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Effect of Seasonal Changes in Environmental Temperatures on Blood Parameters of Local, Necked Neck and White Leghorn Layers

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Abstract: Evaluation of blood parameters of the local hens of Saudi Arabia as subjected to seasonal variation was not documented well in the literature. This study was an attempt to determine the effects of natural seasonal changes of temperature on hematological components and chemical constituents of : the local hens of Saudi Arabia, Naked neck breed and a white leghorn layers. A total of 91 hens of two local of hens (naked neck and Saudi Local) plus an exotic white leghorn hens at 20 weeks of age were used in this study. These were divided into 29 hens of naked neck, 34 hens of Saudi local and 28 of white leghorn laying hens. The results of the study indicated a significant interaction between breed X period only on blood triglycerides. Effect of the breed was evident on mean corpuscular hemoglobin, blood urea nitrogen, total bilirubin and phosphorus. Seasonal variations in temperature had a significant effect on RBC, PCV, WBC, glucose, blood urea nitrogen, total bilirubin, creatinine, calcium, phosphorus, sodium and potassium. It was concluded that breed of the bird had no significant effect on the blood constituents of the birds, however, seasonal effect was evident on most of these constituents.

Key words: Naked neck, local birds, blood parameters, temperature, environment

INTRODUCTION

The effects of environmental temperatures on laying hen's performance are of major importance, especially in a country like Saudi Arabia where temperature in most parts of the Kingdom exceeds 40°C during summer time. The effect of environmental temperature on blood parameters of local birds has not been well established in the literature. This work was an attempt to study the effect of seasonal temperature variations on hematological components and chemical constituents of the blood of local breed of Saudi Arabia, Naked neck breed and the white leghorn laying hens.

Many studies have reported that hematological and biochemical values of many species of birds during summer season, such as Simaraks *et al*. (2004) and Pampori and Iqbal (2007) for Asian birds, Ladokun *et al*. (2008) for African birds. Shawer *et al*. (1984) found that there was a highly significant breed, sex and age effects on Red blood cells (RBC) of Saudi Baladi chickens. The hemogram estimate of these RBC fell within the normal range and was 2.499 X 10^6/mm^3, they further added. Also, Hocking *et al*. (1994) noted that most of heat stress-susceptible group exhibited a larger number of smaller erythrocytes. Based on study by, Gross and Siegl (1983), number of lymphocytes and total leucocytic count in chicken blood samples decreased and the number of hetrophils increased in response to heat stresses. El-Bahy and Nadia (1994) reported that the hematocrit value in naked neck hens was lower than that in Egyptian Dandarawy hens. Effect of season was studied by Kotby and Bakir (1987) who found that season of the year influenced hematocrit values in the growing chickens where the highest observed during winter (32.82%) and the lowest during summer (29.98%). Albokhadaim (2012) determined the hematological and biochemical values of indigenous chickens in Al-Ahsa area of Saudi Arabia during summer season. He found that erythrocyte counts, total leucocytes counts and packed cell volume were significantly higher in male than female chicks and were not age dependent. Breed effect varied among researchers. While Soliman (1988) found average value of hemoglobin in fayoumi birds at sexual maturity was the lowest, El-Bahy and Nadia (1994) found no significant breed effect on blood hemoglobin, mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), between the Dandarawi and necked neck birds, however, He found a significant effect on MCH, where the Dandarawi hen was higher than the naked neck breed. Similarly, Ladokun *et al*. (2008) found no significant differences between the genotypes in the mean values of white blood cells (WBC), (MCV), (MCHC), however, naked neck cocks were significantly superior in packed cell volume (PCV), haemoglobin and RBC when compared with their normally feathered counterparts. Similar results by El-Safty *et al*. (2006) who reported that naked neck was superior in PCV compared to that of the fully feathered birds.

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Serum of glucose was affected by season of the year. Attia *et al.* (1978) recorded a seasonal variation in blood glucose levels in different breeds of hens. Kotby and Bakir (1987) observed that glucose levels of growing chicks in winter, spring, summer and autumn were 264.91, 291.07, 287.10 and 274.05, respectively.

Many studies documented the levels of total protein in the serum of fowls. Ladokun *et al.* (2008) found no significant differences in total protein, albumen, urea, glucose and cholesterol of the genetic groups. Similar results were obtained by El-Bahy and Nadia (1994) who found that differences in total plasma protein due to breed were not significant. Effect of season on plasma cholesterol was significant. Ibraheem (1987) reported that the mean values of total plasma proteins, albumin, globulin and albumen/globulin ratio in Fayoumi chickens at 131 and 219 days of age ranged from 5.6 to 6.8, 2.3 to 2.6, 3.3 to 4.2 g/100 mL and 0.7 to 0.6 g/10 mL of plasma, respectively. Falta *et al.* (1987) reported a significant decrease in blood cholesterol concentration from 160.6 to 147.9 mg/100mL with the increase of ambient temperature. On the contrary, Tawfik (1982) found no significant differences in the concentrations of blood cholesterol between summer and winter.

