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RESEARCH ARTICLE

EFFECTS OF NIGHT GRAZING, WATERING REGIME, TIME OF THE DAY AND SEASON ON RESPIRATION RATE AND RECTAL TEMPERATURE OF SUDAN DESERT SHEEP EWES.

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Abstract

The study was carried out to investigate the effect of grazing management (day and night) , watering regime (every other day and every three days), time of the day and season on respiration rate (RR) and rectal temperature (RT) of Sudan Desert sheep ewes (Ovis aries),
During the day and three consecutive seasons, summer, autumn and winter for one year at Faragalla village, Sheikan Locality in North Kordofan State, Sudan.
Meteorological data during the experimental periods were recorded.
Sixty ewes were randomly assigned to the following treatments:
A = Night grazing + every other day watering regime, B= Night grazing + every three days watering regime, C = Day grazing + every other day watering regime, D = Day grazing + every three days watering regime.
The trial was laid out in a completely randomized design in a 2x2 factorial arrangement of treatments.
Grazing management had no effect ($p > 0.05$) on RR of ewes, with ewes on day grazing recording slightly higher RR. However, the same factor influenced ($p < 0.01$) the RT.
Ewes on day grazing had higher ($p < 0.01$) RT compared with those on night grazing.
Season had a statistically significant ($P<0.01$) effect on both RR and RT, showing different trends during the seasons of the year. RR values increased significantly in rainy season more than in summer and winter.
With regard to the effect of season it was confirmed that the highest RT values were observed in summer, followed by rainy season and winter, correspondingly

Introduction:-

Stressors of farm animals their effects on animal productivity as well as the physiological and behavioral responses of livestock to stress have been examined. All animals experience some level of stress during their lives. Agricultural animals try to cope with stressors using behavioral and physiological stress responses aiming to restore homeostasis (Etim *et al.,* 2013).

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It is generally accepted that sheep would be well adapted to high ambient temperatures as they instigate from as a semi desert environment. However, present-day strains and types may differ in respect of basal nutrient requirements, making them more susceptible to heat stress (Cloete *et al.*, 2000).

The common problems experienced by the sheep in arid tracts are dehydration, heat, transportation, droughts and indirectly diseases, endo- and ectoparasites. When the pressure from these conditions becomes excessive new defense mechanisms are initiated and their determination is an essential part of animal management (Kataria and Kataria, 2005).

Some herd management practices affect the nutrition of livestock by influencing the timing and duration of grazing. For example, night grazing and corralling of grazing ruminants on crop fields for manuring, are common practices in the region (Breman *et al.*, 1978; Powell and Williams, 1993). Moreover, under highly humid days, more grazing occurs at night. In winter, sheep begin night grazing earlier and the morning grazing period begins later in the afternoon (Arnold, 1982). The exact amount of water that sheep need is not known but individually is highly variable. Nonetheless, it is assumed that the voluntary intake of water meets the requirement, so always provide a clean, open source of water. The amount of water sheep voluntarily drink is influenced by many factors, including temperature, rainfall, snow, dew, age, breed, stage of production, wool covering, frequency of watering, amount of feed consumed, composition of feed, exercise or activity and composition of pasture (Sheep Timely Topic, 2003).

Under hot arid and semiarid environments, the high air temperature combined with intense solar radiation produces conditions in which environmental temperature substantially exceeds body temperature.When the total heat load exceeds the level that cannot be dissipated by non-evaporative means, the only effective mechanism employed by mammals to maintain body temperature within tolerable limits is evaporative cooling by panting and sweating (Jessen, Dmi'el and Choshniak, 1998; Walsberg, 2000).

This study was conducted to delineate the effects of grazing management and watering regime on the thermoregulatory system of sheep, through determining the effect of night grazing challenge and watering regime on respiration rate and rectal temperature of Sudan Desert sheep ewes.

