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The Reaction of Turkeys to Climatic Conditions

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THE REACTION of 10 adult males of Bronze and other Beltsville were studied for a whole year in relation to climatic conditions

The reactions were at their lowest values during cold seaso and at their highest values during the hot one, especially the hotn humid months. The increase in the percentage of relatively humidity was of no effect on the reactions during cold season but its influence approved in the hot season especially on respiration rate. The air temperature was the major factor affecting the body reactions as it was obvious from the monthly variations in reactions during the whole year which were statistically significant, The lowest values were recorded in December and January and the highest ones recorded in July and August. Sudden increase in the reactions occured in April due to the effect of Khamassen sandy and stormy winds. The range of variation throughout the whole year was so wide in respiration rate while the least range was for body temperature and this refers to well developed heat regulating mechanism in Turkeys.

The diurnal variations in the body reactions coincided that of air temperature. The wider diurnal variation was that of respiration rate especially in the hot seasons because of its efficiency in cooling the birds. Also the caruncles which is bare showed the higher diurnal variation of all skin regions. The less diurnal variation in the back feather temperature during the hot-humid season was due to the less insulating capacity of feather coat because of the moulting which occurred in this period.

The breed differences which were very slight in cold season became wider in hot season especialiy respiration rate and the highest values were recorded by Bronze more than Beltsville. The Bronze also showed wider diurnal variations than Beltsville.

The temperature gradients from the body core to skin, feather than ambient air were at there highest values in cold months and decreased in hot months especially the hot-humid ones. It was clear that the feather was the item which was greatly affected by the change in air temperature while its effiicient insulative capacity protected skin and body core from climatic variations and kept their temperatures stable to a great extent. The Bronze showed less values of gradients in hot months than Beltsville.

Air temperature of 32.2°C or more caused a significant increase in body temperature of Turkeys above normal (Wilson and Woodard, 1955). In normal conditions, Turkeys have lower body temperatures (41°) than chickens (41.4°) and ducks (41.1°C), (Robinson and Lee, 1946). Breed differences in body tem-

perature of Turkeys were observed (Wilson and Woodard, 1955), and they were also found to differ in their heat tolerance, as white Beltsville males were somewhat tolerant than Bronze males in all classes of temperatures from 18.3 to 40.6°.

Ambient temperature is the more determinant of the thermal regulation. When ambient temperature is lower than that of body temperature, heat loss is mainly controlled by the regulation of insulative agents mainly feather coat (King and Farner, 1964). Consideration must also be given to the environmental temperature to which the birds have become acclimated before the elevation of ambient temperature. Wilson and Woodard (1955), demonstrated that constant air temperature more than 32.2°C, caused hyperthermia for male Turkeys after exposing the birds to air temperatures ranges 15. 6-21.1, 21. 1-26. 7, 26. 7-32. 2 and 32. 2-37. 8 respectivley. They attributed that to the lack of acclimation, because the birds stayed only one day in every air temperture range.

Material and Methods

Ten males of each of Bronze and White Beltsville Turkeys were available. Their body reactions to seasonal, monthly and diurnal variations in air temperature and relative humidity was studied for a whole year. The toms were all of one year old at the begining of the study. The different reactions for all birds were studied twice monthly with two weeks intervals. The birds were set free at sunrise, while they were kept in pens at sunset. The toms were kept apart from hens during the period of study. All the birds were fed and libitum the same ration during the experimental period.

Air temperature and relative humidity of this locality (30-31°N) were measured by using wet and dry bulb thermometers hanged in the shade. The readings were recorded individually for every bird thrice per day. Body temperature was measured by clinical mercury thermometers inserted in the cloaca to depth of 4 cm and left 2 minutes. Skin temperature was measured by a surface thermestor thermometer apparatus. The probe was applied to surface for one minute before recording the temperature. Skin temperature was recorded on three body regions, back, abdomen and caruncles. The same technique was also used to measure feather temperature for the back region. Respiration rate was measured by counting the movements of the abdomen, stop watch and a counter were used to count the rate per minute.

In general, the tests were made in the yards and no excitation or rought handling was permitted avoiding under muscular activity. The tests for the previously mentioned body reactions were carried out and the data recorded for each bird three times per day, *i.e.*, morning (7-9 a.m.) (M) afternoon (1-3 p.m.) (N) and evening (7-9 p.m.) (E). Statistical analysis were carried out according to Snedecor (1956).

