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Egypt. J. Anim. Prod. 19, No. 1, pp. 11—64 (1979)

A Statistical Study on the Heat Tolerance in Friesian Cattle and Buffaloes

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THIS STUDY was carried out at the farms of the south Tahreer Agriculture Company in December 1974 and June, 1975.

The main objective of this work is to study the statistical behaviour, in buffaloes and Friesian cattle, of rectal temperature (RT), skin temperature (ST), respiration rate (RR), pulse rate (PR) and temperature gradien as affeceted by age, pregnancy, body weight, season, some body measurements, fat free milk yield, butter fat production and haematocrit value.

The number of animals used for this investigation were 389 buffaloes, 277 Friesion cattle and 116 Baladi heifers. Data on each breed were divided into four age groups. The buffaloes were represented in all the four age groups. Friesians did not include animals in the third group.

Results coud be summarized as follows :

1. Rectal temperature (RT) and skin temperature (ST) decreased with age till 24 months in the two species and remained almost constant thereafter.

2. The winter and morning readings of RT and ST were lower than summer and evening ones for the ,two species.

3. The effect of peregnancy on RT and ST was statistically insignificant in buffaloes while it had significant effects in Friesians in the last stage of gestation.

4. The partial regression coefficients of RT on body weight were statistically significant for age group 1 and 4 for buffaloes and age group 4 for Friesians. In general, the effect of body weight on ST followed the trend of RT.

5. The partial regression coefficients of RT (in the two species) over skin thickness, heamatocrit, elbow height, FFMY and BEY are statistically insignificant. The partial regression coefficient o' RT on heart girth in growing buffaloes explains most of variance in RT. Comparable Values calculated for ST did not show all the same trend observed on RT.

6. Respiration rate (RR) of buffaloes and Friesian tend to decline with advancing age till 24 months old after which it increases. A gradual increase in RR was observed with advancing pregnancy in the two species.

7. In buffalo, the partial regression coefficient of respiration rate on body weight was negative and significant in age group 1. The same trend was observed in two age groups in Friesian.

8. The partial regression coefficients of RR on skin thickness in buffalo were negative in all age groups except age group 1 and they reached the level of significance in age group 1 and 3. These values were positive and statistically not significant in Friesian. Heart girth showed similar trend on RR.

9. The partial regression coefficients of RR overelbow height were negative in the two species and the partial regression coefficients of RR on FFMY were positiive and statistically significant in both buffalo and Friesian cattle. The partial regression coefficients of BFY were negative and statistically significant in both species.

10. Pulse rate declined, in general, by age in both buffaloes and Friesians. The PR in buffalo is greater in winter than in summer in all age groups. The evening level is higher than the morning level either in winter or in summer except in the case of age group 4 and Friesians which showed different pictures.

11. Buffalo and Friesian showed significantly high PR levels during the last stage of pregnancy.

12. The partial regression coefficient of FR on body weight in buffalo and Friesian cattlel are statistically not significant from zero.

13. In buffalo and Friesian the value of the partial regression coefficients of pulse rate on skin thickness did not reach the level of significance.

14. In buffalo and Friesian the positive partial regression coefficients obtained for pulse rate on FFMY in testing day are statistically highly significant. The partial regression cofficients of pulse rate on BFY were negative and significant.

15. In buffaloes the mean TG value was higher in the second age group compared to the first, but decreased in the third and it rose again in age group 4. In Friesian a gradual increase of TG by age was observed.

The ability of the animals to tolerate heat is one of the important characteristics sought by breeders in subtropical countries like Egypt. With regard to the strategy of animal production in a country, heat tolerance of the animals will be considered only in so far as it reflects variations in productivity of the animals.

The main aim in this work was to give a statistical description of the heat tolerance traits in Friesian cattle and buffaloes in Egypt. The most important of the traits pertaining to heat tolerance and investigated in this study were : rectal temperature (RT) °, skin temperature (ST) °, respiration rate (RR), pulse rate (PR), and temperature gradient (TG) °. Most of the works done on these traits involved very restricted numbers of animls, which would not allow the description of the behaviour of the breeds under the prevailing environmental conditions. Such description is thougt to be of valuable significance in under standing the adaptability of animals and helps decision makers in constructing proper ideas concerning housing and management and of course, the type of cattle breeds to be imported.

A considerable volume of research done in hot countries studied the adaptation of temperate and local breeds (Asker *et al.*,1952 and 1953; Brody,1938; Badreldin *et al.*, 1951; Badreldin and Ghany, 1952 and 1954; Brody *et al.*, 1955; Hafez, 1956; Hafez *et al.*, 1955, Johnson, 1965 a and 1965b ; Kibler and Brody; 1956; Ali, 1968; Ibrahim, 1968, Mullick and Kahar, 1959; Mullick, 1959 and 1960; McDowell, 1967 and McDowell *et al.*, 1954, Mostageer *et al.*, 1974; Seath and Miller, 1947; Shafie, 1958; Shafie and Badreldin, 1962 and 1963, Shafie and Abou-El-Khair, 1970; Shafie and Ali, 1970; Shafie and El-Tannikly 1970 and Shafie and Khalifa, 1972).

Material and Methods

This work was done in Southern Tahreer, a newly reclaimed area in the desert during two months December 1974 and June 1975. Table 1 presents the number of animals involved in the study. The animals were divided according to age into four separate groups :

TABLE 1. **Number of animals under investigation.**

Breed or species	Age group				Total
	1 0—4	2 > 4—12	3 >12—24	4 adult > 24	
Buffalo	55	57	50	227*	389
Friesian cattle . . .	89	67	—	121**	277

* Fifty heads of these animals were milking.

** 68 heads of these animals were milking.

Age group 1 : from birth to 4 months old

,, 2 : from > 4 - 12 months

,, 3 : from > 12 - 24 months

,, 4 : more than 24 months. Within this age group, animals were classified according to their age as follows :

Age group A : from 24-36 months old

,, B : from 37-48 months old

,, C : from > 48 months.

Buffaloes were represented in all the four age groups. The Friesians did not include animals in the third group.

With respect to gestation the animals were divided into 3 groups according to stage of pregnancy.

Group 1 : non-pregnant and one month pregnant.

Group 2 : 2-5 months pregnant.

Group 3 : 6 or more months pregnant.

The heat tolerance traits (rectal temperature (RT), skin temperature (ST) respiration rate (RR), pulse rate (PR) and Temp. gradient (TG) were measured together with some physiological and prouction traits, namely body weight (BW), some body measurements (elbow height (EH) and heart girth (HG), skin thickness (Sth), haematocrit (HT) pregnancy, fat free milk yield (FFMY) and butter fat production (BFY) of testing day. This last set of traits were used in the statistical analysis as factors affecting the heat tolerance characters.

For each of the five characters the model for each observation reads

$$Y_{(i)jk} = u + \sum_{i=1}^{n} x_{(i)j} + \sum_{r=1}^{s} b_r\, z_{(1)jk} + e_{(i)jk}$$

where :

$Y_{(i)jk}$ = the k^{th} observation in the j^{th} level of the i^{th} factor,

u = the overall least squares means for the $Y_{(i)j}$,s

$x_{(i)j}$ = the j^{th} level of the i^{th} factors.

$i = 1, \ldots\ldots n, = j = 1. \ldots\ldots, m$

b = the partial regression coefficient of the dependant variabley y on the independant continuous variable Z holding the $x_{(i)j}$s constant,

$z_{(i)j}$ = the least squares deviation of the continuous independent variable $z_{(i)jk}$ corresponding to the $y_{(i)jk}$ observation from its mean,

$e_{(i)jk}$ = the random error associated with the $Y_{(i)jk}$ observation, and assumed to be IRND (O, σ_e),

s = designate the summation of the linear regression
Σ
r=1 over r = 1, s.

It would be reasonable, before listing the factors which were presumed to influence a certain trait, to define the integers designating the levels of some of these factors :

Season, j = 1, 2, 3, 4 where 1 = winter morning,
2 = winter evening, 3 = summer morning, and
4 = summer evening.

The two following factors, age and pregnancy were inluded only for the group of animals aging 24 months and older.

Age, j = 1, 2, 3 where 1 = 24-36 month, 2 = 37-48 month and 3 $>$ 48 months.

Pregnancy, j = 1, 2, 3 where 1 = non-pregnant and one month pregnancy,
2 = 2-5 monts and 3 $\geq$ 6 months.

for all the characters :

i = 1, 2, 3
1 = season, j = 1, 2, 3, 4
2 = age, j = 1, 2, 3
3 = pregnancy, j = 1, 2, 3

factors 2 and 3 were included only for the groups aging 24 months and greater.

r = 1, 2 ....., 7.

l = the partial linear regression coefficient of the dependent variable Y on the independent variable $Z_{(1)}$ $Z_{(1)}$ = BW, $Z_{(2)}$ = Sth, $Z_{(3)}$ = H.T., $Z_{(4)}$ = H.G. $Z_{(5)}$ = E.H, $Z_{(6)}$ = FFMY and $Z_{(7)}$ = BFY ;
$r_{(6)}$ and $r_{(7)}$ wefe included only in the analyses of all the traits measured on the fourth group (24 months and older).

Results and Discussion

The least squares means of RT, ST, RP, PR and TG with seasonal-diurnal groups, age and pregnancy groups for both buffaloes and Friesians are presented in Tables 2 — 11 The analyses of variances for these five characters in the two species are shown in Tables 12 — 21.

1. *Rectal temperature*

1. *Age effect*

In buffalo age greoup 2 (4-12 months) showed a remarkably high mean compared to the other three groups. These animals were kept all day long under open sheds where rectal temperature (RT) was determined except for

TABLE 2. Least squares means* (± S.E.) of rectal temperature° in buffaloes.

Classification	Age group							
	** N	1 Mean ±S.E.	N	2 Mean ±S.E.	N	3 Mean ±S.E.	N	4 Mean ±S.E.
Overall mean	110	38.81 ±0.066	114	40.36 ±0.446	50	38.26 ±0.048	454	38.14 ±0.043
Seasonal diurnal groups								
WM	47	38.54a ±0.056	11	40.62a ±1.147	14	37.92a ±0.098	108	38.02a ±0.052
WE	47	39.14b ±0.056	11	41.03a ±1.147	14	38.63b ±0.098	108	38.43b ±0.052
SM	8	38.46a ±0.165	46	39.94a ±0.589	11	38.16ac ±0.113	119	37.77c ±0.057
SE	8	39.11b ±0.165	46	39.84a ±0.589	11	38.33bc ±0.113	119	38.35bd ±0.0 75

TABLE 2. (*Cont.*).