Materials and Methods:-

Study Area:-

The study was carried out in Faragalla village, Sheikan province in North Kordofan State. It is located in the arid semi-desert ecological zone, between latitudes 12˚:25 - 30˚: 45́ N and longitudes 29˚:35́ - 3˚́:30́ E. Metrological data and calculated temperature-humidity index **(**THI) during the experimental period and during collection of the samples are shown in Tables 1 and 2.

Table 1:- Meteorological data during the experimental period and calculated THI

Period	**Air Temperature** (ºC)		**Relative Humidity** (RH %)	**Precipitation** (mm)	**THI**
	Min.	Max.			
1st (25Feb. – 25Mar.)	12.3	40.9	13.0	_	23.3**
2nd (25Mar. – 25Apr.)	15.7	41.8	10.7	_	24.8**
3rd (25Apr. – 25May)	23.6	42.4	21.9	_	28.5***
4th (25May – 25Jun.)	20.8	38.9	39.1	0.6	27.0***
5th (25Jun. – 25Jul.)	19.1	35.3	68.2	102.0	25.9***
6th (25Jul. – 25Aug.)	19.4	34.5	71.3	104.3	25.9***
7th (25Aug. – 25Sep.)	19.3	36.3	26.7	60.7	24.7**
8th (25Sep. – 25Oct.)	20.6	38.3	36.4	_	26.3***
9th (25Oct. – 25Nov.)	13.6	38.2	24.7	_	23.3**
10th (25Nov. –25Dec.)	09.3	34.9	28.5	_	20.4*
11th (25Dec. – 25Jan.)	09.6	34.7	26.4	_	20.4*
12th (25Jan. – 25Feb)	09.2	33.4	21.3	_	19.6*
13th (25Feb. – 25Mar.)	12.3	40.4	12.5	_	24.2**

Source: Elobeid Agriculture Research Station.

Scale: <22.2* = absence of heat stress; 22.2 to <23.3 = moderate heat stress; 23.3 to < 25.6** =severe heat stress and 25.6 and more*** = extreme severe heat stress (Marai *et al.*, 2001)

Table 2:- Meteorological data during time of the day (average values of total period)

Time of the day (Hrs.)	Air Temperature (ºC)	Relative Humidity (RH %)
08: 00	21.3	43.7
10: 00	23.5	31.4
12:00	30.0	27.1
14:00	31.9	23.7
16:00	33.0	27.6
18:00	33.7	33.6

Source: Elobeid Agriculture Research Station.

Animals and procedure:-

The study was conducted during three consecutive seasons; summer, rainy and winter, for one year started on February. Sixty (60) Sudan Desert ewes (1-5 years old and weighting 42.3± 0.7) were ear tagged and treated with an anthelmintic (Ivomectin^{R}) administered s/c at 1.0 cc/head., the dose was repeated after two weeks, injected with ox tetracycline as anti-coccidial treatment, vaccinated against epidemic diseases and allowed two weeks adaptation to the experimental treatments. Ewes were weighed after an overnight fast and then divided into two equal groups in such a way that the different ages and weights were evenly distributed through each group. Each group was subdivided into two subgroups of fifteen ewes each. The four subgroups were randomly assigned to the following treatments:

A = Night grazing + every other day watering regime.
B = Night grazing + every three days watering regime.
C = Day grazing + every other day watering regime
D = Day grazing + every three days watering regime.

When the day grazing group was allowed to graze on open range lands during the day hours, the other group was raised under artificial shade until the sunset to start grazing in the evening. The ewes were naturally mated using healthy two rams; one ram was introduced into each of the two main ewes' groups during the normal breeding (mating) season (February-March). The two rams were rotated between ewes' groups to eliminate ram effect and were left with the ewes for 45 days to allow for three estrus periods. Because of the mild temperature and frequent clouds in the rainy season all groups of ewes continued to graze and lay down in the open air until late in the afternoon. Rainy season grazing was restricted to the period from 9:00 a.m to about 4:00 p.m when the plants were without dew.