Results and Discussion

Yearly averages

The yearly average air temperature was 23.8° while that for relative humidity was 58 per cent. Under these conditions the yearly averages of body temperature, back skin, abdomen skin, back feather and caruncles temperatures for Bronze birds were 40.9°, 37.5°, 38.0°, 30.4° and 36.4° respectively, while the respiration rate was 61 breathes per min. The Beltsville averages for body temperature back skin, abdomen skin, back feather and caruncles temepearatures were 40.8°, 37.4°, 37.8°, 30.3° and 36.2°, respectively, while the respiration rate was 51 breathes per min (Table 1 and 2).

The data were classified according to cold and hot seasons. In cold season which included the months from November to April, the average air temperature was 18.7° and relative humidity was 63%. The hot season which begins from May to October has been divided into hot-dry months, including May, June and July, (28.6° and 48% R.H.) while August, September and October represent the hot-humid months (29.2°C and 58%R.H.). The lowest mean values of all items in both breeds were recorded in the cold season (November to April) while they were high in hot season (May to October). The low value in cold season was due to the efficiency of the physical channels, radiation, conduction and convection in dissipating heat during the cold season. The increase in air temperature during hot season was the major factor responsible for the increase of the values of all reactions with clearer difference between the two breed especially in respiration rate (Table 1 and 2). These results agreed with those of Wilson and Woodard, (1955) obtained on the most pronounced increase observed in respiration rate during hot season agreed with the findings of Wilson, (1948) as it showed that the increase in respiration rate began at 26.7°. The feather temperarure was markedly higher in the hot-humid season than in the hot-dry one contrary to the trend observed on the other items. The moult which occurs in Turkeys during summer and early autumn (Payne, 1947) may be the main cause for that increase as it lessens the insulative properties of feathers and increases the influence of skin temperature. The higher response of caruncles to the increase in air temperature more than the other regions of the skin is due to the intensive blood supply of caruncles and that it is bare of feather.

Monthly variation in body reactions

The heat regulating reactions for both breeds varied from one month to another and that coincided with the difference in climatic factors. The lowest values for all items in both breeds were observed during December and January when the mean air temperature was 18.1 and 15.2°C respectively, and the corresponding means in relative humidity were 73% and 72%. The highest values and the widest breed difference were observed during July and August when the air temperatures were 31.2° and 32.2° and the means of relative humidity were 43 and 48% respectively. During the other months the values were within-

TABLE 1. Monthly and diurnal variation

Items	Diurnal	Nov.	Dec.	Jan.	Feb.	March.
Air Temp °C	M	21.5	15.2	12.8	14.2	17.0
	N	29.0	21.8	19.3	20.9	20.9
	E	21.1	17.2	13.4	13.7	15.9
	Av.	23.9	18.1	15.2	16.3	17.9
Rel Hum %	M	74	87	85	76	60
	N	48	56	54	45	39
	E	72	77	78	73	51
	Av.	65	73	72	65	50
Body temp °C	M	40.9	40.8	40.6	40.7	40.8
	N	40.9	40.9	40.8	40.9	40.7
	E	40.3	40.4	40.4	40.5	40.6
	Av.	40.7	40.7	40.6	40.7	40.7
Resp Rate	M	36	34	32	35	33
	N	53	40	34	40	36
	E	37	38	36	34	31
	Av.	42	37	34	36	33
Back Feather Temp °C	M	29.4	25.0	21.8	24.1	36.3
	N	33.7	27.8	25.9	27.0	29.7
	E	30.4	25.5	21.5	21.2	22.9
	Av.	31.2	26.1	23.1	24.1	26.3
Caruncles Temp °C	M	35.3	34.7	36.2	36.8	37.1
	N	36.8	35.0	36.7	37.0	37.1
	E	34.5	34.9	35.9	36.4	36.0
	Av.	35.5	34.9	36.3	36.7	36.7
Back skin Temp °C	M	37.1	37.4	36.7	37.3	37.2
	N	37.7	37.0	37.0	37.4	37.3
	E	37.1	36.8	36.8	37.1	37.0
	Av.	37.3	36.9	36.9	37.3	37.2
Abd skin Temp °C	M	37.5	37.3	37.3	37.4	37.6
	N	38.1	37.5	37.4	37.6	36.7
	E	37.5	37.4	37.4	37.4	37.6
	Av.	37.7	37.4	37.4	37.5	37.6

