microbials or effective microorganisms (EM) refer to a source of live naturally occurring microorganisms which include bacteria, fungi and yeasts which have accepted as safe (non- pathogenic and non – toxic) and as being appropriate for use in animal feed. Each of these organisms is naturally occurring bacteria from the gut of normal, healthy animals and is not genetically engineered. In the same time, these organisms are the same genus and species as those used in human foods (Wallace, 1994). Primary actions of EM are proposed to be minimizing the growth of pathogenic bacteria, increasing desirable microbial populations in the gut, facilitating fiber digestion; and inactivating toxins (Dhuyvetter *et al.*, 1995). It was shown that feeding EM can be used for improving the growth performance of heat-stressed crossbred (Beauchemin *et al.*, 2006). In crossbred baladi calves, Habeeb *et al.* (2002) found that treated rice straw with EM caused significant improvement in daily live and solid body weight gains and significant increase in daily rice straw intake under comfortable and stressed conditions. Habeeb *et al.* (2010a) have shown that EM supplement can be used for improving the growth performance of lambs without any side effects on physiological body metabolism especially under high ambient temperature of summer season in Egypt.

Addition of urea, minerals and vitamins to the diet of heat stressed Friesian calves increased the average LBG by 166 g daily for each calf of which 110g was solids (66%) and increased also DM intake by 6% and caused significant improvements in DM and energy efficiencies by 21 and 27%, respectively when compared to the control group. When gain was expressed as SBG, the corresponding values were more remarkable. The improvements in body weight gain and feed efficiency in heat stressed Friesian calves due to additives were associated with highly significant elevations of T4 (39%) and free T_4-index (33%) as well as hemoglobin values (9%) as compared to the control group. However, transaminase enzymes activities and rectal temperature values increased significantly due to diet supplementation (Habeeb et al., 1995). Improvements in gain, DM and feed efficiency and the trends towards normal blood components in heat stressed Friesian calves as a result to the increase in dietary nitrogen (urea) and biological active substance (minerals and vitamins) may be associated to the recovery of the losses in nitrogen, minerals and vitamins induced in the heat stressed animals (Habeeb et al., 1992) . These substances cause an increase in retained nitrogen and consequently improvement in daily gain. In addition, the trace elements enhance digestibility of nutrients, large microorganisms growth in the rumen, metabolizable energy and ability of protein synthesis (Kamal et al., 1989). Moreover, the increase in T_4 in the treated calves stimulates the protein synthesis by a decrease of the proteolytic action of glucocorticoids or an increase of the glucose transport to provide energy required for peptide synthesis (Habeeb *et al.*, 1989). However, although diet supplementation with urea, minerals and vitamins improved the gain, especially solids gain and feed efficiency, the heat load on the animals did not seem to have been completely alleviated, since transaminase enzyme activities, as well as, rectal temperature were higher in supplemented group than in the control (Marai et al., 1995 and 1997). Abdalla *et al.* (2009) supplementation of dried live yeast to the diet at the rate of 15 g / calf / day may enhance most blood metabolites and improved some physiological and immunological indices and thyroid function. So, this level of DLY could able to improve significantly feed efficiency and growth performance of heat-stressed calves. Dried whey milk is a source of energy and nitrogen that could be utilized well by ruminants. Several studies have been carried out for improving productivity of heat stressed animals. The addition of dried whey milk to the diet reduced rectal temperature and respiratory rate and induced an improvement in most blood biochemical parameters and growth performance of heat stressed calves (El-Masry *et al.*, 2010).

The antioxidant activity is high in medicinal plants and antioxidants play an important role in inhibiting and scavenging radicals which providing protection to humans against infectious and degenerative diseases (Anwar et al., 2004). Some medicinal plant extracts and pure forms of active compounds were evaluated for their potential application as modifiers of rumen microbial fermentation to produce VFA which represent the main supply of metabolizable energy for ruminant (Busquet et al., 2005). From another point of view the Nigella oils can be used as antioxidant agent as it inhibited the non-enzymatic peroxidation which may increase the immunity and may help the animals to tolerate the heat stress (Awadallah, 2002). Curcumin or Turmeric also essentials for antioxidant activity comparable to that vitamins C and E and reduces cholesterol levels and increase good cholesterol, i.e. high-density lipoprotein (Polsa et al., 1992). In addition, Manjunatha and Srinivasan (2006) found that turmeric volatile oil can diffuse into the sperm cells membrane and serve as an intracellular structure. The main yellow bioactive component of turmeric has a wide spectrum of biological actions include its antioxidant, anticoagulant, antibacterial, antifungal, antiprotozoal, antiviral and hypocho-lesteremic activities Chattopadhyay et al., 2004). The antioxidant activity of Curcumin was due to it acts as a scavenger of oxygen free radicals and protect hemoglobin from oxidation. Curcumin lowers the production of reactive oxygen species like super oxide anions, H_2O_2 and nitrite radical generation (Masuda et al., 2001)..