Data Records:-

Temperature-humidity index (THI) calculation:-

The THI was calculated according to the following equation: THI = db °C - {(0.31 - 0.31RH) (db °C - 14.4)}, where db °C is the dry bulb temperature (°C) and RH is the relative humidity (RH %) /100. The values obtained indicate the following: <22.2 = absence of heat stress; 22.2 to <23.3 = moderate heat stress; 23.3 to < 25.6 =severe heat stress and 25.6 and more = extreme severe heat stress (Marai et al., 2001).

Respiration rate (RR) and Rectal temperature (RT):-

All animals were monthly monitored for RR and RT, where six measurements (every two hours) from 8:00 until 18:00 were taken on each measurement day. RR was measured by counting the rate of flank movement for 20 seconds, then adjusted for 1 minute and reported. While RT was measured using a clinical digital thermometer. RR counts were performed by the same person over the whole experimental period to avoid inter-observer variations.

Experimental design and statistical Analyses:-

The trial was laid out in a completely randomized design (CRD) in a 2x2 factorial arrangement of treatments (Steel and Torrie, 1980). The two factors were the grazing management with two levels (night grazing versus day grazing) and watering regime (every other day versus every three days watering). The season (summer, rainy and winter, season) was included as a factor in the analysis of ewes' data on respiration rate and rectal temperature. However, to study the effects of different factors combinations, two or three factors were taken at a time.

The data were analyzed using Statistical Package for Several Science (SPSS, 1997). All values were expressed as mean and standard error (SE±). $P < 0.05$ and $P < 0.01$ were regarded as statistically significant and highly significant, respectively. Duncan's Multiple Range Test was applied to mean values for the various dates of measurements and sampling periods.

Results:-

Temperature-humidity Index (THI):-

THI is commonly used as an indicator of the degree of climatic stress on animals. According to the THI results belonging to the 13 periods of the one year that the data were collected. The obtained values (Table1.) indicated that the ewes were relaxed (meaning they were not stressed by temperature) during the 10th, 11th and 12th periods as the THI values recorded were <22.2. On the other hand, the 1st, 2nd, 7th, 9th and 13th periods demonstrated severe heat stressed ewes as THI values were 23.3 to <25.6.

However, the rest of periods (3rd, 4th, 5th, 6th, 8th periods) pointed to an extreme severe heat stressed ewes, when THI values were 25.6 and more.

Respiration rate (RR) and Rectal temperature (RT):-

The meteorological data (Table1.) indicated that during the experimental period the highest mean value of ambient temperature was measured during 3rd period, while the minimum mean value was recorded during 12th period. Also the maximum mean value of RH was measured during 6th period, whereas the lowest mean value was recorded during 13th period.

The effects of grazing management and watering regime on RR and RT of ewes were given in Tables 3 and 4. Grazing management had no effect ($p > 0.05$) on RR of ewes, with ewes on day grazing recording slightly higher RR. However, the same factor influenced ($p < 0.01$) the RT.

Ewes on day grazing had higher ($p < 0.01$) RT compared with those on night grazing. Watering regime, on the other hand, had no main effect on RR and RT (Table3.), with ewes on every three days watering regime recording comparatively higher RR and RT in comparison with those on every other day watering.

The meteorological data during the daytime (Table2.) showed that the minimum ambient temperature was 21.3^{o}C at 08:00, while the maximum ambient temperature was 33.7^{o}C at 18:00 on time of data measurements. RR and RT were all influenced ($p<0.01$) by time of the day. RR rose from 31.9 to 52.2 with the increased ambient temperature from 8:00 up to noon time (12:00). Thereafter, RR decreased throughout afternoon until attaining the lowest average (25.0) at 18:00. There was a concurrent increase ($p<0.01$) in the RT, with rising ambient temperature, reaching its maximum (38.8^{o}C) at 12:00hrs and stayed stable thereafter until the evening (18:00hr) despite that ambient temperature values at the last three readings (14:00-18:00hrs) had recorded the maximum diurnal variation of 0.9^{o}C. No significant ($p>0.05$) grazing management x watering regime interaction effects were found on RR and RT (Table3.).