In body reaction of Bronze males

April	Cold season	May	June	July	Hot dry season	Aug.	Sep.	Oct.	Hot humid season	General Av.
19.4	16.7	21.2	26.7	28.3	25.4	29.2	26.7	25.2	27.0	
25.0	22.8	27.4	37.0	36.3	33.6	37.6	34.1	31.5	34.4	
17.5	16.5	22.6	28.9	28.9	26.8	29.8	25.9	22.4	26.0	
20.6	18.7	23.7	30.9	31.2	28.6	32.2	28.9	26.4	29.2	23.8
68	75	66	60	57	61	72	74	73	73	
41	47	40	22	31	31	42	38	40	40	
32	67	54	48	57	53	53	63	66	61	
54	63	53	43	48	48	56	58	60	58	58
41.0	40.8	41.0	41.2	41.1	41.1	41.1	40.8	40.8	40.9	
41.0	41.0	40.9	41.0	41.1	41.0	41.0	41.4	41.1	4.12	
40.9	40.5	40.6	41.1	41.3	41.0	41.0	40.8	40.7	40.8	
41.1	40.7	40.9	41.1	41.1	41.1	41.2	40.9	40.9	41.0	40.9
41	35	32	99	97	76	83	64	54	64	
47	42	39	137	181	119	190	128	102	133	
31	35	32	100	78	70	72	45	35	51	
40	37	34	112	119	88	108	79	61	83	61
30.2	26.1	26.4	32.8	33.9	31.0	34.5	33.9	32.6	33.7	
36.6	29.6	30.8	36.7	37.2	34.9	38.0	37.2	35.5	36.9	
31.1	35.4	36.9	34.3	35.6	32.3	35.0	34.2	31.7	33.6	
31.9	27.0	28.0	34.6	35.6	32.7	35.8	35.1	33.3	34.7	30.4
37.5	36.2	36.4	35.3	36.0	55.9	36.0	35.8	35.0	35.6	
37.7	36.7	37.4	38.0	38.0	37.9	38.5	37.5	36.6	37.5	
36.9	35.8	36.3	36.5	36.7	36.5	35.6	35.4	34.5	35.2	
37.2	36.2	36.7	36.6	36.9	36.7	36.7	36.6	35.4	36.1	36.4
37.5	37.1	37.6	37.0	37.4	37.3	37.1	37.1	37.8	37.1	
38.2	37.5	38.0	38.5	38.6	38.4	39.0	38.0	37.7	38.4	
37.7	37.1	37.7	37.7	37.9	37.8	37.4	37.2	36.7	37.1	
37.8	37.2	37.8	37.7	38.0	37.8	37.8	37.6	37.1	37.5	37.5
38.2	37.6	37.9	38.2	38.1	38.1	37.6	35.6	37.5	37.6	
38.8	37.9	38.5	39.2	39.3	39.0	39.6	38.9	38.1	38.9	
38.4	37.5	38.0	37.8	38.4	38.1	38.1	38.3	37.3	37.8	
38.5	37.7	38.1	38.4	38.6	38.4	38.4	38.2	37.6	38.1	38.0

TABLE 2. Monthly and diurnal variation

Items	Dirunal	Nov,	Dec.	Jan.	Feb.	March.
Air Temp. °C	M	21.5	15.2	12.8	14.2	17.0
	N	29.0	21.8	19.3	20.9	20.9
	E	21.1	17.2	13.4	13.7	15.9
	Av.	23.9	18.1	15.2	16.3	17.9
Rel Hum %	M	74	87	85	76	60
	N	43	56	54	45	39
	E	72	77	78	73	51
	Av.	65	73	72	65	50
Body Temp. °C	M	41.0	40.7	40.6	40.7	40.8
	N	40.9	40.4	40.7	40.9	40.7
	E	40.4	40.3	40.4	40.5	40.5
	Av.	40.8	40.6	40.6	40.7	40.7
Resp Rate	M	36	36	31	34	35
	N	49	39	34	41	36
	E	35	36	35	35	31
	Av.	40	37	33	37	34
Back feather Temp. °C	M	30.4	25.7	21.7	24.8	26.7
	N	33.8	27.5	76.0	27.3	28.1
	E	29.7	24.1	21.4	21.6	23.5
	Av.	31.3	25.8	33.1	24.6	26.1
Caruncles Temp. °C	M	35.3	34.3	35.7	37.0	36.8
	N	36.4	35.2	36.5	37.0	37.1
	E	34.2	34.4	35.9	36.1	35.9
	Av.	35.5	34.6	36.0	36.7	36.6
Back skin Temp.	M	37.2	36.8	36.9	37.3	37.2
	N	37.1	37.0	37.4	37.4	37.3
	E	36.9	37.0	37.5	32.4	37.2
	Av:	37.3	36.9	37.1	37.4	37.2
Abd skin Temp. °C	M	37.4	37.7	37.3	37.3	37.4
	N	38.0	37.4	37.4	37.6	37.8
	E	36.9	37.2	37.4	37.5	37.5
	Av.	37.5	37.3	37.4	37.	37.6

