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THERMAL REACTIONS OF BREEDS OF CHICKENS OF DIFFERENT COLOURS TO HOT WEATHER

By

G. A. R. Kamar and M. A. S. Khaliefa*

Four males and eight females from each of Fayoumi breed representing the greyish black colour, white Baladi representing the white colour and Rhode Island Red representing the red colour were used to test the thermal reactions of these breeds. Thermal reactions tested were the temperature of body, back skin, back feather, leg skin, wing skin, abdomen skin, comb and respiration rate, The highest body and skin temperatures and the least diurnal variations were observed for the White Baladi, followed by the Fayoumi and RIR birds. Meanwhile, the Fayoumi had the highest respiration rate, followed by the Baladi than the RIR. The two native breeds are considered to be adapted to hot weather of summer in Egypt. The subjection of birds to heat stress caused them to react with the same manner, whilst the optimum temperatures causes the differences in reaction according to thermogenesis. The fluctuation in temperatures of the different items and the difference between this item and body temperature increases as the distance of the region is away from body core.

Plumage colour of breeds may play a role in breed differences in their thermal reactions. The White Leghorn fowls appear to tolerate the strong sunlight more than Rhode Island Reds and the experimentally coloured White Leghorns. The better heat tolerance is probably mainly due to the white plumage colour in addition to other unknown factors Ohamoto *et al.*, (1956). Also, Australorps are more susceptible to heat than wcaphite Leghorns under different environmental temperatures and humidities, as the increase in air temperature causes a pronounced increase in body temperature in the Australorps more than in the White Leghorn which may be due to differences in colours of the birds (Lee et al., 1945). Meanwhile, the Rhode Island Red has a significantly longer average survival time than White Leghorn at an environmental temperature of 42.2°C. This provides some evidence that the rule of plumage colour is not of great significance in the relative tolerance of fowls to high environmental temperatures when the birds were not exposed to direct sunlight. Accordingly in order to ascertain the effect of plumage colour on heat tolerance in the fowl, it is important to compare the reaction of birds of different colours after the exposure to direct sunlight at hot weather (Randall and Hiestand, 1939; Yeates *et al.*, 1941; Ohamoto *et al.*, 1956).

Materials and Methods

Three groups of birds, of different colours were used; the Fayoumi of greyish black colour (represent the dark colour), The Baladi of white colour (represent the light colour) and Rhode Island of red colour (represent the medium

* Foculty of Agriculture, Cairo University, Giza Egypt.

colour). This experiment was designed to study the effect of plumage colour of different breeds on thermal reactions of the birds during summer months. Four males and eight females were used for each group. The birds of all groups were of 18 months of age. The weekly tests were done at 7-9.5 a.m., at 1-3.5 p.m. and at 7-9.5 p.m., for six times during August and September months. Respiration rate, body temperature, feather temperature and skin temperatures of different regions were measured and recorded air temperature averaged 29, 35 and 28°C, relative humidity averaged 64, 41 and 61%, wind speed averaged 4, 8 and 6 km/hr. for the three tests respectively. The daily average of bright sunshine was 11 hours.

Results and Discussion

The three breeds studied in this work differed in their plumage colour. The Baladi had white feathers, the Fayomi had dark bluish grey feathers which resembled the dark glossy colour in this experiment and the Rhode Island Red had red feathers which resembles the dark chalky colour. In general, the Baladi birds had the highest body temperature and skin temperatures followed by the Fayoumi and Rhode Island Red birds. Meanwhile, the Fayomi had the highest respiration rate followed by the Baladi then the Rhode Island Red (Table 1). The Fayoumi and also the Rhode Island breeds had wider diurnal variations than the Baladi breed. Diurnal variations were found to be highly significant with respect to body, feather and skin temperatures of abdomen, back, leg, comb, and wind regions and also respiration rate (Table 2). Breed differences in respiration rate, body temperature and skin temperatures of abdomen, leg, and wing regions were found to be highly significant (Table 2). Sex differences in resperation rate, body, feather and skin of the back and abdomen region temperatures were found to be significant (Table 2).

The colour of feather and skin determines, to a certain extent, the proportion of the sun's radiation falling upon the bird which is absorbed by the body. The energy contained in the sunshine falls upon the birds either directly or after reflection from the atmosphere, clouds, ground and other surrounding objects. About one half of this energy is in the visible portion of the spectrum. This portion is the only part that has the effective solar energy in the sunshine. A white surface may absorb only 20 percent of this visible radiation falling upon it, whereas a black surface may absorb 80 percent (Lee, 1953).