Concerning the effect of Nigella or Curcumin on growth performance Awadallah (2002) reported that Friesian calves under heat stress condition fed diets supplemented daily with NSS at the rate of 100 mg/kg body weight improved body weight gain. Awadallah and Gehad (2003) found that supplementing growing sheep ration with NSS improved significantly average daily gain, feed conversion ratio as kg DM intake /kg gain. Sheep fed rations supplemented with NSS had a significantly higher average daily gain (179.7 g/daily in control vs. 200.9 and 212.9 g/daily, supplemented with 1 and 2% with NSS, respectively). Allam *et al.* (1999) found that ration of lactating goats supplemented with 0.25 g NSS powder / kg LBW /day improved significantly litter size and litter weight during suckling period and at weaning in Zaraibi kids. Khattab *et al.*(2011) showed that calves of buffaloes fed on black seed oil diet grew faster than those of buffaloes fed on diet without black seed oil. Moreover, calves of black seed oil had significantly the highest weaning weight and significant highest total gain. It is clear that calves of black seed oil treated buffaloes showed the highest ($P<0.05$) daily gain. Khattab *et al.*(2011) concluded that the effect of treating buffaloes before parturition was transferred to offspring and consequently led to more gain for calves received black seed oil treatment Habeeb and El-Tarabany (2012) found that Nigella and Curcumin additives to the diet of Zaraibi kids during months of the hot summer season at the rate of 2 gram from both Nigella seeds or Curcumin / kg CFM improved significantly average final LBW from 25.2 kg to 33.5 and 32.0 kg, respectively. These results mean that LBW during 5 months of the hot summer season improved by 5.56 and 4.80 kg due to supplement the diet of kids Zaraibi goats with Nigella and Curcumin, respectively. The LBW values of Zaraibi kids were better with addition Nigella in their diet than with Curcumin by 0.760 kg / month. In addition, Nigella and Curcumin increased average DBG in kids of goats by 62.2 and 54.2 g%, respectively and the improvement in DBG was better with Nigella than with Curcumin by 8.0 g daily. Supplementation improved the animal immunity function as well as increased significantly Hb value and RBC'S count and thyroid hormonal levels (T_4 & T_3) and decreased the factor related to heart disease (total cholesterol and total lipids), glucose and cortisol levels in the blood plasma. At the same time, liver and kidney functions were not affected negatively by supplementation either with Nigella or Curcumin.

Concerning the effect of Nigella or Curcumin on feed performance, Allam *et al* (1999) observed that using black seed in dairy goat diets had a positive effect on feed efficiency. El-Gendy et al (2001) found that DM, OM, CF and GE digestibility of rations containing Nigella in Rahmany rams were significantly higher than for other rations. In addition, the DE and TDN of rations containing Nigella were higher than control and the authors concluded that Nigella could be used successfully in ruminant rations to improve its nutrients digestibility coefficients and nutritive values.

Awadallah and Gehad (2003) reported that the growing sheep fed the 2% NSS supplemented ration had the lowest significantly conversion ratio calculated as kg DM intake/ kg body weight gain (8.04 in control vs. 6.97 and 6.25 in rations supplemented with 1 and 2 %, respectively). From the metabolism trial, Awadallah and Gehad (2003) reported that supplementation caused significant increase in nutrients digestibility, nitrogen utilization, nitrogen retention and increase the nutritive values (TDN and DCP) of the supplemented rations. Mohammed *et al.*(2003) reported that supplementation feeds by 100 mg NSS /kg LBW of ewes improved significantly the feed intake and the digestibility coefficient of DM, OM, CP, CF and NFE and nutritive values as TDN, SE and DCP. Allam *et al.* (1999) found that ration of lactating goats supplemented with 0.25 g NSS powder / kg LBW /day improved significantly feed efficiency as g gain/ g DM or g TDN. Khattab *et al.*(2011) found that buffalo calves fed supplemented ration with black seed oil had higher nutrient digestibility values than those of the non supplemented groups. The same authors reported that feed conversion values expressed as DM, TDN and DCP intakes per gain were significantly better for calves of buffaloes supplemented by black seed than the control. Habeeb and El-Tarabany (2012) found that Nigella additive to the diet of Zaraibi kids increased significantly DMI during months of hot summer season by 4.42 and 0.18 g/kg LBW in CFM and barseem hay, respectively. The corresponding increase values with Curcumin additive were 3.3 and 0.16 g/kg LBW.