Age group 4

Group	Mature age groups		Pregnancy groups		
	N	Mean ± S.E	Group	N	Mean ± S.E.
A	36	38.11 ± 0.076a	1	362	38.12 ± 0.033a
B	52	38.12 ± 0.063a	2	66	38.07 ± 0.061a
C	366	38.21 ± 0.035a	3	26	38.24 ± 0.087a

* Means within classification not followed by the same letter differ significantly from each other ($P < 0.05$).

** Number of observations = doubl the numaber of animals.

TABLE 3. Least square means* (±S.E.) of rectal temperature° in Friesian cattle.

Classification	Age group 1		Age group 2		Age group 4	
	N**	Mean±S.E.	N	Mean±S.E.	N.	Mean±S.E
Overall mean. .	178	39.03 ± 0.033	134	39.01 ± 0.566	244	38.72 ± 0.122
Seasonal diurnal groups						
WM. . . .	50	39.02 ± 0.065a	13	38.45 ± 1.441a	59	38.20 ± 0.129a
WE	50	38.57 ± 0.065b	13	38.91 ± 1.441b	59	38.87 ± 0.129b
SM	39	39.03 ± 0.075a	54	38.47 ± 0.685a	63	38.38 ± 0.140a
SE	39	39.51 ± 0.075c	54	40.21 ± 0.685c	63	39.45 ± 0.140c

TABLE 3. (*Cont.*).

Group	Age group 4: Mature age groups ***		Group	Age group 4: Pregnancy groups	
	N	Mean ± S.E.		N	Mean ± S.E.
B	6	38.83 ± 0.219a	1	166	38.54 ± 0.111a
C	238	38.61 ± 0.065a	2	8	38.78 ± 0.210ab
			3	70	38.84 ± 0.120b

* Means within classification not followed by the same letter differ significantly from each other ($P < 0{,}05$).

** Number of observations = double the number of animals.

*** No animals in age group A.

TABLE 4. Least squares means* (±S.E.) of skin temperature° in buffaloes.

Classification	Age group 1		Age group 2		Age group 3		Age group 4	
	** N	Mean ±S.E	N	Mean ±S.E.	N	Mean ±.E.S.	N	Mean ±S.E.
Overall mean	110	31.15 ±0.239	114	30.58 ±0.312	50	30.13 ±0.117	454	29.65 ±0.144
Seasonal diurnal groups								
WM	47	30.07a ±0.201a	11	29.73ab ±0.801ab	14	28.59a ±0.238	108	28.23a ±0.176a
WE	47	31.54b ±0.201b	11	30.31ab ±0 801ab	14	30.29b ±0.801ab	108	30.21b ±0.1761
SM	8	30.29ab ±0.598ab	46	30.52a ±0.421	11	30.28b ±0.274	119	28.62c ±0.193
SE	8	32.73cb ±0.5978c	46	31.77b ±0.421	11	31.36c ±0.274	119	31.55d ±0.193

TABLE 4. (*Cont.*).

Group	Age group 4: Mature age groups		Age group 4: Pregnancy groups		
	N	Mean ± S.E	Group	N	Mean ± S.E
A	36	29.90 ± 0.256 a	1	362	29.40 ± 0.110 a
B	52	29.50 ± 0213 a	2	66	29,77 ± 0,206 a
C	366	29.56 ± 0.118 a	3	26	29.79 ± 0294 a

* Means within classification not followed by the same letter differ significantly from each other (P<0,05).

** Number of observations =double the number of animals,

TABLE 5. Least squares means* (±S.E.) of skin temperature in Friesian cattle.

Classification	Age group					
	1		2		4	
	N**	Mean ± S.E.	++ N	Mean ± S.E.	++ N	Mean ± S.E.
Overall mean. .	178	32.27±0.075	134	30.97±0.498	244	29.10±0.195
Seasonal diurnal groups						
WM	50	30.64±0.149a	13	27.97±1.262a	59	25.46±0.207a
WE	50	32.20±0.149a	13	30.78±1.262ab	59	28.04±0.207b
SM	39	32.60±0.173b	54	32.02±0.600b	63	30.37±0.225c
SE	39	34.05±0.173c	54	33.13±0.600b	63	32.53±0.225d

Age group 4

TABLE 5 (*Cont.*).

Mature age groups***			Pregnancy groups		
Group	N	Mean ± S.E.	Group	N	Mean ± S.E.
B	6	28.86 ± 0.351 a	1	166	28.90 ± 0.178a
C	238	29.35 ± 0.105 a	2	8	29.13 ± 0.337a
			3	70	29.27 ± 0.193b

* Means within classification not followed by the same letter differ significantly from each other ($P<0.05$).
** Number of observations = double the number of animals.
*** No. animals in age group A.

TABLE 6. Least squares means* (±S.E.) of respiration rate in buffaloes.

Classification	Age group 1		Age group 2		Age group 3		Age group 4	
	** N	Mean ±S.E.	N	Mean ±S.E.	N	Mean ±S.E.	N	Mean ±S.E.
Overall mean. . . .	110	18.75 ±1.380	114	14.33 ±1.217	50	9.06 ±0.529	454	14.48 ±0.661
Seasonal diurnal grouups								
WM.	47	11.32a ±1.159	11	8.24a ±3.127	14	5.05a ±1.074	108	10.84a ±0.811
WE	47	22.53b ±1.159	11	21.06b ±3.127	14	12.69b ±1.074	108	12.30a ±0.811
SM	8	7.21a ±3.449	46	8.78a ±1.608	11	7.03a ±1.237	119	14.49b ±0.888
SE	8	33.96c ±3.449	46	19.23b ±1.608	11	11.49b ±1.237	119	20.30c ±0.888

TABLE 6. (Cont.)

Age group 4

Mature Group	Age N	Groups Mean±S.E.	Group	Pregnancy groups N	Mean±S.E
A	36	13.73 ± 1.176 a	1	362	13.99 ± 0.506 a
B	52	14.95 ± 0.981 a	2	66	14.41 ± 0.946 a
C	366	14.76 ± 0.541 a	3	26	15.04 ± 1.349 a

* Means within classification not followed by the same letter differ significantly from each other ($P<0.05$).

** Number of observations = double the number of animals.

TABLE 7. Least squares means* (±S.E.) of respiration rate in Friesian cattle.

Classification	Age group					
	1		2		4	
	N**	Mean±S.E.	N	Mean±S.E.	N	Mean±S.E.
Overall mean	178	33.74±0.439	134	24.60±0.785	224	28.78±1.457
Seasonal diurnal groups						
W.M . . .	50	17.78±0.880a	13	10.42±2.000a	59	20.52±1.544a
WE	50	35.56±0.880b	13	₅5.04±2.000b	59	24.49±1.544b
SM	39	25.76±1.010c	54	20.04±0.950c	63	39.11±1.678c
SE	39	55.83±1.010d	54	32.897±0.950b	63	39.99±1.678d

TABLE 7 (*Cont.*).

Age group 4					
Ma'ure age groups**			Pregnancy groups		
Group	N	Mean±S.E.	Group	N	Mean±S.E.
B	6	28.90 ± 2.620 a	1	166	27.08 ± 1.329 a
C	238	28.66 ± 0.780 a	2	8	26.43 ± 2.516 a
			3	70	32.83 ± 1.442 b

* Means within classification not followed by the same letter differ significantly from each other ($P < 0.05$).

** Number of observations = double the number of animals.

*** No animals in age group A.

TABLE 8. Least squares means* (±S.E.) of pulse rate in buffaloes.

Classification	Age group 1 N**	Age group 1 Mean ± S.E.	Age group 2 N	Age group 2 Mean± S.E.	Age group 3 N	Age group 3 Mean± S.E.	Age group 4 N	Age group 4 Mean± S.E.
Overall mean	110	81.12 ±3.487	114	81.78 ±3.913	50	56.77 ±1.530	454	58.32 ±1.465
Seasonal diurnal groups								
WM	47	a 81.14 ±2.929	11	81.16 a ±10.052	14	60.86 a ±3.11	108	58.59ab ±1.798
WE	47	b 90.16 ±2.929	11	90.19 a ±10.052	14	62.15a ±3.11	108	56.63b ±1.798
SM	8	b 77.18a ±8.716	46	73.76 a ±5.169	11	50.08 b ±3.58	119	56.22b ±1.969
SE	8	b 76.03a ±8.716	46	82.05 a ±5.169	11	53.99ab ±3.58	119	61.82a ±1.969

TABLE 8 (*Cont.*)

Age group 4

Mature age groups			Pregnancy groups		
Group	N	Mean±S.E.	Group	N	Mean±S.E.
A	36	60.46 ± 2.607 a	1	362	55.85 ± 1.122a
B	52	59.16 ± 2.174ab	2	66	55.57 ± 2.098a
C	366	55.32 ± 1.199 b	3	26	63.53 ± 2.991b

TABLE 9. Least squares means* (±S.E.) of pulse rate in Friesian cattle.

Classification	Age group					
	1		2		4	
	N**	Mean±S.E.	N	Mean± S.E	N	Mean±S.E.
Overallmean	178	108.90±1.370	134	79.81±8.301	244	62.58±2.218
Seasonal-diurnal groups						
WM	50	100.84±2.735 a	13	73.03±21.141 a	59	57.98±2.350 a
WE	50	110.94±2.735 b	13	84.64±21.141 a	59	67.24±2.350 b
SM	39	100.48±3.154 a	54	74.32±10.050 a	63	57.50±2.554 a
SE	39	123.35±3.154 c	54	87.25±10.050 a	63	67.61±2.554 b

TABLE 9. *(Cont.)*.

Age group 4

Mature age groups ***			Pregnancy groups		
Group	N	Mean±S.E.	Groups	N	Mean ± S.E
B	6	65.42±3.988 a	1	166	59.10 ± 2.022 a
C	238	59.74 ± 1.188 a	2	8	60.71 ± 3.828 a
			3	70	67.93 ± 2.194 b

* Meads within classification not followed by the same letter differ significantly from each other($P < 0.05$).

* * Number of observations = double the numbr of animals.

* * * No animals in age group A

TABLE 10. Least squares means* (±S.E.) of temperature grdient ° in buffaloes.

Classification	Age group							
	1		2		3		4	
	N	±S.E. Mean	N	Mean± S.E.	N	Mean± S.E.	N	Mean ±S.E.
Overall mean	110	7.66 ±0.237	114	9.77 ±0.204	50	8.13 ±0.108	454	12.67 ±0.153
Seasonal diurnal groups								
WM	47	8.48 ±0.199 a	11	10.88 ±0.524 a	14	9.33 ±0.220 a	108	9.79 ±0.168 a
WE	47	7.60 ±0.199b	11	10.72 ±0.524 a	14	8.34	108	8.21 ±0.168 b
SM	8	8.17 ±0.593 ab	46	9.42 ±0.269 b	11	7.88 ±0.253 b	119	9.16 ±0.183 c
SE	8	6.38 ±0.593 c	46	8.07 ±0.269 c	11	6.97 ±0.253 c	119	6.80 ±0.183 d

TABLE 10. (Cont.)