in body reaction of Beltsville males

April	Cold season	May	June	July	Hot dry season	Aug.	Sep.	Oct.	Hot humid season	General
19.4	16.7	21.2	36.7	28.3	25.4	29.2	26.7	25 2	27.0	
25.0	22.8	27.4	37.0	36.3	33.6	37.6	31.1	31.5	34.4	
17.5	16.5	22 6	28.9	28.9	26.8	28.8	25.9	76.4	26.0	
20.6	18.7	23.7	30.9	31.7	28.6	32.2	28.9	76.4	29.2	23.8
68	75	66	60	57	61	77	74	73	73	
41	47	40	22	31	31	42	38	40	40	
52	67	54	48	57	53	53	63	66	61	
54	63	53	43	48	48	46	58	60	58	58
40.9	40.8	40.9	41.2	41.0	41.0	41.0	40 1	40.8	40.9	
41.1	40.9	41.0	41.1	41.2	41.1	41.3	41.1	41.8	41.1	
40.8	40.5	40.6	41.1	41.2	41.0	40.9	40.6	40.6	40.7	
0.9	40.7	40.8	41.1	41.1	41.0	41.1	40.8	40.8	40.9	40.8
32	36	32	72	58	54	57	54	45	52	
50	50	40	97	137	91	130	100	79	103	
34	35	30	62	55	49	46	39	36	40	
39	38	34	77	83	65	78	65	53	65	51
29.9	26.4	76.0	32.7	33.7	30.7	34.7	33.4	33.7	33.4	
32 8	29.7	30.0	36.4	37.0	34.4	37.6	36.2	35.0	36.3	
32.7	25.6	27.6	24.7	35.5	32.4	34.7	33.5	32.1	33 4	
31.8	27.1	27.9	43.3	35.4	32.5	35.5	34.4	33.3	34.4	30.3
37.0	36.0	36.5	35.1	35.5	35.7	35.7	35.8	34.9	35.5	
37.6	36.6	37.2	37.7	37.7	37.5	38.1	37.5	36.7	37.4	
36.7	35.5	36.3	36.1	36.6	36.3	35.5	35.1	34.9	35.2	
36.1	36.0	36.7	36.3	36.6	36.5	36.5	36.5	35.5	36.6	36.2
37.4	37.1	37.3	36.9	36.7	37.0	37.0	37.0	37.0	37.0	
37.9	37.5	37 7	38.3	38.5	38.2	38.6	38.1	37.5	38.0	
37.7	37.2	37.4	37.3	38.0	37.6	37.3	37.2	36.6	37.0	
37.7	37.3	37.5	37.5	37.7	37.6	37.6	37.3	37.0	37.3	37.
38.0	37.5	37.8	37.8	37.5	37.7	37.5	37.4	37.4	37.4	
38.4	37.8	38.3	38.7	39.1	38.7	39.1	38.6	38 0	38.6	
38.2	37.4	37.7	37.3	38.4	37.8	38.0	37.8	37.4	37.8	
38.2	37.6	37.9	37.9	38.3	38.1	38.2	37.9	37.6	37.9	37.9

the range between the highest and the lowest values except the increase in values found in April. This can be attributed to the incidence of Khamaseen, stormy, dry and sandy winds (spells) which have a harmful effect (Table 1 and2) Caruncless' temperature was remarkably affected more than the other skin regions during this month.