Concerning the effect of Nigella or Curcumin on hormonal levels Habeeb and El-Tarabany (2012) reported that Nigella additive to the diet of Zaraibi kids increased significantly T_4 and T_3 during months of the hot summer season by 20.3 and 1.3 ng ml^{-1} with percentages increase of 39.26 and 28.26, respectively. The corresponding increase values with Curcumin additive were 11.1 and 1.0 $ngml^{-1}$ with percentages increase of 21.47 and 21.74, respectively. On the other hand, Nigella or Curcumin additive to the diet of Zaraibi kids decreased significantly cortisol level during months of the hot summer season by 3.0 or 2.0 ng ml^{-1} with percentage decrease of 23.44 or 15.63, respectively. T_4/T_3 ratio increased from 11.24 to 12.20 due to addition of Nigella due to the increase in T_4 level was higher than the increase in T_3 level

Concerning the effect of Nigella or Curcumin on blood picture, El-Saadany *et al.* (2008) reported that supplementation the diet of lactating goats with Nigella increased significantly the Hb values and RBC'S count by 34.4 and 25.3%, respectively. Habeeb *et al.* (2009) found that supplementation the diet of lactating Zaraibi goats during hot summer months with Curcumin increased significantly Hb values as well as RBC'S count. Habeeb and El-Tarabany (2012) found that RBC'S count and Hb values in blood of Zaraibi kids goats during months of the hot summer season increased significantly by $1.33x10^{6}$ and 1.34 g/dl, respectively, due to supplement Nigella to the diet of Zaraibi kids. Curcumin also improved significantly RBC'S count and Hb values in blood of Zaraibi kid's goats during months of the hot summer season by $1.03x10^{6}$ and 0.94 g/dl, respectively (Habeeb and El-Tarabany, 2012) (Tables 19 and 20, 21, 22, 23 and 24).

Table19. *Effect of Nigella or Curcumin on live body weight of growing male Zaraibi goats during hot summer conditions*

Experimental period	Live body weight (LBW, kg)				
	Summer without treatment	Summer treated with Nigella	Monthly increase	Summer treated with Curcumin	Monthly increase
Initial LBW	9.5^{a} ± 0.50	9.7^{a} ± 0.60	---	9.4^{a} ± 0.40	---
1st month	12.1^{b} ± 0.62	14.7^{a} ± 0.20	+2.600	14.3^{a} ± 0.80	+2.200
2nd month	15.5^{b} ± 0.65	19.9^{a} ± 0.63	+4.400	19.3^{a} ± 1.16	+3.800
3rd month	18.7^{b} ± 0.76	24.5^{a} ± 0.81	+5.800	23.8^{a} ± 1.19	+5.100
4th month	22.5^{b} ± 1.08	29.8^{a} ± 1.08	+6.700	28.6^{a} ± 1.04	+6.100
Final LBW	25.2^{c} ± 2.03	33.5^{a} ± 2.48	+8.300	32.0^{a} ± 2.05	+6.800
Overall mean			+5.56		+4.80

a, b,…Means for each parameter in the same raw with different superscript are significantly different (P<0.05)

Table20. *Effect of Nigella or Curcumin on daily body weight gain of growing male Zaraibi goats during hot summer conditions*

Experimental period	Daily live body weight gain (DBWG), gram)				
	Summer without treatment	Summer treated with Nigella	Daily increase	Summer treated with Curcumin	Daily increase
1st month	86^{b} ± 2.2	167^{a} ± 2.5	81.0	163^{a} ± 3.2	77.0
2nd month	113^{b} ± 5.4	173^{a} ± 4.2	60.0	167^{a} ± 3.1	54.0
3rd month	106^{b} ± 5.0	153^{a} ± 4.2	47.0	150^{a} ± 2.0	44.0
4th month	87^{c} ± 4.2	177^{a} ± 5.4	90.0	160^{b} ± 3.5	73.0
5th month	90^{c} ± 3.4	123^{a} ± 3.0	33.0	113^{b} ± 2.4	23.0
Overall mean			+62.2		+54.2

a, b,…Means for each parameter in the same raw with different superscript are significantly different (P<0.05)