Age group 4

Group	Mature age groups		Group	Pregnancy groups	
	N	Mean±S E.		N	Mean±S.E.
A	36	8.21 ± 243 a	1	362	8.73 ± 0.105 a
B	52	8.61 ± 0.203 a	2	66	8.29 ± 0.195 b
C	366	8.65 ± 0.112 a	3	26	8.45 ± 0.279ab

* Means within classification not followed by the smae letter differ significantly from each other ($P < 0.05$).

** Number of observations = double the number of animals.

TABLE 11. Least squares means* (±S.E.) of temperature gradient in Friesian cattle.

Classification	Age group 1		Age group 2		Age group 4	
	N**	Means ±S.E.	N++	Mean±S.E.	N	Mean ±S.E.
Overall mean	178	6.66 ± 0.078	134	8.04 ± 0.713	244	9.62 ± 0.230
Seasonal diurnal groups						
WM	50	8.38±0.156 a	13	10.48±1.815 a	59	12.74±0.244 a
WE	50	6.37±0.156 p	13	8 .13±1.815 a	59	10.82±0.244 b
SM	39	6.42±0.179 b	54	6.46±0.863 a	36	8.00±0.265 c
SE	39	5.46±0.179 c	54	7.08±0.863 a	63	6.91±0.265 d

TABLE 11. *(Cont.)*.

Age group 4

Group	Mature age groups*** N	Mean ± S.E.	Group	Pregnancy groups N	Mean ± S.E.
B	6	9.98±0.413 a	1	166	9.64±0.210 a
C	238	9.26±0.123 a	2	8	9.66±0.397 a
			3	70	9.57±0.227 a

* Means within classification not followed by the same letter differ significantly from each other ($P < 0.05$).

** Number of observations = double the number of animals.

*** No animals in age group A.

TABLE 12. Analyses of variances of rectal temperature in buffaloes.

Source of variance	Age group							
	1		2		3		4	
	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Pregnancy							2	0.2598 NS
Age							2	0.2604 NS
Seasonal-diurnal groups	3	3.3685 **	3	4.1638 NS	3	1.2468 **	3	10.1789**
Regression on								
BW	1	1.0431**	1	2.0974 NS	1	0.0779 NS	1	0.8208 NS
Sth	1	0.0123 NS	1	6.3469 NS	1	0.0201 NS	1	0.0633 NS
HT	1	0.0059 NS	1	0.0085 NS	1	0.2118 NS	1	0.0948 NS
HG	1	0.0865 NS	1	1182.2545**	1	0.0507 NS	1	0.0891 NS
EH	1	0.0065 NS	1	21.5287 NS	1	0.0028 NS	1	0.2165 NS
FFMY							1	0.0477 NS
BFY							1	0.0746 NS
Residual	101	0.1249	105	13.3131	41	0.1142	439	0.1538

NS = not significant.

* Significant at the 5% level.
** Significant at the 1% level.

TABLE 13. Analyses of variances of rectal temperature in Friesian cattle.

Source of variance	Age group 1		Age group 2		Age group 4	
	d.f.	M.S.	d.f.	M.S.	d. f.	M.S.
Pregnancy					2	1.2439**
Age					1	0.2576 NS
Seasonal-diurnal groups	3	5.1137**	3	30.1414 NS	3	18.6373 **
Regression on :						
BW	1	0.4651 NS	1	3.5070 NS	1	1.1314 *
Sth	1	1.2994 **	1	0.1278 NS	1	0.0998 NS
HT	1	0.1095 NS	1	1.0780 NS	1	0.1269 NS
HG	1	0.2347 NS	1	0.4465 NS	1	0.0006 NS
EH	1	0.1418 NS		0.8198 NS	1	0.3061 NS
FFMY					1	0.9181 NS
BFY					1	0.2579 NS
Residual	169	0.1840	125	24.8266	230	0.2421

NS = not significant.
* = significant at the 5% level.
** = significant at the 1% level.

TABLE 14 Analyses of variances of skin temperature in buffaloes.

Source of variance	Age group 1		Age group 2		Age group 3		Age group 4	
	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Pregnancy							2	3.6700 NS
Age							2	1.8601 NS
seasonal-diurnal groups	3	25.7284**	3	18.0651 *	3	13.1503 **	3	258.7446 **
Regression on :								
BW	1	7.7802 *	1	5.2609 NS	1	0.00009 NS	1	4.5613 NS
Sth	1	0.5128 NS	1	109.5547 **	1	2.9584 *	1	0.1457 NS
HT	1	0.9489 NS	1	0.1589 NS	1	0.1124 NS	1	3.304 NS
HG	1	0.5525 NS	1	311.5046**	1	1.0996 NS	1	6.2694 NS
EH	1	0.4195 NS	1	0.0176 NS	1	0.4771 NS	1	0.5584 NS
FFMY							1	1.8295 NS
BFY							1	1.8630 NS
Residual	101	1.6299	105	6.5006	41	0.6683	439	1.7391 NS

NS = not significant.
* Significant at the 5% level .
** Significant at the 1% level .

TABLE. 15. Analyses of variances of skin temperature in Friesian cattle.

Source of variance	Age group					
	1		2		4	
	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Pregnancy					2	1,8907 *
Age					1	1,3057 NS
Seasonal-diurnal . .						
Groups	3	65.5216**	3	86.9442**	3	445.2049**
Regression on :						
BW	1	0.0394 NS	1	6.3033 NS	1	0.6709 NS
Stb	1	0.4827 NS	1	0.0024 NS	1	0.0231 NS
HT	1	0.0039 NS	1	76.6932**	1	0.7768 NS
HG	1	1.8947 NS	1	1.6678 NS	1	0.4611 NS
EH	1	0.0088 NS	1	0.0362 NS	1	0.7220 NS
FFMY					1	9.5020 **
BFY					1	2.9484*
Residual	169	0.9757	125	19.9490	230	0.6227

NS = not significant. * = Significant at the 5% level.
** = Significant at the 1% level.

TABLE 16 . Analyses of variances of respiration rate in buffaloes.

Source of variance	Age group							
	1		2		3		4	
	d.f	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Pregnancy . . .							2	12.7435 NS
Age							2	17.3048 NS
Seasonal-diurnal groups . .	3	1961.1017**	3	1141.2895**	3	173.0210**	3	1541.4918*
Regression on :								
BW	1	254.6768*	1	51.6467 NS	1	6.3122 NS	1	1.1733 NS
Sth	1	356.0308*	1	73.0854 NS	1	96.2734*	1	19.1311 NS
HT	1	310.7735*	1	371.1172 NS	1	29.8267NS	1	1.0257 NS
HG	1	124.1868NS	1	2836.2433**	1	2.1162NS	1	29.0475 NS
EH	1	425.2406**	1	96.2628	1	0.0001NS	1	12.7297 NS
FFMY. . .							1	964.2939**
BFY . . .							1	301.2187**
Residual	101	54.2775	105	98.9698	41	13.6157	439	36.7430

NS = Not significant. * Significant at the 5% level.
** Significant at the 1% level.

TABLE 17. Analyses of variances of respiration rate in Friesian cattle.

Source of variance	Age group 1 d.f	Age group 1 M. S.	Age group 2 d.f.	Age group 2 M.S.	Age group 4 d.f	Age group 4 M.S.
Pregnancy . . .					2	487.1672**
Age					1	0.3136 N.S
Seasonal-diurnal groups . .	3	10244.0699**	3	2879.6035**	3	3205.1737**
Regression on						
BW	1	685.7055**	1	326.7619**	1	33.3742 NS
Sth	1	11.3451 NS	1	35.8433 NS	1	20.6363 NS
HT	1	10.1505 NS	1	84.4141 NS	1	29.4501 NS
HG	1	126 4329 NS	1	405.3300**	1	27.5419 NS
EH	1	0.1437 NS	1	611.3051**	1	14.5087 NS
FFMY. . .					1	1400.3975**
BFY. . . .					1	756.7278**
Residual . . .	169	33.4051	125	47.7569	230	34.6677

NS = not significant. ** = Significant at the 1% level.

TABLE 18. **Analyses of variances of pulse rate in buffaloes.**

Source of variance	Age group							
	1		2		3		4	
	d.f	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Pregnancy . . .							2	633.6335*
Age							2	583.0317*
Seasonal-diurnal groups . .	3	774.9375 NS	3	955.9273 NS	3	231.4887 NS	3	739.6144*
Regression on: BW	1	238.6469 NS	1	1987.6738 NS	1	48.6168 NS	1	17.8206 NS
Sth	1	2006.6702 **	1	1149.4326 NS	1	353.6904 NS	1	20.7245 NS
HT	1	230.2452 NS	1	370.2919 NS	1	1.4626 NS	1	726.3042*
HG	1	20.2936 NS	1	94996.6575**	1	7.9597 NS	1	44.8274 NS
EH	1	2337.4291**	1	6797.7079**	1	165.1733 NS	1	992.1319*
FFMY. . .							1	1984.6023**
BFY. . . .							1	907.1908*
Residual . . .	101	346.4985	105	1022.8780	41	114.0084	439	180.5786

N.S. = not significant.
** Significant at the 5% level.
**Significant at the 1% level.

TABLE 19. Analyses of variances of pulse rate in Friesian cattle.

Source of variance	Age group					
	1		2		4	
	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Pregnancy . . .					2	1078.6137**
Age					1	173.1890 NS
Seasonal-diurnal groups . .	3	4565.0615**	3	1817.8200 NS	3	1915.6519**
Regression on :						
BW	1	1370.4582*	1	1871.6854 NS	1	32.2975 NS
Sth	1	57.8731 NS	1	508.1472 NS	1	224.1869 NS
HT	1	280.3503 NS	1	273.4223 NS	1	17.6745 NS
HG	1	153.0725 NS	1	556.3256 NS	1	121.7753 NS
EH	1	1162.7318 NS	1	894.9348 NS	1	391.0241*
FFMY. . .					1	4063.7223**
BFY. . . .					1	1617.5912**
Residual	169	325.2353	125	5340.6546	230	80.2911

NS = not significant .

* = Significant at the 5% level.
** = Significant at the 1% level.