With respect to temperature, the white feathers which reflects the majority of sun energy that falls upon it, also can reflect the majority of heat that comes from the body to outside, so it can preserve more heat inside the body, which causes the high temperatures of white Baladi and also the least diurnal variations. The Fayoumi and Rhode Island Red which have dark colours permit inside or outside more energy, so they have the lowest temperatures. It seems that the white coloured feathers can be considered of more insulating ability than dark feathers. However, the later two breeds seem to be more affected by the varying air temperature than the Baladi as observed by wider diurnal variations than the Baladi.

TABLE 1.—BREED DIFFERENCES IN DIFFERENT ITEMS STUDIED

Items	Test	Baladi		Fayoumi		RIR	
		Male	Female	Male	Female	Male	Female
Body temp.°C	1	42.4	42.3	42.2	42.1	42.0	41.8
	2	42.4	42.2	42.3	42.4	42.0	42.2
	3	42.1	41.9	42.0	41.7	41.6	41.7
Back skin temp.°C.	1	40.6	40.5	40.5	40.2	40.5	40.4
	2	41.4	41.0	41.2	41.0	40.9	41.1
	3	40.3	40.3	40.8	39.8	40.3	40.0
Back feather temp.°C.	1	38.7	38.8	38.7	38.7	38.8	38.6
	2	39.9	39.7	39.9	39.8	39.7	39.7
	3	38.9	38.5	39.1	38.7	38.9	38.4
Leg skin temp.°C.	1	41.1	41.1	40.7	40.8	40.7	40.7
	2	41.8	41.5	41.6	41.7	41.1	41.5
	3	40.8	40.8	40.9	40.6	40.8	40.6
Wing skin temp.°C.	1	40.2	40.5	40.0	39.8	40.2	40.2
	2	41.0	40.9	40.7	40.8	40.8	41.1
	3	40.0	39.7	40.1	39.4	40.0	39.8
Abdomen skin temp.°C.	1	41.2	40.6	40.5	39.8	40.4	40.3
	2	41.9	41.0	41.4	41.0	40.9	41.1
	3	40.8	40.2	40.6	39.8	40.3	40.1
Comb temp.°C.	1	35.9	36.7	35.5	35.8	36.3	37.5
	2	38.7	38.5	38.7	38.3	38.5	39.0
	3	36.9	36.4	36.2	36.1	35.6	36.6
Respiration rate	1	31	43	45	48	27	36
	2	34	46	46	60	27	42
	3	26	38	45	47	23	32

The Fayoumi being more adapted to the wide variations in air temperature which is normal in Egypt, has raised his respiration greatly to minimize the variation in temperature inside his body and on his skin. The Rhode Island being not adapted to these environments, cannot raise his respiration rate. The two native breeds seem to be adapted to normal environmental conditions but through two different functions; the Fayoumi through raising his repiration rate, while the Baladi through its white colour which serves as

an insulating layer. Also, the observed higher tolerance of the White Leghorn to the stormy sunlight more than the Rhode Island Red (Ohamoto, *et al.*, 1956) seems to be due to the higher insulating function of white colour than the dark colour of feathers. To ascertain the effect of plumage colour on heat regulating reactions, further studies should be done under direct exposure to sunlight for different colours of birds from the same breed.

TABLE 2.—ANALYSIS OF VARIANCE OF THE EFFECT OF FEATHER COLOUR ON HEAT REGULATING REACTIONS.

Items	d.f.	Source of variation			
		Breed	Diurnal	Sex	Error
		2	2	1	354
Cloacal Temp. °C	M.S	3.9755	6.3719	1.0026	0.1040
	F. value	38.23**	61.27**	9.64**	
Back feather Temp °C	M.S	0.2928	43.8908	3.6199	0.6202
	F. value	0.47	70.77**	5.84**	
Abdomen Temp. °C	M.S.	7.3223	29.6206	20.2590	0.4016
	F. value	18.23**	73.76**	50.45**	
Leg Temp. °C	M.S.	1.8877	21.9442	0.0588	0.3545
	F. value	5.32**	61.90**	0.17	
Back skin Temp. °C	M.S.	0.829	24.5727	6.2409	0.4277
	F. value	1.97	57.45**	14.59**	
Wing Temp. °C	M.S.	1.9145	33.0314	0.5445	0.4147
	F. value	4.62**	79.65**	1.31	
Comb Temp. °C	M.S.	6.8884	231.7847	6.0840	3.1552
	F. value	2.18	73.46**	1.93	
Respiration Rate/Minute	M.S.	9568.8361	1678.6861	8614.2249	75.1941
	F. value	127.26**	22.32**	114.56**	

The sex differences observed in this study are mainly due to the differences between the physiological functions of males and females which have been previously discussed.