Table21. *Effect of Nigella or Curcumin on voluntary daily DMI (g /kg LBW/head) from feed stuffs in growing male Zaraibi goats during hot summer conditions*

Experimental period	DMI, (g/kg LBW) from feed stuffs	Average dry matter intake from feed stuffs (g DMI/kg LBW/head)		
		Summer without treatment	Summer treated with Nigella	Summer treated with Curcumin
1st month	CFM Berseem hay	22.4^{b}±0.30 2.2^{B}±0.20	26.9^{a}±0.50 2.5^{A}±0.20	26.0^{a} ±0.40 2.5^{A} ±0.10
2nd month	CFM Berseem hay	34.4^{b}±0.30 2.7±0.10	40.9^{a}±0.30 2.9±0.10	39.9^{a} ±0.30 2.8±0.10
3rd month	CFM Berseem hay	46.4^{b}±0.50 2.9±0.20	51.9^{a}±0.30 3.0±0.20	49.9^{a} ±0.30 3.0±0.20
4th month	CFM Berseem hay	55.9^{c}±0.70 3.4±0.30	60.6^{a}±0.40 3.4±0.20	58.7^{b}±0.30 3.4±0.20
5th month	CFM Berseem hay	59.1±0.90 3.5^{B}±0.20	60.0±0.50 3.8^{A} ±0.20	60.2 ±0.30 3.8^{A}±0.30
Overall mean	CFM Berseem hay	43.64^{b}±1.82 2.94±0.12	48.06^{a}±1.48 3.12±0.13	46.94^{a}±1.05 3.10 ±0.10

a, b,…or A, B, …Means for each parameter in the same raw with different superscript are significantly different (P<0.05); CFM= Concentrate feed mixture.

Table22. *Effect of Nigella or Curcumin on Thyroxin (T_4), Triiodothyronine (T_3), T_4 /T_3 ratio and cortisol concentrations in growing male Zaraibi goats during hot summer conditions*

Hormones	Hormonal levels		
	Summer without treatment	Summer treated with Nigella	Summer treated with Curcumin
T_4 (ng ml^{-1})	$51.7^c \pm 3.0$	$72.0^a \pm 4.0$	$62.8^b \pm 3.0$
T_3 (ng ml^{-1})	$4.6^b \pm 0.07$	$6.9^a \pm 0.86$	$6.6^a \pm 0.53$
T_4/T_3 ratio	11.24	10.43	9.97
Cortisol (ng ml^{-1})	$12.8^a \pm 0.93$	$9.8^c \pm 0.93$	$10.8^b \pm 0.93$

a, b,…Means for each parameter in the same raw with different superscript are significantly different (P<0.05)

Table23. *Effect of Nigella or Curcumin addition to diet on blood picture parameters in growing male Zaraibi goats during hot summer conditions*

Blood picture	Blood picture in experimental groups		
	Summer without treatment	Summer treated with Nigella	Summer treated with Curcumin
WBC count	5605 ± 111	5598 ± 130	5534 ± 118
RBCx10^6 count	$10.55^b \pm 0.55$	$11.88^a \pm 0.60$	$11.58^a \pm 0.60$
Hb, g/dl	$11.56^b \pm 0.41$	$12.90^a \pm 0.52$	$12.50^a \pm 0.60$
Hematocrit ratio	36.50 ± 1.00	36.00 ± 1.00	35.80 ± 2.00

a, b,…Means for each parameter in the same raw with different superscript are significantly different (P<0.05)

Concerning the income from addition of Nigella or Curcumin, Habeeb and El-Tarabany (2012) found that better utilization of the absorbed nutrients when Nigella or Curcumin was incorporated in the diet of farm animals and at the same time, the profit above feeding cost was higher with Nigella or Curcumin supplemented ration than that not supplemented by 31.06 and 28.41 %, respectively.

This may be explained by:

- Nigella or Curcumin may be having a stimulating effect on the rumen proper functions and digestion.
- The higher digestibility that was recorded particularly for groups supplemented by Black seed or Curcumin which led to increase the absorbed nutrients from small intestine, consequently increased body weight gain.
- Nigella or Curcumin supplementation increased efficiency of nutrient utilization and consequently led to more gain.
- Increased protein anabolism due to an increase in thyroid activity, as well as higher protein digestibility which led to higher blood plasma total protein and albumin concentration that increase protein biosyntheses.