TABLE 20. **Analysis of variance of temperature gradient in buffaloes.**

Source of variance	Age group							
	1		2		3		4	
	d.f.	M.S.	d.f.	MS	d.f	MS	d.f.	MS
Pregnancy . . .							2	3.9195 NS
Age							2	2.7227 NS
Seasonal diurnal groups . .	3	11.2115**	3	32.2585**	3	8.2096**	3	179.9026**
Regression on :								
BW	1	3.1257NS	1	0.7147NS	1	0.0834NS	1	1.5123 NS
Sth	1	0.3665NS	1	63.1632**	1	2.4910*	1	0.0169 NS
HT	1	0.8056NS	1	0.0938NS	1	0.6330NS	1	2.2184 NS
HG	1	0.2018NS	1	280.0413**	1	1.6226NS	1	7.8528
EH	1	0.3218NS	1	22.7778**	1	0.4071NS	1	1.4703 NS
FFMY. . .							1	1.2865 NS
BFY. . . .							1	1.1919 NS
Residual	101	1.6053	105	2.7764	41	0.5689	439	1.5676

N.S. = not significant.

* Significant at the 5% level.
** Significant at the 1% elvel.

TABLE 21. Analyses of variances of temperature gradient° in Friesian cattle.

Source of variance	Age group 1 d.f.	Age group 1 MS	Age group 2 d.f.	Age group 2 MS	Age group 4 d.f.	Age group 4 MS
Pregnancy					2	0.0836 NS
Age					1	2.7232 NS
Seasonal-diurnal groups	3	57.4862**	3	52.2167 NS	3	327.4669**
Regression on						
BW	1	0.2336NS	1	0.4070 NS	1	0.0598 NS
Sth	1	0.1981NS	1	0.0951 NS	1	0.2191 NS
HT	1	0.1545NS	1	95.9562 NS	1	0.2759 NS
HG	1	3.4631NS	1	0.3884 NS	1	0.4961 NS
EH	1	0.2213NS	1	0.5114 NS	1	1.9684 NS
FFMY					1	4.5130 *
BFY					1	1.4622 NS
Residual	169	1.0539	125	39.3515	230	0.8630

NS = not significant. * Significant at the 5% level.
** Significant at the 1% level.

age group 2, rectal temperature decreased with age till 24 months. Differences in RT between ages after 24 months (*i.e.* within age group 4) were not statistically significant.

The Friesian cattle showed almost the same trend of the buffaloes. Comparing similar age groups of the two species, it is obvious that Friesian cattle had higher rectal temperature means in age groups 1 and 4 but growing buffaloes (age group 2) showed a higher mean than the Friesian of the same age. RT is known to decrease by age in these two species (Riek and Lee, 1948 a and b Brody *et al.*, 1948, Kibler and Brody, 1951; Asker, *et al.*, 1953, Pineda *et al.*, 1967 and Mostageer *et al.*, 1975).

2. *Seasonal diurnal effects*

The analyses of variances of RT of buffaloes and Friesians showed that the seasonal-diurnal effects on rectal temperature are statistically significant in all age groups except the growing animals (age group 2). The tests of these animals were carried out while they were kept in open sheds and the ambient temperature ranged between 10° to 14° in winter and 19° to 27° in summer.

In buffalo (Table 2) the morning reading the each of the two seasons, winter and summer, showed in general lower values compared to the relevant evening ones. These differences reached the level of significance, except in age group 2 and the summer readings of age group 3. The rise in rectal temperature in evening readings is probably due to the rise in air temperature and the increase in metabolic rate during the day. Similar results were obtained by Brody *et al.* (1955), Kibler and Brody (1956), Pinedea *et al.* (1967), Shafie and Aly, (1970) and Shafie and Khalifa (1972). Comparing the two seasonal means of the morning or the evening readings in buffaloes, it can be generally seen that the winter readings are always higher than the corresponding summer ones, except for the morning ones in age group 3.

Such differences, however, are only significant between the two morning readings in age group 4. This result is probably due to the rise in metabolic rate of the animal to oppose the effect of the low climatic temperature and also to the more conservation of heat through restricted blood circulation in the skin.

Friesian shows, except in age group 1, the same trend in the diurnal variations in body temperatures as in buffalo but the differences in Friesian are statistically significant in all age groups.

Under the prevailing climatic conditions of the experiment, the previous results indicate that the diurnal differences in rectal temperature of the buffaloes in all age groups are much more conspicuous, as compared to the seasonal differences.

The Frisian shows different results to that obtained in buffalo in comparing the two seasonal means of the morning (or evening) rectal temperature readings. The winter readings were always lower than the comparable summer ones. Differences between the pairs of morning readings are statistically not significant, but those between pairs of the evening ones are statistically significant. The most persistant result is that the summer evening readings are greater than all other readings and differ significantly from all other means in all age groups. The air temperature was at time of measurement, equal to 31° which is more than the critical air temperature known for the Friesian (21.1-23.9°), (Ragesdale *et al.*, 1948; Kibler and Brody, 1949; Ragesdale *et al.*, 1950; Kibler and Brody, 1950; Worstell and Brody, 1953; Findlay, 1953; Jonson, 1965 and Youssef and Joson, 1966).

Comparing the amount of variance of rectal temperature in the different age groups of both buffalo and Friesian (Tables 22,23) (that is; $\sigma^2+\sigma^2$ where σ^2 is the error variance and σ^2_s is the variance due to seasons), it is quite clear that Friesians have higher values in all the comparable ages. The amount of variance of Friesians in age groups 1 and 4 are almost 1.5-2.0 times the corresponding figures of buffalo. But the difference in age group 2 is noticeably striking. Under open sheds the two species (Bovine and Bubalis) showed different behaviour, the Friesian kept the mean rectal temperature controlled but allowed a bigger increase in variance, while the buffalo raised the rectal temperature and kept the variance relatively low. At this age, it could also be seen that the error variance due to seasonal diurnal effect showed higher values in Friesian compared to buffalo.

3. *Pregnancy effect*

Table 12 shows that the effect of pregnancy is insignificant in buffaloes while Friesian (Table 13) had different results.

The effect of gestation on rectal temperature appears to occur only in the last stage of gestation. Means presented in Tables 2 and 3 indicate an increase of about 0.3° and 0.12 ° in Friesian and buffalo respectively in group 3 over group 1. Mostageer *et al.* (1974) found an increase in the evening summer average of rectal temperature during the last month (or two) of pregnancy in these two species. The increase reached the significant value of 0.8° and 0.4° for the buffaloes and Friesians respectively. Abdel -Ghani *et al.* (1975) showed that pregnant Friesian cows and buffaloes had the highest values of body temperature during the later stage of pregnancy.

TABLE 22. The total variance of RT, ST, RR, PR and TG in buffaloes.

Characters	Age group			
	1	2	3	4
RT	0.2872	12.9206	0.2214	0.2584
ST	2.9355	6.9967	1.8502	4.3322
RR	367.9331	1019.1482	11.7923	201.5733
PR	441.8960	143.6810	28.7096	37.6454
TG	2.0859	4.0411	1.2924	3.4584

TABLE 23. The total variances of RT, ST, RR, PR and TG in Friesian cattle.

Characters	Age group		
	1	2	4
RT	0.4226	25.0154	0.5981
ST	2.6592	21.4594	8.6007
RR	435.8171	5215.1403	66.676
PR	60.0362	148.6521	70.9893
TG	2.9952	39.8205	6.7924

4. The effect of body weight, skin thickness, haematocrit, heart girth, elbow height, milk and fat production of testing day

a) *Body weight*

The effect of body weight on rectal temperature is expressed in terms of partial regression coefficients (Tables 24 and 25) and the amount of variance explained by regression (Tables 12 and 13). The partial regression coefficients are statistically significant for age group 1 and 4 for the buffaloes and only group 4 for the Friesians. All the values of the partial regression coefficients in both species are negative. This indicates that the increase in body weight is accompanied by decreased rectal temperature. Thompson (1954) stated that increasing body weight should decrease heat production per unit body weight.

b) *Skin thickness, haematocrit, elbow height, milk and butter fat production*

Table 24 and 25 show the partial regression coefficients of rectal temperature in the two species, on skin thickness haematocrit, elbow height, FFMY and BFY production of the testing day. It is evident from the tables of the analyses of variances (Tables 12 and 13) that all the regression coefficients are statistically insignificant from zero in both species except in the case of skin thickness of age grouping Friesian. Corrections for these characters when comparing animals within each age group in both species are not needed.

c) *Heart girth*

It is of interest to note that the partial regression coefficient of rectal temperature on heart girth in the growing buffalo (age group 2) explains most of variance in rectal temperature. Body weight is known to be correlated with heart girth (Johansson and Hildeman, 1954). Since this last character has no significant effect on rectal temperature of this age group, it could be seem that heart girth is much more effective in explaining variance in rectal temperature. This may be due to the nearly complete relationship between the heart girth and the volume of the lungs which is a major factor in both metabolism and heat dissipation and also to the change of the relationship between the heart girth and body weight with the advancement of age due to the differential growth of the trunk and the other body components particularly extremities, neck and head.

TABLE 24. **Partial regression coefficients (±S.E.) of rectal temperature ° of buffaloes on the different traits used in the models.**

Trait	Age group			
	1	2	3	4
BW	—0.0029±0.0010**	—0.0071±0.0179	—0.0015±0.0018	—0.0006±0.0002**
Sth	0.0093±0.0230	—0.1708±0.2473	0.0096±0.0228	0.0055±0.0086
HT	—0.0006±0.0025	0.0008±0.0316	0.0062±0.0046	—0.0014±0.0018
HG	0.0040±0.0048	0.0569±0.0060**	0.0035±0.0053	0.0010±0.0013
EH	—0.0020±0.0086	—0.1259±0.0990	—0.0019±0.0126	0.0031±0.0027
FFMY				—0.0124±0.0223
BFY				0.3203±0.4597

** Significant at the 1% level.

TABLE 25. **Partial regression coefficients (±S.E.) of rectal temperature of Friesian cattle on the different traits used in the models.**

Trait	Age group		
	1	2	4
BW	—0.0030±0.0019	—0.0072±0.0193	—0.0016±0.0008*
Sth	—0.1240±0.0466**	0.0459±0.6393	0.0259±0.0403
HT	0.0023±0.0030	0.0078±0.0376	—0.0038±0.0052
HG	0.0104±0.0092	0.0160±0.1193	0.0002±0.0030
EH	—0.0182±0.0207	0.0382±0.2102	0.0119±0.0106
FFMY			0.0515±0.0265
BFY			—1.1973±1.1600

* significant at the 5% level.
** significant at the 1% level.

II. Skin temperature

1. *Effect of age*

Table 4 shows the overall means of skin temperature in buffalo for the four age groups. Skin temperature decreased with advancing age till 24 months. Differences between ages within the *4th* age group were not statistically significant.

The observed decrease by age of skin temperature could be attributed to differences in hair coat and in skin histology. This result was in agreement with the finding of Hafes *et al.* (1955) and Jenkinson and Nay (1968). Table 15, shows the overall means of skin temperature in Friesian which are slightly higher than comparable figures obtained in buffalo. Age effects on skin temperature in Friesian shows the same pattern observed in buffalo.