Season had a statistically significant ($P<0.01$) effect on both RR and RT, showing different trends during the seasons of the year (Table 4.). RR values increased significantly in rainy season more than in summer and winter. With regard to the effect of season it was confirmed that the highest RT values were observed in summer, followed by rainy season and winter, correspondingly. In the range of RR and RT values, the interactions between factors were found to be statistically insignificant ($p>0.05$). However, the grazing management × season interaction on RR determined to be statistically significant ($p<0.05$).

Table 3:- Main effects of grazing management (GM), watering regime (WR) and time of the day (TD) on respiration rate (RR) and rectal temperature (RT) of Sudan Desert ewes

Factor	Respiration Rate (RR) Breaths/Minute	Rectal Temperature (RT) °C
Grazing Management:		
Night Grazing	39.0	38.4
Day Grazing	40.0	38.6
SE±	0.71^{NS}	0.03**
Watering Regime:		
Every other day	40.6	38.5
Every three days	38.7	38.6
SE±	0.71^{NS}	0.03^{NS}
Time of the Day:		
08: 00	31.9^{d}	37.9^{d}
10: 00	43.9^{b}	38.2^{c}
12: 00	52.2^{a}	38.5^{b}
14: 00	45.6^{b}	38.8^{a}
16: 00	39.3^{c}	38.8^{a}
18: 00	25.0^{e}	38.8^{a}
SE±	1.24**	0.05**
Interaction: SE±		
GM×WR	1.01 ^{NS}	0.04^{NS}
GM × TD	1.76 ^{NS}	0.07 ^{NS}
TD × WR	1.75 ^{NS}	0.07 ^{NS}
GM × WR × TD	2.47 ^{NS}	0.10 ^{NS}

^{a,b,c,d,e} Means in the same column under the same factor with different superscripts are significantly different according to Duncan Multiple Range Test (^{NS} Not Significant P>0.05, ** Highly Significant P<0.01)

Table 4:- Main effects of grazing management (GM), watering regime (WR) and season (S) on respiration rate (RR) and rectal temperature (RT) of Sudan Desert ewes

Factor	Respiration Rate (R R) Breaths/Minute	Rectal Temperature (R T) °C
Grazing Management:		
Night Grazing	40.0	38.4
Day Grazing	41.3	38.6
SE±	0.66^{NS}	0.03**
Watering Regime:		
Every other day	41.6	38.5
Every three days	39.7	38.5
SE±	0.66^{NS}	0.03^{NS}
Season:		
Summer	44.4^{b}	38.7^{a}
Rainy	53.5^{a}	38.5^{b}
Winter	24.1^{c}	38.3^{c}
SE±	0.81**	0.04**
Interaction: SE±		
GM × WR	0.94^{NS}	0.04^{NS}
GM × S	1.15*	0.05^{NS}
WR × S	1.15^{NS}	0.05^{NS}
GM × WR × S	1.60^{NS}	0.07^{NS}

[a, b, c] Means with the different superscripts are different at ($P<0.05$) according to Duncan's Multiple Range Test ([NS], Not Significant $P>0.05$, * Significant $P<0.05$, ** Highly Significant $P<0.01$).

Discussion:-

Respiration rate (RR) and rectal temperature (RT) have been shown to be good indicators of thermal stress and may be used to assess the adversity of the thermal environment (AL-Haidary, 2004). In the present study, exposure to night and day grazing results in an insignificant increase in RR, but day grazing resulted in higher ($p<0.01$) ewes' RT in comparison with night grazing (Table3.). Measuring RR and RT only during the day and at the same time interval for both day and night grazing groups might have influenced the results. RR may still be a more appropriate indicator of heat stress than internal temperature (Robertshaw, 1985). RR during heat exposure is known to increase more rapidly than other responses and often occurs at a lower critical ambient temperature than other responses such as RT or changes in feed intake (Hahn, 1999). Higher RT in day grazing ewes (Table3.) might be a reflection of the diurnal fluctuations of the ambient temperature (Table2.) and if the temperature drops at night below 21ºC for 3–6 h, the animal could sufficient opportunity to lose at night all the heat gained from the previous day (Igono *et al.*, 1992; Muller *et al.*, 1994; Sevi *et al.*, 2001). However, night temperatures during these trials have been recorded.