From the obtained results it could be concluded that adding Nigella or Curcumin to rations of farm animal's improved nutrient digestibility, enhanced the immune responses and productive performance, especially, under hot summer conditions of Egypt (Habeeb and El-Tarabany, 2012).

Table24. *Economical gain/head during experimental period (5 months) due to Nigella or Curcumin supplemental to ration of Zaraibi kids during summer season.*

Particulars income	Experimental Groups		
	Summer without treatment	Summer treated with Nigella	Summer treated with Curcumin
Total gain (kg)	15.70	23.80	22.60
Total income from gain(L.E)	518.10	785.40	745.80
Concentrate feed mixture (CFM) (kg)	113.04	188.73	175.03
Barseem hay (BH) (kg)	8.09	12.80	12.08
Cost of feed stuff (L.E)	266.46	444.31	412.16
Cost of Nigella in 5 months (L.E)	-----	11.28	-----
Cost of Curcumin in 5 months	-----	------	10.50
Total expenditure	266.46	455.59	422.66
Net income =Total income –Expenditure	251.64	329.81	323.14
Percent monitory gain over control	100.00	131.06	128.41

Price of kg live body weight=33 Egyptian pound (L.E.). Price of kg from Nigella and Curcumin= 30 and 30 L.E., respectively. Price of feed stuffs, CFM and BH =2.3 and 0.80 L.E., respectively, according to the price in Egypt during 2011.

Change in Time of Feeding

Habeeb *et al* (2010b) showed that ewes in groups fed at 1200 and 1500h were better than ewes fed at 0900h in physiological and nutritional aspects. Respiration rate and temperatures of rectal, skin and ear values decreased significantly while daily feed intake, dry matter intake and water intake values increased significantly due to late of feeding time under summer time. Digestibility each of

Table25. *Feed and water intake of pregnant Ossimi ewes as affected by feeding time regime at late pregnancy period during hot summer of Egypt.*

Intake parameters	Feeding time		
	Control	Treatments	
	At 9.00hr	At 12.00hr	At 15.00hr
Average of total feed intake (kg/day)	1.62[b] ± 0.02	1.89[a] ± 0.04	1.97[a] ± 0.06
Average of water intake (l/day)	1.97[b] ± 0.03	2.76[a] ± 0.07	2.65[a] ± 0.06
Dry matter intake(g/kg LBW/day)	28.8[b] ± 0.5	33.6[a] ± 0.9	35.0[a] ± 1.1

a, b,...Means for each parameter in the same raw with different superscript are significantly different (P<0.05)

Schwartzkopf-Genswein *et al.* (2004) reported that cattle fed late (21.00hr) in the day gained marginally more weight than cattle fed in the morning (0900).

The lowest ADG was observed for morning fed steers, where as the highest ADG was recorded for evening fed steers (1.00± 0.04 vs. 1.28± 0.04 kg/d). Cattle fed in the evening also had higher significantly daily dry matter intake than morning fed cattle (7.48 0.06 vs. 7.26 0.06 kg/d). These results indicate that it may be beneficial to feed in the evening from a cold climate thermodynamics perspective because the heat produced during fermentation and metabolism is shifted to the evening when cold stress is more likely to occur. In addition, in regions where heat stress is a concern, evening feeding would help decrease any additional heat load that could occur if the animals were fed during the warmest part of the day.

DM, OM, CP, CF, and NFE as well as TDN and DCP of diet improved significantly in ewes fed at 1200 and 1500h as compared to ewes fed at 0900h.

The same authors concluded that late of feeding time decreased the heat load of summer season on pregnant ewes and providing feed at 1200h or at 1500h to animal without adversely affecting performance under hyperthermia (Habeeb et al., 2010b) (Tables 25, 26 and 27).

Simone (2010) suggests that by altering feeding time to the afternoon or evening can help to alleviate heat stress. Heat is generated in the animal by the process of consuming and fermenting feed. Adjusting the time of feeding to late afternoon or evening will mean that additional heat generated from feed will occur in the cooler hours of the day. In addition, multiple feeding can also be beneficial during hot weather through offering 20 to 40% of total feed delivery in the morning, and the remainder (60 to 80%) in the evening will help to alleviate heat stress.