2. *Seasonal-diurnal effects*

Table 4 shows that the morning readings in buffaloes were always significantly lower (except in one case) than the evenings reading recorded at the same season. This was also the general trend with respect to rectal temperature in this species.

The morning skin temperature readings in buffalo (Table 4) are always higher in summer than in winter though it reached the level of significance only in age group 3. The same observation could be noticed with respect to the evening readings and it was significant in age groups 3 and 4. This in general is similar to the results discussed in rectal temperature though the differences in skin temperature are generally more distinct than the comparable differences in rectal temperature.

The Friesian (Table 5) shows the same trend exhibited by buffaloes with respect to the differences between the two winter readings and between winter morning and summer evening readings in all age groups. The differences between the two seasonal morning readings in Friesians are statistically significant in all age groups. The results of Friesian age groups 2 and 4 show the same trend as those obtained in buffalo for the difference between the two pairs of evening readings. Moreover, the Frieian shows the same trend of results observed in buffalo for the difference between the two summer reading. except in group 2 which shows a significant difference..

In all the groups of buffaloes and Friesians it could be seen that the morning skin temperature is lower than the evening either in winter or in summer.

Comparing the two pairs of morning (or evening) readings, the winter readings show lower values. This may suggest that skin temperature seems to be greatly influenced by ambient temperature, radiation and air velocity. This conclusion is in agreement with the findings of Thompson *et al.*(1952); Findlay(1953); Kibler and Brody, (1954); Thompson *et al.* (1954); Stewart and Brody (1954); Shafie and Badreldin (1963); Allen *et al.* (1963); Kibler *et al.* (1965) and Joshi *et al.* (1968).

Different results were obtained on Friesian cows by Shafie and Ali (1970), who stated that skin temperature showed lower values in summer and autumn than in winter.

The skin temperature was 29.5°, 28.9° and 33.2° for these three seasons respectively when air temperature was 29.3° 28.5° and 16.6° in the same respective order.

3. *Pregnancy effects*

Tables 14 and 17 show that pregnancy has no significant effect on skin temperature in the buffalo. On the other hand, in Friesian (Table 5 and 15) pregnant animals had higher skin temperature than non -pregnent ones and the differences in skin temperature reached the level of significance only between class 3 (6-9 months of pregnancy) and the two other classes (0-1 month and 2-5 months). The efficient insulative hair coat in Friesian affects the response of the skin temperature to either air temperature or body temperature. The case is different form the almost exposed buffalo skin. Hafez *et al.* (1955) stated that the hair in buffaloes seem to play a minor role in counteracting air temperature.

Comparing the amount of total variance of skin temperature (Tables 22 and and 23) it is clear that the Friesian showed higher values compared to the buffalo. The difference was very clear in age group 2 (the Friesian showing about 3 times the variance of buffalo) almost the same trend observed in rectal temperature.

4. *The effect of body weight, skin thickness, haemotocrit heart girth, elbow, height, and milk and fat production of the testing day.*

a. Body weight

Tables 26 and 27 indicate the partial regression coefficients of skin temperature on bodyweight of buffaloes and Friesian. The values of these regressions were negative in Friesians and buffaloes (except age group 3). The values reached the level of significance only in age group 1 in buffalo. In spite of the mainly insignificant regression coefficients obtained, the negative values indicat that the increased weight of the animal is accompanied by decreased skin temperature.

In general the effect of body weight on skin temperature as expressed by regression followed the same trend of rectal temperature in the two species. Skin temperature is highly correlated with body temperature (Shafie, 1958). Calculating the correlation coefficients between rectal and skin temperature in buffalo of this study showed the values of 0 39; 0.93, 0·36 and 0·39 in the 4 age groups. This indicates that the amount of variance in skin temeprature explained by rectal temperature reached the values of 15%, 86%, 13% and15% in the four ages respectively.

b. Skin thickness

The values of the partial regression coefficients of skin temperature on skin thickness in buffaloes (Table 26) are positive in all age groups except in age group 2 where it was negative. These values did not reach the level of significance except for age group 2 and 3. Age group 2 was measured and kept all the day long in open sheds, also the animals of this group showed higher rectal temperature compared to the other age groups. Badreldin and Ghany (1952) stated that the thick skin of the buffalo may prevent heating of the body resulting from the surrounding hot air and by radiation from the sun or hot ground.

Table 27 shows the values of partial regression coefficients of the skin temperature on skin thickness in Friesian cattle. These values are statistically not significant from zero.

C. Haematocrit

It is apparent from Tables 26 and 27 in buffaloes and Friesian cattle that the partial regression coefficients of skin temperature on haematocrit are generally negative and insignificant. It reached the level of significance only in the Friesians of age group 2. Thus, it could be seen that the decrease in haematocrit values is accompanied by increase in skin temperature.

d. Heart girth, elbow height, milk and butter fat production of the testing day

Since body measurements are highly correlated with body weight (Johansson and Hildeman, 1954), they are expected to act like body weight. It is noticeable that the regression coefficients of skin temperature on heart girth and elbow

TABLE 26. Partial regression coefficients (±S.E.) of skin temperature° of the buffaloes on the different traits used in the models.

Trait	Age group			
	1	2	3	4
BW	−0.0080±0.0037*	−0.0113±0 0125	0.0005±0.0044	−0.0013±0.0008
Sth	0.0601±0.1072	−0.7095±0.1728**	0.1163±0.0553*	0.0084±0.0291
HT	−0.0070±0.0092	0.0034±0.2206	−0.0045±0.0111	−0.0083±0.0061
HG	0.0101±0.0174	0.0292±0.0042**	−0.0165±0.0129	−0.0085±0.0045
EH	−0.0157±0.0310	0.0036±0.0692	−0.0258±0.0305	−0.0051±0.0089
FFMY				−0.0771±0.0752
BFY				1.6003±1.5461

* Significant at the 5% level.
** Significant at the 1% level.

TABLE 27. **Partial regression coefficients (±S.E.) of skin temperatures° of the Friesian cattle on the different traits used in the models.**

Trait	Age group		
	1	2	4
BW	—0.0009±0.0044	—0.0097±0.0169	—0.0013±0.0012
Sth	—0.0756±0.1074	0.0063±0.5598	—0.0125±0.0646
HT	—0.0004±0.0068	—0.0661±0.0329**	—0.0093±0.0084
HG	—0.0296±0.0212	0.0309±0.1045	—0.0041±0.0048
EH	0.0045±0.0478	0.0080±0.1841	—0.0182±0.0169
FFMY			0.1658±0.0424**
BFY			—4.0481±1.8603*

* Significant at the 5% level.
** Significant at the 1% level.

were statistically insignificant in Friesian cattle and buffaloes except in the case of heart girth in age group 2 in buffaloes. The values in general show the same trend as body weight. It could also be seen that heart girth explains a big amount of variance of skin temperature in age group 2 in buffalo. A similar observation was found in rectal temperature.

The partial regression coefficients of skin temperature on milk and butter fat production of testing day in buffalo are -0.077 ±0 0752 and 1.6003 ± 1.5461 respectively. The comparable two regression coefficients in the Friesian are 0.1658 ±0.0424, - 4 0481 ± 1.8603 respectively and these proved to be significant. Kibler *et al.* (1965) stated that the rise in skin temperature in cattle above 18° air temperature was only 4.4° in lactating cows, and this difference in response to heat was caused by the difference in hair density in the two groups. Badreldin and Ghany (1952), stated that lactating hastened shedding of hair in buffaloes. Hafez *et al.* (1954), showed that the hair in buffaloes seems to a play a minor role in counteracting air teremperature.

III Respiration rates

1. *Age effect*

Tables 6 and 7 show the overall means of spiration rate in buffaloes and, Friesians. Friesians had the highest means while buffaloes had the lowest.

It may be noted that the standard erroes of the overall means of age groups 1 and 2 are higher in buffaloes compared to Friesians of the same age groups but that was not the case with respect to the means of age group 4. Mostageer *et al.* (1974) stated that the standard errors of the means of respiration rate of the age groups : (<3 years), 3 <5 years), (5 —7 years) and (7) and more years), are higher in Friesian cattle compared to buffaloes.

Respiration rate of buffaloes and Friesians tends to decline with advancing age till 24 months old (3rd age group) after which it increases. The decrease in respiration rates with age was observed by Brody, (1938) Kibler and Broy (1951), Mostageer *et al.* (1974) and AbdelGhani *et al.* (1975). According to Kibler *et al.* (1951) and Ibrahim (1968), the decrease in respiration rate with the advancement of age could be attributed to a corresponding decline in heat production per kilogram body weight which induced similar decrease in thyroid activity with the advance in age free of body weight.

The increase in respiration rate in age group 4 of Friesian and buffaloes seems to be caused by the effect of pregnancy and lactation. The differences between age classes within age group 4 are statistically not significant. Mostageer *et al.* (1974) found that the differences in Friesian between the three age groups : (3- <5 years), (5- < 7 years) and (7 years and mor) are statistically insignificant but in buffaloes there is a significant drop between the means of the two last groups.

2-Seasonal—diurnal effects

The respiration rate values as shown in Table 7 for buffaloes tend to follow a diurnal rythm. The morning values are lower than the evening ones either in winter or in summer. The values obtained for respiration rates in winter evening are at least double that obtained for winter morning. The summer evening values are more than four times greater than the values of the summer morning in age group 1 and about double or 1 - 5 times greater in age groups 2,3 and 4 respectively. Differences between the morning estimates of the two seasons are statistically not significant except for age group 4, while the differences between the two evening estimates in age groups 1 and 4 show statistical significance. Differences such as these could be attributed to the increase in metabolic rate during the day and to the increase in air temperature in the afternoon (Brody *et al.*, 1948; Badreldin and Ghany, 1952; Asker *et al.* 1952; Riek and Lee, 1948a and b, Kibler and Brody, 1949, 1950 and 1953 ; Kibler, *et al* ., 1951 ; Findlay, 1953 ; Worstell and Johanston *et al.*, 1959; Youssef and Johnson, 1966;. Shafie and Ali, 1970 Brody 1953, and Shafie and Khalifa, 1972).

With respect to the Friesian cattle (Table 7) the same trend discussed above in buffalo could also be observed except that the differences in this case are more apparent. The winter estimates are in general lower than those of summer.

With respect to the amount of the total variance of respiration rate(Tables 22 and 23) it was found that the variance in Friesians of age group 1 is more than double the corresponding figure of buffaloes (260 *vs.* 124). In age group 2 and 4 the amount of variance was about the same for buffaloes and Friesians.