Desert adapted ruminants are known to tolerate prolonged periods of water deprivation. Following a period of dehydration, they can drink a large amount of water and then store it in the rumen (Silanikove, 2000). Sheep are thermo-stable even during dehydration (MacFarlane, 1964; Degen, 1977). Watering regime exerted no main effects ($p>0.05$) on RR and RT, but prolonged watering interval (every three days vs. every other day) had resulted in comparatively lower RR and slightly higher RT (Table3.). Abdelatif and Ahmed, (1994) and Ismail *et al.* (1996) presented a noticeable reduction in respiratory activity during water deprivation in sheep. However, RT values for the different treatments groups (Table3.) are in line with the results obtained by Jaber *et al.* (2004) and Hamadeh *et al.* (2006) who reported that RT was not significantly affected by water restriction.

The rise in RR and RT with time of the day (Table3.) up to noon (12:00 hrs) and declining thereafter till the evening (18:00 hrs) was in conformity with increased respiration frequency following heat stress reported in goats (Katamoto *et al.*, 1998), sheep (Gadberry *et al.*, 2003) and cattle (Gaughan *et al.*, 1999). Gaughan (2002) stated that a decreasing RR with rising ambient temperature is not always indicative of an animal coping with the hot conditions, but may indicate a failure to cope.

The diurnal rhythm in the RT of the ewes (Table3.) was analogous the findings of Igono *et al.* (1982) in Savannah Brown goat, Orji and Umesiobi (1985) in West African Dwarf sheep, Igono *et al.* (1982) and Ayo *et al.* (1996) in the Yankasa sheep and Ahmed and Abdellatif (1995) with Desert sheep. The diurnal range of RT could serve as a measure of how stressful the weather is to the animals. If the diurnal range is less than 1ºC, it is established that it is not stressful, but ranges over 1^oC are stressful (Bianca, 1961). The mean minimum RT of some temperate breeds; Corriedale and Rambouillet were 39.0 and 38.8ºC, while the mean maximum RT were 40.7 and 41.2ºC, as the mean diurnal ranges were 1.7 and 2.4ºC, respectively (Mittal and Gosh, 1979; Singh et al., 1980). In this study, the diurnal range is 0.9^oC (Table3.), indicating that Desert sheep are thermally adapted animals to the arid and semiarid conditions during the hottest part of the daily cycle.

According to the current results (Table4.), the higher RR levels were observed in summer more than winter. This is in concurrence with the findings of Fahmy, 1994; Marai et al., 1997, who reported, that during summer, the respiration rate is higher than in winter for sheep. In other words, the heat stress during summer is characterized by an increase in respiration rate. Moreover, the present result indicates that highest RR levels observed in the rainy season suggest a similar trend to that reported by Marai et al., 2002. With regard to the effect of humidity, when a load of high relative humidity was superimposed upon an already high ambient temperature, there was a further increase in respiratory frequency in sheep.

In line with the present results numerous investigators, Marai et al., 1997; El Darawany, 1999; Abdel- Hafez, 2002) reported that, during the year, significant variation in rectal temperature was observed. These values were markedly lower during winter than during summer in rams. Similar trend was observed in the same trait in the different breed types for illustration the Rahmani and Suffolk × Ossimi, the values of RT were 38.3 and 39.03ºC in winter and 38.8 and 39.5ºC in summer, respectively (El-Sheikh et al., 1981; Marai et al., 1997).

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