When air temperature rises at noon during the hot months of experiment, namely, August and September (35-40°C), the differences between breeds diminishes with respect to the temperatures of the body or the different body regions. It seems that when the birds are subjected to heat stress, they react with the same manner with respect to either body, skin or feather temperatures giving almost the same temperatures. Cooling by, evaporative is the only pathway for dispating the excess of heat, which rises greatly at noon test. Accordingly, the bird's ability to withstand high environmental tempratures depends on the increase in its number of breaths. The efficiency and capacity of the lungs and air sacs in different breeds under different environments is suggested to be studied in relation to heat regulating mechanism. This is obvious when the three breeds used were compared. The two native breeds showed the highest respiration rates, whilst the Rhodes showed the least.

At the optimum level of air temperature, the temperatures of the brids are within the thermoneutral levels and the differences which occurs at this case are due to thermogenesis. Accordingly, most of the differences observed between breeds were found at the morning and evening tests when air temperatures were at almost optimum levels (20-25°C).

The inner part of the body is designated as the core, in which most of the thermogensis occurs. In this part the fluctuations in tempertaure are minimized. The outer part is designated as the coat and consists of the feathers and skin. The coat is of characteristic importance in controlling heat exchange according to its low, bright controllable, thermal conductance which makes it effectively a layer of variable insulation. The efficiency of this insulation varies in different parts of the coat as a function of both the structure of the layer and its curvature. The oil secreted by the uropegeal gland may play a role in thermoregulation of birds. The increase in the efficiency of insulating proporties of a region narrows the differences between this region and body temperatures as found in abdomen skin and leg skin temperatures. Back skin and wring skin being of less insulating efficiency were of lower tempratures than the body and the flucuations that occurs in these portions were more related to the air temperature. The differences in temperatures between the outer part of coat which is the back feather and body were high, and again the flucutations in the both feather temperature were more related to air rather than body temperatures. The comb being an unfeathered portion plays an important role in heat dissipation. Its temperature is almost alike that of air temperature and most of variations that occurs in air temperature are synchrionized by similar variations in comb temperature.

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التنظيم الحرارى لأنواع ذات لون ريش مختلف فى الجو الحار

جمال قمر ، محمد عبد الصمد خليفه

الملخص

استعمل اربع ذكور وثمانية اناث من كل من الدجاج الفيومى كممثل اللون الرمادى الأسود والبلدى الأبيض كممثل للون الأبيض والرود ايلاندرد كممثل للون الأحمر الطوبى وذلك لدراسة التنظيم الحرارى لها فى الجو الحار . وقد درس فى هذه التجربة درجة حرارة الجسم وجلد الظهور وريش الظهر وجلد الأرجل وجلد الجناح وجلد البطن والعرف ومعدل التنفس . ووجد أن أعلى درجة حرارة للجسم الجلد وأقل تغير دورى يومى كانت فى البلدى الأبيض ثم الفيومى ثم الرود . هذا بينما وجد أن الفيومى كان أعلاها فى سرعة التنفس ثم البلدى الأبيض ثم الرود . وقد اعتبر النوعين المحليين أكثر تأقلما للجو الحار فى الصيف فى مصر وذلك بأن رفع الفيومى من سرعة التنفس لأن له لون أسود أما البلدى فقد ساعده على التأقلم لونه الأبيض برفع درجة حرارة جسمه . تعرض الطيور لدرجات حرارة عالية يسبب لها نفس أعراض التأثر أما فى درجات الحرارة المتوسطة فتظهر الاختلافات بين الطيور نتيجة للاختلافات الوراثية ــ تزداد التغيرات ويزداد الفرض بين كل صفة ودرجة حرارة الجسم كلما بعدت هذه المنطقة عن وسط الجسم أو زادت انحرافاتها السطحية .