3. Pregnancy effect

Examining Tables 6 and 7 a gradual increase in respiration rate with advancing pregnancy could be observed in buffaloes and Friesians. The increase in the mean of respiration rate of the last group (6- 9 or 10 months pregnant) over the first group (0-1 month pregnant) is 1.05 and 4.25 breaths per minute in buffalo and Friesian respectively. These differences are statistically signifficant in Friesian.

The increase in respiration rate in the last stage of pregnancy may due to the large amountof energy expanded in pregnancy (Brody, 1938; Brody *et al.* 1948: Ragsdale *et al.*, 1948; Mostageer *et al.*,1974; and Abdel Ghani *et al.*, 1975).

4. The effect of pody weight, skin thickenss, heart girth, elbow height, milk and butterbfat production of testing day

a) Body weight

In buffaloes (Table 28) the values of the partial regression coefficients of respiraton rate on body weight for age groups 2,3 and 4 are positive but statistically not significant from zero, whereas the regression obtained in age group was negative(- 0.0458) 1 and siginficant.

In Friesian cattle (Table 29) the corresponding regression coefficients were negative and statistically significant in age groups 1 and 2and positive but insignificant in age group 4. The negative and significant values of the partial regression coefficients of respiration rate on body weight indicate that the increase in body weight in the early ages in buffaloes and Friesian is accompanied by decrease in respiration rate. Thompson(1954) stated that increasing body weight should decrease heat production per unit body wight. McDowell (1967) found that the level of metabolic heat production had a high positive relationship to the changes in respiration rates.

b) Skin thickness

Table 28 shows the partial regression coefficients of respiration rate on skin thickness in buffalo. These partial regressions coefficients are negative in all age groups except age group 1 and they reached the level of significance in age groups 1 and 3. Since skin is considered to be the first insulating mechanism, its thicknes should have its effect on physical transportation of heat from the animal surface to the ambient air and *vice versa*. The thick skin of the buffalo prevent heating of the body by hot air (Badreldin and Ghany, 1952). On the other hand the thick skin affects physical heat dissipation from the body, the blood circulation particularty is less efficient (as recorded in buffalo by Shafie and Badreldin (1963).

In Friesian cattle (Table 29) the partial regression coefficients of respiration rate on skin thickness were positive in all ages studied, though they were statstically not significant.

TABLE 28. **Partial regression coefficients (±S.E.) of respiration rate of the buffaloes on the different traits used in the models.**

Trait	Age group			
	1	2	3	4
BW	−0.0458±0.0212*	0.0353±0.0488	0.0135±0.0198	0.0007±0.0037
Sth	1.5843±0.6186*	−0.8918±0.6744	−0.6630±0.2495*	−0.0964±0.1335
HT	−0.1264±0.0528*	0.1667±0.0861	0.0739±0 0499	−0.0047±0.0279
HG	0.1516±0.1003	0,0882±0,0165**	−0.0229±0.0580	0.0182±0.0205
EH	−0.5006±0.1789*	−0 2662±0.2700	0.0003±0.1377	−0.0241±0.0410
FFMY				1.7699±0.3455**
BFY				−20 3481±7.1067**

* Significant at the 5% level.

** Significant at the 1% level.

TABLE 29. **Partial regression coefficiets (±S.E.) of respiration rate of Friesian attlec on the different traits used in the models.**

Trait	Age group		
	1	2	4
BW . . .	—0.1163 ± 0.0257*	—0.0699 ± 0.0267*	0.0088 ± 0.0090
Sth . . .	0.3663 ± 0.6285	0.7681 ± 0.8866	0.3721 ± 0.4823
HT . . .	—0.0219 ± 0.0397	0.0693 ± 0.0522	0.0575 ± 0.0624
HG . . .	0.2414 ± 0.1241	0.4822 ± 0.1655**	—0.0319 ± 0.0359
EH . . .	0.0183 ± 0.2800	—1.0430 ± 0.2195**	0.0817 ± 0.1264
FFMY. .			2.0130 ± 0.3167**
BFY. . .			—64.8530 ± 13.8811**

* Significant at the 5% level.

** Significant at the 1% level.

It seems thus that the thickness of the skin has no effect on respiration rate in the Friesian cattle, while in buffaloes it exerts its effect in the early ages. The Friesian as a breed of temperate zones possesses a well developed hair coat which is the major insulative agent and not the skin, in comparison to the less hair covered buffalo.

c. Heart girth

In buffaloes and Friesian, heart girth seems to have little influence on respiration rate. Except in age group 2, the partial regression coefficient of respiration rate on heart girth explains most of the variance of respiration rate in buffalo and considerable amount in Friesian. It is observed that this trend is similar to the effect of heart girth on both rectal and skin temperature in the two species.

d. Elbow height

Tables 28 and 29 show the partial regression coefficients of respiration rate on elbow height of the buffaloes and Friesian cattle. In buffalo these regressions are generally negative and reached the level of significance only in age group 1. In Friesian the partial regression coefficient was negative and significant only in age group 2.The negative value of the regression may indicate in general that the higher, the animal the lower is his respiration rate. The shorter animals are likely to be affected by heat radiation from the more than the high animals. A point of interest is that the amount of variance in respiration rate explained by the regression on elbow height is considerable in the Friesian of the second age group, measured the open shed but has no significant value in buffaloes of the same age group. It seems that the dark skin of the buffalo does not absorb the infra-red radiation (Badreldin and Gani, 1952), while the whitish colour of the Friesian abdomen absorb such radiation, and this provides a reason for the effect of the height of the animal on respiration rate.

According to Stewart and Brody (1954) and Kibler and Brody (1954) increasing radiation intensity steadily increased the respiration rates in Jerseys and Brahmans.

e. *Milk and butterfat production of the testing day*

The partial regression coeffcients of respiration rate on FFMY of the testing day are positive and statistically highly significant from zero in both buffalo and Friesian cattle (Tables 28 and 29). The amount of variance explained by regression (Tables 6 and 7) is very high in both species. Mostageer *et al.* (1974) found that the partial regression coefficent of respiration rate on milk yield in Friesian cattle is much higher than that of buffaloes, though both have significant effects in explaning variability of respiration rate. Abdel-Ghani *et al.* (1975) found that respiration of Friesian cows rose gradually with the increase in the amount of milk produced during the day of testing. Such an effect could be due to the increase of heat production produced by milking animals.

The partial regression coefficients of respiration rate on BFY of the testing day are negative and statistically significant in both species (Tables 28 and 29). However in buffaloes the amount of variance of respiration rate due to BFY (301.2) is almost the amount explained by FFMY, while in Friesian the comparable amount (756.7) is about ½ of the variance due to FFMY.

IV. *Pulse rate*

1. *Age effect*

Table 8 shows the overall means of pulse rate in buffalo in the different age groups. It could be observed that the mean was reduced from 81 beats per minute in age groups 1 and 2 to 56 and 58 in age groups 3 and 4. Differences between age classes, within age group 4 proved to be significantly lower in group C. Pineda *et al* (1967) working on the heavy cattle breed Charolais and Charolais and Tharparkar cross with different age groups (1-3 months old till five years old), found that age did not show any effect on pulse rate of the animals.

The Friesian cattle (Table 9) show a definite trend with respect to pulse rate. The pulse rate declines by age till 24 months when the means of the classes within age group 4 showed no significant difference. Brody *et al.* (1948) found that pulse rate in Holstein decline from about 90 Ppm at birth to about 60 at 20 months of age.

The high pulse rate of Friesian compared to buffalo could be taken as an indication that this foreing breed is under climatic stress. Pineda *et al.* (1967) comparing Charolais with sta. Gurtrudis and Phillipine cattle with respect to pulse rate, came to the same conclusion.

2. *Seasonal-diurnal effects*

The pulse rate in buffalo (Table 8) is greater in winter than in summer in all age groups. The evning level is higher than the morning level either in winter or in summer except in the case of age group 4. The differences in winter between pulse rate in the morning and the evening are statistically not significant except for age group 1. Also the differences between the two levels in summer are statistically not significant except for age groups4. With respect to the pair of morning levels, differences are statistically significant only in age group 3. On the other hand the difference between the pair of evening levels are statistically significant in age group 4 only.

In Friesian (Table 9) no differences could be observed between the 4 levels in age group 2. In other two age groups, the difference between the two readings of each of the two season are statistically significant.

Differences between the two pairs of morning and evening levels are statistically insignificant except for the evening pairs in age group 1. The increase in pulse rate level from winter to summer may due to the effect of high air temperature during summer.

The previous results for buffalo are in agreement with the findings of Kibler *et al.* (1949), Kibler and Brody (1950 and 1951), Findlay (1953), Dale *et al.* (1956) and Youssef and Johnson (1966) who observed the decline of pulse rate with increasing air temperature. Friesian, however, werein contrast to the previous mentioned results but in agreement with Worstell and Brody (1953) who estimated the critical air temperature after which pulse rate incrased is 90°F Friesian cows, 95°F for Brown Swiss cows and 100°F for Brahman cows.

The increase of metabolic rate and in turn heat production during the day could also offer a reason for the increase in pulse rate from the morning to the evening (Kibler and Brody, 1949, 1950 and 1951 and Kibler *el al.* (1965).

Kibler and Brody (1956) stated that pulse rate followed temperature, increasing with rising environmental temperature and decreasing with falling temperature. Such conclusion could be drawn with regard to Friesian readings but the buffalo showed a completely different picture. The sensitivity of pulse rate to diurnal changes did not appear to be dependent on temperature level or breed. Large differences in pulse rates between individual animals and random fluctuations burred the sharpness of diurnal pattern (Kibler and Brody, 1956).

3. *Pregnancy effect*

Buffalo and Friesian showed significantly high pulse rate level during the last stage of pregnancy (Tables 8, 9, 18 and 19). This could be attributed to the increase in heat production during this stage of pregnancy (Brody *et al.*, 1948).

4. *Effect of body wight skin thickness, haematocrit, heart girth, elbow height and butterfat production of the testing day*

a) *Body weight*

The partial regression coefficients of pulse rate on body weight in buffalo and Friesian cattle (Tables 30 and 31) are statistically not significant from zero (except in age group 1 in Friesian).

Kibler and Brody (1951) stated that the increase in body weight is associated with a decrease in pulse rate.

b. Skin thickness

In buffalo (Table 30) it is observed that the partial regression coefficients of pulse rate on skin thickness do not reach the level of significant except for age group 1. Comparable values in Friesian (Table 31) are statistically not significant for all age groups under investigation.

c. Haematocrit value

The partial regression coefficients of pulse rate on haematocrit are statistically insignificant (Tables 30 and 31) excpt for age group 4 in buffalo. The negatibe and staistically significant values obtained for the partial regression coefficients of pulse rate on haematocrit could be the relationship between body temperature, haematocrit and pulse rate. Shafie (1958) found that when rectal temperature increased haematocrit values decreased. A positive relationship was found by Kibler and Brody (1951) between pulse rate and rectal temperature. Consequently one could except a negative regression coefficient of haematocrit over pulse rate. Such was not the case in Friesian or in the first three age groups in buffalo. However, the only significant values of this regression coefficient (age group 4 in buffalo) showed the negative sign.

d. Heart girth

Tables 30 and 31 show the partial regression coefficients of heart girth on pulse rate. Of all the regression coefficients presented in these tables only those in age group 2 of buffaloes showed highly significant positive value. In this case it is of interest to note that most of the variance of pulse rate is due to difference in heart girth. The same observation was previously observed with respect to respiration rate. This group as already mentioned, was kept in open sheds.