The lowest body temperature reached 40.6°C for both breeds in January, while the highest values were observed in August being 41.2 and 41°C for Bronze and Peltsville respectively. The least variation shown in body temperature emphasizes that the birds have a well developed heat regulating mechanism. On the contrary, feather temperature showed a wide range of change between the lowest temperature in Junary and the highest one in August. This range which reached 12.7 and 12.4°C for Bronze and Beltsville respectively showed the great agreement in the variation of feather and air temperature. This affirms that the insulative capacity of the feather coat is greater in Bronze and Beltsville than in chickens. Monthly variation in skin temperature which accompanied the variation in air temperature was not so wide like that noticed in feather temperature. This is due to the weak effect of air temperature on skin temperature because of the feather coat which acts as intermediate medium between them. It could be stated that the ambient air temperature is the major factor that affects feather and skin temperatures while the effect of relative humidity was only evident during the hot-humid months.

Generally speaking, it may be inferred that the decrease in skin and feather temperatures observed in cold months is due to the increase in radiation, conduction and convection as physical channels for heat dissipation. The caruncles is the skin region which was remarkably affected by the decrease in air temperature. This may be due to the vasoconstriction which is a natural response for the decline in temperature and consequently the blood flow becomes less and the skin temperature is reduced in such region. On the other hand, the increase in temperature reduces the efficiency of the physical channels until they become functionless. In August, the feather temperature was approximately equal to that of air temperature at noon, since the latter was 37.7°C and the former was 37.9 and 37.6°C for Bronze and Beltsville respectively. Therefore, at this month the birds become unable to lose enough heat from the body surface. It was observed at this condition that the birds manifested special behaviour as the owing a good deal of water on the dewbill and caruncles while drinking and most of the heat then will be dissipated by evaporation than by the other ways. This was evidence as the respiration rate increased.

In the present work multiple regression proved that body temperature had a greater effect on respiration than air temperature in both breeds. The regression coefficients were 15.882 and 17.016 for the effect of body temperature and 4.413 and 2.674 for the effect of air temperature in Bronze and Beltsville respectively. This means that 1°C increase in air temperature induces an increase in respiration by 2.5 and 4.5 breathes in the two breeds respectively. On the other hand, only 0.1°C increase in body temperature increases the respiration rate more than 1.5 breatehs in both breeds. In chickens

panting was associated with rise in body temperature from 0.1 to 0.4°C (Lee *et al.* 1945). Also, increase in respiration rate evidenced in hot-humid temperature accompanied by the rise in the percentage of relative humidity. Since the evaporative heat loss is a direct function of the difference in pressure of water vapour between the most surface of respiratory system and the inhaled environmental air, we find that the hot-humid environment could cause strict limitation in respect to dissipation of excess heat. In this study, the increased respiration frequency especially at noon during hot-humid months may be explained as a response from the birds to overcome the low water vapour eliminated by breathing due to the increase in ambient humidity. Analysis of variance for both breeds showed that the monthly variation was highly significant (Table 3.).

TABLE 3. **Test of signaificance (F values) for the effect of months breed, and day time difference on body reactions in turkeys**

Items	F value		
	Months	Breed	Day time
Body temperature . . . . . °C	44.9 **	3.18	118**
Back skin temperature . . . °C	21.01**	0.46	14.0 **
Abdomen skin temperature . °C	58.07**	30.8**	209.6**
Back feather temperature . . °C	99. **	0.245	55.7 **
Caruncles temperature . . . °C	79.6è**	10 **	379. **
Respiration rate/minute . .	93. **	41. **	166.5 **

*: Significant.

** Highly significant.

Diurnal variations in body reactions

Diurnal variations for all items during the whole seasons of the year coincided with the diurnal variation in air temperature. In cold months, it was clear that all items, body temperature, back skin, back feather abdomen skin and caruncles' temperatures and respiration rate increased at noon to the maximum and gradually declined again to approximately the same values in the morning. The wider diurnal variation was observed in rate when it was about 20% at noon more than its value in the morning. The percentage value of increase was approximately the same for both breeds although there was slight variations in the initial values of the morning. Feather temperature

showed a remark increase at noon, 13.4% and 10. 6% than those at morning for Bronze and Beltsville respectively. Other items showed less difference in diurnal variation. However, the greatest differences in these diurnal variations were for back feather and caruncles temperatures followed by back skin, abdomen skin then body temperatures (Tables 4).