Table26. *Effect of feeding time regime on nutrient digestibility and nutritive values of the heat stressed pregnant ewes during hot summer season of Egypt.*

Items	Feeding time		
	Control At 9.00hr	At 12.00hr	At 15.00hr
Percentage of apparent digestibility			
Dry matter (DM)	70.5[b]± 0.90	79.3[a] ± 0.74	78.5[a] ± 0.34
Organic matter	71.5[b]± 0.80	79.3[a] ± 0.78	77.9[a] ± 0.55
Crude protein (CP)	68.3[b] ± 1.00	74.9[a] ± 1.08	75.9[a] ± 1.18
Crude fiber (CF)	50.1[b] ± 1.91	58.8[a] ± 1.50	57.8[a] ± 1.44
Ether extract (EE)	69.0 ± 2.05	72.3 ± 1.36	72.8 ± 1.22
(NFE)	77.5[b] ± 0.74	83.8[a] ± 0.52	82.9[a] ± 0.55
Percentage of nutritive values			
% (TDN)	67.9[b] ± 0.70	74.22[a] ± 0.71	73.11[a] ± 0.66
(DCP)	9.1[b] ± 0.18	10.03[a] ± 0.23	9.89[a] ± 0.20

a, b,...Means for each parameter in the same raw with different superscript are significantly different (P<0.05)

Table27. *Immunity functions of pregnant Ossimi ewes as affected by feeding time regime at late pregnancy period during hot summer of Egypt.*

Liver function	Feeding time regime		
	Control At 9.00hr	At 12.00hr	At 15.00hr
Total proteins (g/dl)	$5.68^{c} \pm 0.05$	$6.37^{a} \pm 0.06$	$5.95^{b} \pm 0.05$
Albumin(g/dl)	3.84 ± 0.02	3.79 ± 0.01	3.82 ± 0.01
Globulin(g/dl)	$1.84^{c} \pm 0.03$	$2.58^{a} \pm 0.05$	$2.13^{b} \pm 0.04$
GOT(u/ml)	$54.80^{a} \pm 3.4$	$42.40^{b} \pm 3.0$	$44.33^{b} \pm 4.2$
GPT(u/ml)	$36.00^{a} \pm 2.7$	$27.26^{b} \pm 2.0$	$28.00^{b} \pm 2.6$
γGT(u/l)	$39.07^{a} \pm 3.2$	$32.98^{b} \pm 4.3$	$33.07^{b} \pm 4.1$

Physiological Technique

Hormonal Substances

Administration or injection of hormones can be used as a technique for alleviation of heat load on animals since the secretion of most of the hormones is depressed under heat stress conditions. Injection of T4 for this purpose was found to be improved animal productivity but associated with the increase of body temperature of the animals (Marai *et al.*, 1994). Similarly, in insulin injection in the udder was found to show the same effect besides it increases milk production. In injection by bovine somatotropin (BST) also minimized the negative effects of moderately high environmental temperature on milk yield by increasing heat loss and minimizing the endogenous heat production and related physiological functions without any significant increase in rectal temperature and respiratory rates (Mohamed and Johnson, 1985). However, such techniques require some specific precautions and arc expensive at the same time.

Goitrogens Administration

These compounds block thyroidal iodine uptake and consequently depress thyroid gland activity. It depresses the secretion of T4 in the heat stressed animals to decrease heat production. However, this technique is not favored under heat stress conditions, since the treated animals under such conditions may be affected seriously due to their need to more energy for greater muscular activity for the high respiratory activity, O2 consumption and energy metabolism (Kamal et al., 1972).

Diuretics Administration

Diuretic compounds are used to increase water excretion to increase the heat loss by excreting water in urine with the same body temperature and then followed by drinking water which is also of lower temperature than that of the body and increase sweat production in animals (Daader et al., 1989).

Diaphoretics Administration

These compounds are used to increase sweat production for increasing the evaporative cooling of the heat stressed animals. However, such treatments cause significant increases in each of rectal temperature and respiration rate (Marai ct al., 1995).

CONCLUSION

Alleviation of heat stressed animals can be applied by different techniques. The managemental practices concerned in hot climate involve modification of the environment, reducing the animal's heat production and increasing its heat loss. Some techniques that can be used to help the animal in dissipating the heat load and to correct the negative effects caused by heat stress arc classified to physical, physiological and nutritional techniques.

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