TABLE 30. **Partial regression coefficients (+S.E.) of pulse rate of the buffaloes on the different traits used in the models.**

Trait	Age group			
	1	2	3	4
BW	—0.0444 ± 0.0535	0.2188 ± 0.1570	0.0374 ± 0.0574	0.0026 ± 0.0002
Sth	3.7613 ± 1.5630*	—2.2982 ± 2.1680	—1.2716 ± 0.7219	0.1003 ± 0.2960
HT	0.1088 ± 0.1335	0.1665 ± 0.2767	0.0164 ± 0.1445	—0.1239 ± 0.0618*
HG	—0.0965 ± 0.2533*	0.5104 ± 0.0530**	—0.0444 ± 0.1679	—0.0227 ± 0.0455
EH	—1.1738 ± 0.4519*	—2.2373 ± 0.8679*	—0.4798 ± 0.3986	—0.2129 ± 0.0908*
FFMY				2.5391 ± 0.7659**
BFY				—35.3127 ± 15.7549*

* Significant at the 5% level.
** Significant at the 1% level.

TABLE 31. Partial regression coefficients (±.S.E.) of pulse rate of Friesian cattle on different traits used in the models.

Traits	Age group		
	1	2	4
BW . . .	—0.1645 ± 0.0801*	—0.1674 ± 0.2827	0.0087 ± 0.0137
Sth . . .	—0.8273 ± 1.9610	2.8921 ± 9.3958	1.2264 ± 0.7339
HT . . .	0.1151 ± 0.1240	0.1248 ± 0.3515	0.0445 ± 0.0949
HG . . .	0.2656 ± 0.3871	0.5649 ± 1.7503	—0.0672 ± 0.0546
EH . . .	—1.6493 ± 0.8723	—1.2620 ± 3.0828	—0.4244 ± 0.1923*
FFMY . .			3.4291 ± 0.4820**
BFY. . .			94.8188 ± 21.1249**

* Significant at the 5% level.
** Significant at the 1% level.

e. Elbow height

Tables 30 and 31 for buffalo and Friesian show that all the computed partial regression coefficients of pulse rate over elbow hight are negative for all animals under investigaton.

In buffalo the partial regression coefficients of pulse rate on eblbow hight were significant except that of age group 3.

In Friesian the only significant regression coefficient was that of age group 4.

It may be noted that the amount of variance explained by elbow hight regression is of considerable magnitude in the early age of cattle and buffaloes.

f. Milk and butter fat production of the testing day

Tbles 30 and 31 show that in buffalo and Friesian the positive partial regression coeffecients obtained forpulse rate on FFMY in testing day are statistically highly significant. High lactation animals have double the rate of heat production as compared to non-lactating animals (Regsdal *et al.*, 1948). Lactating animals thus requires a large amount of blood pumped to supply the animal with oxygen and nutrients for heat production. Consequenty pulse rate paralells milk and heat production (Kibler and Brody, 1950; Worstell and Brody, 1953 and Kiber *et al.*, 1965).

Negative and significant partial regression coefficients of pulse rate on butterfat production were obtained for buffalo and Friesian (Tables 30 and and 31).

V. *Temperature gradient*

1. *Age effect*

In buffaloes the mean temperature gradient (TG.) value was higher in the second age group compared to the first, but decreased in the third while it rose in age group 4 within this last group, age showed no effect on TG.

In the three age groups of Friesian, a gradual increase of the TG by age is observed within age group 4 there is no effect of age on TG. Comparing similar age groups of buffaloes and Friesians, it could be observed that the buffaloes showed higher values.

Rectal temperature is mainly affected by the metabolic rate of the animal (Brody *et al.*, 1955; Kibler and Brody,1956 and Pineda *et al.*, 1967), this rate in turn is affected by the animal's age. On the other hand skin temperature is mainly affected by air temperature (Kibler *et al.*,1965) and it declines by age too. The decline of rectal temperature by age, however, is steeper than that of the skin when the effect of air temperature is constant.

2. *Seasonal - diurnal effects*

The seasonal - diurnal differences in TG in buffalo are also shown in Table 10. It is clear in all age groups that the two values obtained in the cold season (winter) are greater than their comparable values obtained in the hot season (summer). The higher values obtained in winter may be explained by the observed reduction of skin temperature (Table 10), due to the direct effect of lower air temperature,was also observed by Steward and Brody (1954),Thompson *et al.* (1954), and Joshi *et al.* (1968) and the increase of metabolic rate of the animals which increases the rectal temperature . On the other hand the lower values obtained in summer may be due to the high air temperature, which increases both skin temperature and rectal temperature but affects skin temperature more. Shafie (1958) working on Shorthorn and Baladi cattle indicated that the regression coefficient of skin temperature on air temperature was about ten times the coefficient of body temperature. Similar conclusions could be drawn when comparing the morning values obtained in this work with the evening ones observed in the same season. The morning values are greater than the evening ones in all age groups and differences reached the level of significance in all cases except age group 2 in winter. The differences between the TG values obtained for winter morning and summer evening are as expected statistically significant.

The Friesians (Table 11) shows in general the same trend observed in buffaloes the morning reading in both winter and summer have higher values than the evening ones of the same season.

The total variances of temperature gradient for buffaloes are lower than the corresponding figures of Friesian.

Comparing the total varinces of the different age groups in buffalo and Friesian, it is clear that age group 2 shows the highest values in either species. This age group was measured and kept all the day long under open sheds.

These results, in general, are expected since the total variances of both rectal and skin temperature show the same trend.

Tables 20 and 21 represent the ANOVA of TG in buffaloes and Friesians.

3. *Pregnancy effect*

It is noticeable from Tables 10 and 11 that pregnancy has no effect on T G in buffaloes and Friesian.

4. *Effect of body weight, skin thickness, haematocrit, heart girth, elbow height, FFMV and BFY of the testing day*

In the three age groups of Friesian, the partial regression coefficients of TG on BW, Sth, HT, and EH are statistically not significant from zero (Table 32). In age group 4 the negative and significant value obtained for the partial regression coefficient of temperature gradient on fat free milk yield of the testing day may be due to the rise in rectal temperature for lactating cows and to the effect of hair coat (Kibler *et al.*,1965). Since Friesian are not affected by these factors discussion will be confined to buffalo.

a. Body weight

The body weight showed no effect on TG in buffalees (Table 45).

b. Skin thickness

The partial regression coefficents of TG on skin thickness of buffaloes were all negative except in age group 2 (Table 33). Badreldin and Ghany (1952) showed that the thick skin of the buffaloes may prevent heating of the body from the microclimate and this could explain the negative values obtained. In heat stress, to which age group 2 of buffaloes was exposed, it seems that the thick skin of the buffaloes prevent the dissipation of the excess heat from the body. Thus increase rectal temperature in such a way that the increase in rectal temperature is greater than the increase in skin temperature caused by the heat stress and this would cause a positive value of the regression coefficient. It is worthy to note, that though the regression coefficients in Friesian all are insignifcant yet they show exactly the same signs of the corresponding groups of buffaloes'.

TABLE 32. **Partial** regression **coefficients** of temperature gradient° of the **buffaloes on the different trait used in the models.**

Trait	Age group			
	1	2	3	4
BW	0.0051 ± 0.00036	0.0042 ± 0.0082	—0.0016 ± 0.004L	0.0008 ± 0.0008
Sth	—0.0508 ± 0.1064	0.5388 ± 0.1130**	—0.1067 ± 0.0510*	—0.0029 ± 0.0276
HT	0.0064 ± 0.0091	—0.0027 ± 0.0144	0.0108 ± 0.0102	0.0068 ± 0.0058
HG	—0.0061 ± 0.0172	0.0277 ± 0.0028**	0.0200 ± 0.0119	0.0095 ± 0.0042*
EH	0.0138 ± 0.0308	—0.1295 ± 0.0452**	0.0238 ± 0.0282	0.0082 ± 0.0085
FFMY				0.0646 ± 0.0714
BFY				—1.2800 ± 1.4670

* Significant at the 5% level.
** Significant at the 1% level.

TABLE 33. Partial regression coefficients of temperature gradient° of Friesian cattle on different traits used in the models.

Traits	Age group		
	1	2	3
BW . .	—0.0022 ± .0045	0.0025 ± 0.0243	—0.0004 ± 0.0014
Sth . . .	—0.0484 ± 0.1116	0.0396 ± 0.8048	0.0383 ± 0.0761
HT . . .	0.0027 ± 0.0071	0.0739 ± 0.7129	0.0056 ± 0.0098
HG . .	0.0399 ± 0.0220	—0.0149 ± 0.1502	0.0043 ± 0.0057
BH . . .	—0.0228 ± 0.0497	0.0302 ± 0.2646	0.0301 ± 0.0199
FFMY .			—0.1143 ± 0.0500*
BFY . .			2.8508 ± 2.1901

* Significant at the 5% level.

c. Haematocrit value

The partial regression coefficients (Table 33) of TG on heamatorcit value are statistically not significant from zero in all age groups of buffaloes.

d. Heart girth

Table 45 points out the partial regression coefficients of TG on heart girth in buffaloes The regression cofficients are all positive in the buffalo groups except in age group 1 which showed a very low significant value.

e. Elbow height

For buffaloes the values of the partial regression coefficient of TG over elbow height (Table 32) did not reach the level of significance except in age group 2 in which the regression coefficient was negative.

f. FFMY and BFY the testing day

It is clear from (Table 32) that FFMY and BFY of the testing day in buffaloes has no effect on temperature gradient.