TABLE 4. The Percentage of diurnal variations (between morning and noon) in body reactions of bronze & beltsville

Items	Cold		Hot			
			Dry		Humid	
	Bronze	Beltsville	Bronze	Beltsville	Bronze	Beltsville
Body temperature °C	0.24	0.24	No Variation	0.24	0.73	0.49
Back skin temp . °C	1.07	1.07	2.95	3.24	3.50	2.70
Abdomen skin temp.°C	0.79	0.80	2.36	2.65	3.45	3.20
Back feather temp .°C	13.4	10.6	12.58	12.37	9.49	8.68
Caruncles temp . .°C	1.38	1.66	5.29	5.04	5.33	5.35
Respiration rate/minute	20.0	19.44	56.57	68.52	107.8	98.07

In the hot months (May to October), the diurnal variations were more obvious. The main cause is the wider variation in air temperature during hot months than cold ones (November to April). Respiration rate showed the greatest diurnal variation of all items especially in hothumid months. Also, the extent of diurnal variations in the other items studied were higher in hot-humid months than in hot-dry ones except that of feather which was less. The low diurnal variation observed on feather temperature in hot humid months was attributed to the high initial value of the morning. Also, the higher value of feather temperature was due to moult which occurs during this period. The caruncles' temperature recorded higher diurnal variation than other skin regions. The least diunal variation was that of the body temperature for both breeds. The analysis of variance showed that the diurnal variations in all items studied was hightly significant (Table 3). Diurnal variations were more obvious in Bronze than Beltsville. Although the Bronze showed a marked higher respiration rate at noon than Beltsville, diurnal variation percentage recorded near values for both breeds because the initia value was higher in the former one (Table 4).

TABLE 5. The relationship between the environmental temperature and the internal temperature of Bronze males (Temperature gradients).

Months	Morning				Noon				Evening				Average			
	B-S	S-F	F-A	B-A	B-S	S-F	F-A	B-A	B-S	S-F	F-A	B-A	B-S	S-F	F-A	B-A
Nov.	3.8	7.7	7.9	19.4	3.2	4.0	4.7	11.9	3.2	6.7	9.3	19.2	3.1	6.1	7.3	16.8
Dec.	3 8	12 0	9 8	25 6	3 9	9 2	6.0	19.1	3.6	11.3	8.3	23.2	3.8	10.8	8.0	22 6
Jan.	3.9	14.9	9.0	27.8	3.7	11.2	6.6	21.5	3.6	15.3	8.0	26.4	3.7	13.8	7.4	25 6
Feb.	3.4	13.2	9.9	26.5	3.5	10.3	6.2	20.0	3.4	15.9	7 5	26.8	3.4	13.1	7.4	24.4
Mar.	3.6	10.9	9.3	23.8	3.4	7.6	8.8	19.8	3.5	14.2	7 0	24.7	3.5	10.9	8.4	22.8
Apr.	7.5	7.3	10.8	21.6	2 8	3.6	9.6	6.0	3.2	6.6	13 6	23.4	3.2	5 8	11.3	20.3
Cold season	3.7	11.0	9.4	24.1	3.4	7.6	7.0	18.0	3.3	11.6	9.1	24.0	3.5	10.1	8.5	22.1
May	3.4	11.2	5.2	19.8	3.0	7.3	3.4	13.7	2.9	10.8	4.3	18.0	3.1	9.8	4.3	17.2
June	4.2	4.2	6.1	14.5	2.6	1.8	0.3	4.1	3.4	3.4	5.4	12.2	3.4	3.1	3.7	10.2
July	3.7	3.5	5.6	12.8	2.4	1.4	0.9	4.7	3.4	2.3	6.7	12.4	3 2	2.4	4.4	10.0
Hot dry season	3.8	6.3	5.6	13.7	2.7	3 5	1.3	7.5	3.2	5.5	5.5	14.2	3.2	5.	4.1	12.4
Aug.	4.0	2.6	5.3	11.9	2.5	1.0	0.4	3.9	3.6	2.4	5.2	11.2	3.4	2.0	3.6	9.0
Sep.	3.7	3.1	7.3	14.1	2.5	1.3	3.1	6.9	3.6	3.2	8.1	14.9	3.3	2 5	6.2	12.0
Oct.	3.8	4.4	7.4	15.6	3.4	2.2	4.0	9.6	4.0	5.0	9.3	18.3	3.7	3.9	6.9	14.5
Hot humid season	3.8	3.4	6.7	13.9	2.8	1.5	5.2	6.8	3.7	3.6	7.5	14.8	3.4	2.8	5.6	11.8

B-S = Body to skin temperature gradient.
S-F = Skin to feather temperature gradient.
F-A = Feather to air temperature gradient.
B-A = Body to air temperature gradient.