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دراسة احصائية عن التحمل الحرارى فى الماشية الفريزيان والجاموس

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أجريت هذه الدراسة فى شهرى ديسمبر ١٩٧٤ ويونيو ١٩٧٥ بمزرعتى أم صابر وصلاح الدين بشركة جنوب التحرير الزراعية ٠

كان الهدف الرئيسى من هذه التجربة هو دراسة السلوك الاحصائى لبعض الصفات الفسيولوجية المتعلقة بالتحمل الحرارى للجاموس والفريزيان والبلدى٠ وقد استخدم من هذه الأنواع ٣٨٩ رأسا من الجاموس ، ٢٧٧ رأسا من الفريزيان ٠ وقد قسمت الحيوانات طبقا لأعمارها الى أربع مجموعات هى :

(١) من الميلاد حتى سن أربع شهور ٠

(٢) أكثر من أربعة شهور وحتى ١٢ شهر ٠

(٣) أكثر من ١٢ شهر وحتى ٢٤ شهر ٠

(٤) أكثر من ٢٤ شهر ٠

وكان الجاموس ممثلا فى المجموعات الأربعة ، أما الفريزيان فقد اشتمل على المجموعات ١ ، ٢ ، ٤

١ ـ درجة حرارة الجسم :

(أ) كان المتوسط العام لدرجة حرارة الجسم فى الجاموس فى مجاميع العمر الأربعة كالآتى
٣٨٫٨١°م ، ٤٠٫٣٦°م ، ٣٨٫٢٦°م ، ٣٨٫١٤°م على التوالى ٠ أما متوسطات حرارة جسم الفريزيان فى الأعمار الثلاثة فكانت ٣٩٫٠٣°م ، ٣٩٫٠١°م ، ٣٨٫٧٢°م ٠

(ب) انخفضت درجة حرارة الجسم بتقدم العمر فى كل من الجاموس والأبقار وذلك حتى عمر ٢٤ شهر ثم استمرت بعد ذلك ثابتة تقريبا ٠

(جـ) درجة حرارة الجسم فى الشتاء وفى الصباح كانت أقل من مثيلتها فى الصيف والمساء لكل من الأبقار والجاموس وقد كان التأثير الموسمى معنويا فى كل مجموعات العمر ٠

(د) لم يكن للحمل تأثير معنوى على درجة حرارة الجسم فى الجاموس بينما كان له تأثير معنوى فى الفريزيان خلال فترة الحمل الأخيرة ٠

(هـ) معاملات الأنحدار الجزئية لدرجة حرارة الجسم على وزن الجسم كانت سلبية ومعنويا فى العمر الأول والرابع فى الجاموس والعمر الرابع فى الفريزيان

(و) معاملات الأنحدار الجزئية لدرجة حرار الجسم (فى الأبقار والجاموس) على سمك الجلد والهيماتوكريت ولرتفاع الكوع وناتج اللبن والدهن كانت كلها غير معنوية ويفسر معامل الأنحدار الجزئى لدرجة حرارة الجسم على محيط الصدر للحيونات النامية فى الجاموس معظم الاختلافات فى درجة حرارة الجسم ٠

٢ ـ درجة حرارة الجلد :

(أ) كان المتوسط العام لدرجة حرارة الجلد لمجموعات العمر الأربعة في الجاموس هو ٣١٫١٥°م ، ٣٠٫٥٨°م ، ٣٠٫١٣°م ، ٢٩٫٦٥°م ، أما المتوسط العام لدرجة حرارة جلد مجموعات الفريزيان فكانت ٣٢٫٢٧°م، ٣٠٫٧٧°م ، ٢٩٫١°م .

(ب) انخفض متوسط درجة حرارة الجلد بتقدم عمر الحيوان حتى عمر ٢٤ شهر (في الأبقار والجاموس) واستمر ثابتا تقريبا بعد هذا العمر .

(جـ) كانت النتائج المتحصل عليها للتأثير الموسمى ـ اليومى (الميوموسمى) تماثل النتائج المتحصل عليها لدرجة حرارة الجسم الا أن درجة حرارة الجلد كانت أكثر وضوحا .

(د) لم يكن للحمل تأثير معنوى على درجة حرارة جلد الجاموس أما الفريزيان فقد ارتفعت درجة حرارة جلد الحيوانات الحوامل (فى نهاية فترة الحمل) بحوالى ٣٫٥°م .

(هـ) لم يكن معامل الأنحدار الجزئى لدرجة حرارة الجلد على وزن الحيوان معنويا الا فى مجموعة العمر الأولى فى الجاموس .

(و) لم يكن معامل الأنحدار لدرجة حرارة الجلد على سمك الجلد معنوية فى الجاموس والفريزيان .

(ل) معاملات الأنحدار الجزئية لدرجة حرارة الجلد على الهيماتوكريت كانت غير معنوية وسالبة فى جميع الحالات ما عدا مجموعة العمر الثانية فى الفريزيان .

(م) معاملات الأنحدار الجزئى لدرجة حرارة الجلد على مقاييس الجسم (ارتفاع الكوع ومحيط الصدر) كانت مشابهه لمعامل الأنحدار الجزئى لدرجة حرارة الجلد على وزن الجسم . كما لوحظ أن معامل الأنحدار الجزئى لدرجة حرارة الجلد على ناتج اللبن اليومى وكمية الدهن المنتجة يوم اجراء الاختبار لم يكن لها أى تأثير معنوى فى الجاموس وكان التأثير معنويا بالنسبة للفريزيان ووصلت قيمة ى لهاتين الصفتين الى ٠٫١٦٥٨ ، ٠٫٠٤٨٤ .

٣ ـ معدل التنفس :

(أ) كان المتوسط العام لمعدلات التنفس لمجموعات العمر الأربعة فى الجاموس هو : ١٨٫٧٥ ، ١٤٫٣٣ ، ٩٫٠٦ ، ١٤٫٤٨ وكانت القيم المقابلة فى الفريزيان هى : ٣٣٫٧٤ ، ٢٤٫٦ ، ٢٨٫٧٨ .

(ب) انخفض معدل التنفس بتقدم عمر الحيوان حتى عمر ٢٤ شهر ثم زاد بعد ذلك فى الجاموس والفريزيان .

(جـ) كانت الفروق فى معدل التنفس صباحا فى الشتاء والصيف غير معنوية فى الجاموس والابقار الفريزيان ، بينما كانت الفروق بين معدل التنفس فى المساء فى الصيف والشتاء معنوية فى الجاموس والأبقار .

(د) يزداد التنفس زيادة منتظمة بتقدم الحمل .

(هـ) كان معامل الأنحدار الجزئى لمعدل التنفس على وزن الجسم فى الجاموس معنويا وسالب القيمة (ـ ٠٫٠٤٥٨) فى العمر الأول واعطت مجموعتى العمر الأولى والثانية فى الفريزيان نفس الاتجاه (قيمة ى = ـ ٠٫١١٣٦ ، ـ ٠٫٠٦٩٩) ٠

(و) كانت معاملات الانحدار الجزئى لمعدل التنفس على سمك الجلد ذات قيمة سالبة فى الجاموس فيما عدا مجموعة العمر الأولى وكانت النتائج معنوية فى مجموعتى العمر الأولى والثالثة ، أما الفريزيان فقد كانت قيم هذه المعاملات موجبة وغير معنوية ٠

(ل) الانحدار الجزئى لمعدل التنفس علىمحيط الصدر أعطى نفس الأثر السابق ذكره لمعاملى الانحدار الجزئى لدرجة حرارة الجسم ودرجة حرارة الجلد على محيط الصدر ٠ كما أن معاملات الانحدار الجزئية لمعدل التنفس على ارتفاع الكوع كانت كلها سالبة القيمة فىكل من الجاموس والابقار.

(م) كان معامل الانحدار الجزئى لمعدل التنفس على ناتج اللبن يوم التجربة فى الجاموس والأبقار هما ١٫٧٦٩٩ ، ٠٫٠١٣٠ وكان معاملات انحدار معدل التنفس على ناتج الدهن يوم التجربة فى الجاموس والأبقار٠ هما ـ ٢٠٫٣٤٨ ، ٦٤٫٨٥٣٠

٤ ـ معدل النبض :

(أ) كان المتوسط العام لمعدل النبض فى مجموعات العمر الأربعة فىالجاموس ٨١٫١٢ ، ٨١٫٧٨ ، ٥٦٫٧٧ ، ٥٨٫٣٢ وكانت القيم المقابلة لها فى الفريزيان ١٠٨٫٩ ، ٧٩٫٨١ ، ٦٢٫٥٨ ٠

(ب) انخفض معدل النبض بتقدم العمر فى الجاموس والفريزيان وكان هذا الانخفاض أكثر وضوحا فى الفريزيان حيث انخفض حتى عمر ٢٤ شهر٠

(جـ) كان معدل النبض فى الجاموس شتاء أعلى منه صيفا كما كأن هذا المعدل مرتفعا فى المساء عن الصباح سواء كان ذلك شتاء أم صيفا فيما عدا العمر الرابع ٠

(د) كان للحمل المتأخر تأثير مؤكد على زيادة النبض سواء فى الجاموس أو الفريزيان ٠

(هـ) لم يكن لمعاملى الانحدار الجزئى لمعدل النبض على وزن الجسم وسمك الجلد قيمة معنوية فى الفريزيان والجاموس ٠

(و) معامل الانحدار الجزئى لمعدل النبض على قيمته الهيماتوكريت لم يكن معنويا فى الأبقار والجاموس الا فى المجموعة الرابعة فى الجاموس ٠

(ل) معامل الانحدار الجزئى لمعدل النبض على محيط الصدر كان معنويا فى مجموعة العمر الثانية فى الجاموس ٠

(م) معاملات الانحدار الجزئى لمعدل النبض على ارتفاع الكوع كانت قيمتها سالبة وغير معنوية لجميع الحيوانات تحت الدراسة فيما عدا مجموعة

(ن) معاملا الانحدار الجزئى للنبض على ناتج اللبن يوم التجربة فى الجاموس والفريزيان كانا معنويين (ى = ٢٫٥٣٩١ ، ٣٫٤٢٩١)٠ وكذا كان معاملا الانحدار الجزئى للنبض على كمية الدهن المنتجة يوم التجربة أيضا ولكنهما سالبان فى كل من الفريزيان والجاموس (ى = ـ ٣٥٫٣١٢٧ ، ـ ٩٤٫١٨٨) ٠

٥ ـ الفرق بين درجة حرارة الجسم والجلد (درجة مئوية) :

(أ) المتوسط العام لمجموعات العمر الأربعة فى الجاموس كان ٧ر٦٦ ، ٩ر٧٧ ، ٨ر١٣ ، ١٢ر٦٧ وكانت هذه القيم للفريزيان ٦ر٦٦ ، ٨ر٠٤ ، ٩ر٦٢ ٠

(ب) كانت القيمتان المتحصل عليهما فى فصل الشتاء أكبر منها فى الصيف فى الجاموس والأبقار ٠

(جـ) لم يكن للحمل أى أثر ظاهر على هذه الصفة ٠

(د) لم يكن لقيم معاملات انحدار هذه الصفة على وزن الحيوان وسمك الجلد ، الهيماتوكريت ومحيط الصدر وارتفاع الكوع أى تأثير معنوى فى الفريزيان ٠