TABLE 6. The relationship between the environmental temperature and the internal-temperature of Beltsville males (Temperature gradients).

Months	Morning				Noon				Evening				Average			
	B-S	S-F	F-A	B-A	B-S	S-F	F-A	B-A	B-S	S-F	F-A	B-A	B-S	S-F	F-A	B-A
Nov.	3.8	6.8	8.9	19.5	3.1	4.0	4.8	11.9	3.5	7.2	8.6	19.3	3.5	6.0	7.4	16.9
Dec.	3.9	11.6	10.0	25.5	3.9	9.5	5.7	19.1	3.3	12.2	7.6	23.1	3.7	11.1	7.8	22.6
Jan.	3.7	15.2	8.9	27.8	3.3	11.4	6.7	21.4	3.3	15.6	8.0	26.9	3.4	14.1	7.9	25.4
Feb.	3.4	12.5	10.6	26.5	3.5	10.1	6.4	20.0	3.1	15.8	7.9	26.8	3.3	12.8	8.3	24.4
Mar.	3.6	10.5	9.7	23.8	3.4	9.2	7.2	19.8	3.3	13.7	7.6	24.6	3.4	11.1	8.2	22.7
Apr.	3.5	7.5	10.5	21.5	3.2	5.1	7.8	16.1	3.1	5.0	15.2	23.3	3.3	5.9	7.8	17.0
Cold season	3.6	10.7	9.8	24.1	3.4	8.2	6.4	18.0	3.3	11.6	9.1	24.0	3.4	10.2	8.4	22.0
May.	3.6	11.2	4.9	19.7	3.3	7.7	2.7	13.7	3.2	9.8	5.0	18.0	3.3	9.6	4.2	17.1
June.	4.3	4.7	5.3	14.3	2.8	1.9	0.1	4.5	3.8	3.1	5.3	12.2	3.6	3.2	3.4	10.2
July.	4.3	3.0	5.4	12.7	2.7	1.5	0.7	4.9	3.2	2.5	6.6	12.3	3.4	2.3	4.2	9.9
Hot dry season	4.1	6.3	5.2	15.6	2.9	3.7	1.0	7.6	3.4	5.1	5.6	14.1	3.5	5.0	3.9	12.4
Aug.	4.0	2.8	5.0	11.8	2.4	10.8	0.0	3.7	3.6	2.6	4.9	11.1	3.4	2.1	3.3	8.8
Sept.	3.8	3.6	6.7	14.1	3.1	1.8	2.1	7.0	3.6	3.5	7.6	14.7	3.5	2.9	5.5	11.9
Oct.	3.8	4.3	7.5	16.6	3.5	2.5	3.5	5.7	4.0	4.5	9.7	18.2	3.7	3.8	6.9	14.4
Hot humid season	3.8	3.6	6.4	13.8	3.1	1.8	1.9	6.8	3.7	3.6	7.4	14.7	3.5	3.0	5.2	11.9

Temperature gradient

The temperature gradients, the differences between body and skin (B-S), skin and feather (S-F), feather and air (F-A) and body and air (B-A), temperatures reached thier highest values in cold months (Table 5 and 6). Feather temperature which markedly declined in cold atmosphere was still higher than the surrounding air. The decrease in skin temperature was lower than that of feather temperature whatever the decline in air temperature was. The peripheral circulation, the trapped warm air and the well insulative properties of feather kept the change in skin temperature within narrow limits. Accordingly, the body temperature varied within narrower limits due to the intensive insulation of the skin and feather which acted as intermediate medium betweeen it and the external environment.

As air temperature increased in hot months the difference between all the components of the gradient decreased. The S-F and B-A gradients recorded the least value in hot-humid months (August to October) but the other gradients B-S and F-A were lower in hot-dry months (May to July) than in hot-humid ones. The diurnal variation in the gradients coincided with the climatic conditions. The lowest values were observed at noon in both cold and hot months but were lower during the latter months. The different items did not show the same level of variation . The increase was the highest in feather temperature and the lowest in body remperature. Accordingly, all the components of temperature gradient were near to each other denoting less efficiency in heat dissipation through the physical channels. Since the breed difference in body temperature was slight and the two breeds were subjected to the same air temperature the two breeds also exhibited slight breed different in (B-S) gradient especially in cold months. The least difference showed by Bronze was due to its higher skin temperature. The least value of (S-F) recorded by Bronze in hot-humid months may be attributed to either its dark plumage which possesses higher temperature than the white plumage by absorbing much heat rays or to the effect of moulting which occurs during this period of the year.

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تاثير الظروف المناخية على ظواهر التحمل الحرارى للرومى

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تمت دراسة الظواهر الحرارية الآتية وهى :

حرارة كل من الجسم وجلد الظهر وجلدالبطن وريش الظهر والعرف وكذلك سرعة التنفس . على عشرة ديوك بالنسبة لكل من البرونز والبلتسفيل على مدار سنة كاملة بالنسبة للظروف المناخية .

بلغت هذه الظواهر أقل قيمة لها فى خلال الموسم البارد (من نوفمبر الى أبريل) وأعلى قيمة لها فى الموسم الحار (من مايو الى أكتوبر) وخاصة فى الاشهر الحارة الرطبة (من أغسطس الى أكتوبر) كما وجد أن ارتفاع الرطوبة النسبية لم يكن ذا أثر على ظواهر التحمل الحرارى فى الموسم البارد الا أن تأثير ظهر فى الموسم الحار وخاصة على سرعة التنفس .

وكانت حرارة الجو أكثر تأثيرا على ظواهر التحمل الحرارى من الرطوبة الجوية كما اتضح من التغيرات الشهرية على مدار السنة والتى وضحت وضوحا معنويا من التحليل الاحصائى فنجد أن أقل قيمة للظواهر الحرارية سجلت فى شهرى ديسمبر ويناير بينما أعلى قيمة سجلت فى شهر يولية وأغسطس .

وقد حدث ارتفاع مفاجىء فى الظواهر الحرارية للطيور فى شهر أبريل وقد عزى هذا الى رياح الخماسين وما تسببه من عواصف رملية . ولوحظ أيضا أن أكبر مدى فى هذا التغير على مدار السنة حدث فى سرعة التنفس بينما كانت أقلها فى درجة حرارة الجسم مما يشير الى الكفاءة المرتفعة للتنظيم الحرارى فى الرومى .

كما وأن التغيرات اليومية فى ظواهر التحمل الحرارى اتفقت مع التغيرات اليومية فى درجة حرارة الجو وأوسع هذه التغيرات اليومية كان فى سرعة التنفس وخاصة فى الموسم الحار لما للتنفس من كفاءة فى تبريد الطيور . ووجد أيضا أن التعرف وهو العارى من الريش كان أكبر مناطق الجلد تغيرا فى حرارته اليومية . كما لوحظ قلة التغير اليومى فى حرارة الريش (الفصل الحار الرطب من السنة (أغسطس الى أكتوبر) وقد يعزى هذا الى قلة مقدرة الريش على العزل بسبب القلش الذى يحدث فى هذه الفترة من السنة .

ووجد أن الفروق بين كل من البرونز والبلتسفيل فى قيمة ظواهر التحمل الحرارى التى كانت طفيفه فى الموسم البارد أصبحت أكبر فى الموسم الحار وخاصة فى سرعة التنفس حيث سجل البرونز قيما للظواهر الحرارية أعلا من البلتسفيل كما وأظهر البرونز مدى أوسع فى التغيرات اليومية عن البلتسفيل .

أما الفارق الحرارى وهو الفروق بين درجة حرارة الجسم ودرجة حرارة الجلد وبين حرارة الجلد وحرارة الريش وبين حرارة الأخيرة وحراره الجو كانت أعلى فى الموسم البارد وأقل فى الموسم الحار وخاصة الأشهر الحارة الرطبة . ووضح أن الريش كان هو الأكثر تأثير بالتغيير فى حرارة الجو بينما عملت كفاءته العالية فى العزل على بقاء حرارة الجلد والجسم ثابتة الى حد كبير وأظهر البرونز قيما لهذه الفروق فى الجو الحار أقل من التى أظهرها البلتسفيل .