This study was an attempt to determine the blood constituents of two local breeds of layers, Saudi local (SL), naked neck (NN) and the single comb white leghorn layers (WL) when subjected to seasonal variation in ambient temperatures.

MATERIALS AND METHODS

A total of 91 hens of two local of hens (naked neck and Saudi Local) plus an exotic white egg laying hens (white leghorn) at 20 weeks of age were used in this study. These were divided in to 29 hens of naked neck, 34 hens of Saudi local and 28 of white egg laying hens. They were randomly distributed among 12 pens, each of 9 to 10 birds of each breed. This resulted into 4 replications (pens) per breed. One to 1.5 mL of blood was collected on a monthly basis from the hens. Five birds from each breed were selected at random for bleeding purpose. The experiment continued for summer (period 1, where average temperature is 40°C and winter season (period 2, where average temperature is 25°C).

Blood was taken by sterile disposable needles and syringes from the wing vein of the hen and transferred to a dry bottle containing ethylene diamine tetra-acetic acid (EDTA) an anticoagulant. These samples were then taken to the laboratory to perform the chemical analysis. The total RBC and WBC counts were carried out by Natt and Herrick's method (1952) using diluting pipette and Natt Herrick solution. The method used for the determination of hemoglobin was the cyanomethemoglobin method that adopted by Van Kampen and Zijstra (1961).

When anticoagulant was added to a blood sample and centrifuged, the space occupied by the packed red blood cells was termed the hematocrit or PCV and expressed as the percentage of red cells in volume of whole blood. The hematocrit value was determined by micro-hematocrit tubes (length 75 mm; inner diameter, 1.2 mm; wall thickness. 0.20 mm).

The MCV refers to the average volume of the RBC = MCV (fi)= Hematocrit X 10/RBC count (millions/mm^3). The MCH refers to the average weight of hemoglobin in the RBC and was estimated as follows:

MCH (pg) = Hemoglobin X 10/RBC count (million/mm^3)

The MCHC, represent the average concentration of hemoglobin in the red blood cells. It was estimated by the ratio of hemoglobin weight to the volume of red blood cell as follows:

MCHC (%) = Hemoglobin in g/dL/hematocrit value X 100

Estimation of glucose, total protein, blood urea nitrogen, total bilirubin, uric acid, creatinine, cholesterol, triglycerides, calcium, phosphorus, sodium and potassium, were performed. Data of this experiment were subjected to the analysis of variance using the general linear models (GLM) procedure of SAS® (SAS, 2010). Means were compared using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The results of this study indicated a significant breed X period interaction only on blood triglycerides. Hemoglobin data, presented in Table 1, showed no significant interaction between period and breed. Neither was any significant breed effect or period effect. Hemoglobin values were 8.8, 8.7 and 8.6 g/100 mL for NN, SL and WL, respectively. These results agreed with the results of Albokhadaim (2012) who compared Saudi local chickens of different ages and sexes in hot weather. He found that hemoglobin and blood indices were not significantly ($p>0.05$) differed in all birds. Similarly, mean values of MCV, MCH and MCHC were not significantly different between genotypes, but NN roasters had significantly higher PCV, hemoglobin (HB) and RBC (Ladokun *et al.*, 2008). Oke *et al.* (2007) agreed and reported similar findings. However, this result disagreed with Shawer *et al.* (1984), who found highly significant breed effect on hemoglobin in Saudi Baladi (local) as compared with the White Leghorn. Average PCV of the three breeds were significantly lower at summer period compared to winter period. This could be due to the lower RBCs concentration of these birds during summer period (Table 1). This Table also revealed that the WBC counts were not significantly affected by breed of the chicken. Ladokun *et al.* (2008)

Table 1: Effect of seasonal temperature on some hematological traits

Treatments	Red blood cells (10^6/mm^3)	HB (g/dl)	Packed cell volume (%)	White blood cells (10^3/mm^3)	Mean corpuscular volume (f1)	Mean corpuscular hemoglobin (pg)	Mean corpuscular hemoglobin concentration (%)
P X B	NS	NS	NS	NS	NS	NS	NS
1 NN	2.54±0.3	8.85±1.0	22.75±1.2	33.96±5.4	85.16±9.2	33.10±5.8	40.34±2.3
1 SL	2.48±0.3	8.40±1.1	22.17±1.6	30.45±5.2	85.94±9.7	36.58±9.2	40.35±5.3
1 WL	2.50±0.3	7.96±1.6	21.20±2.2	31.62±5.2	84.64±13.8	30.81±5.8	37.51±6.1
2 NN	2.97±0.4	8.82±1.6	23.27±2.4	23.48±3.4	79.91±14.9	30.22±6.9	38.32±8.2
2 SL	2.79±0.6	8.87±2.5	23.24±2.2	21.47±5.0	86.28±17.9	32.69±10.7	38.61±11.5
2 WL	3.00±0.5	9.09±1.9	22.98±1.3	21.84±4.9	78.39±13.4	30.86±7.4	39.63±8.3
Among breeds	NS	NS	NS	NS	NS	*	NS
NN	2.800^a	8.83^a	23.12^a	27.67^a	81.41^a	31.48^{ab}	38.83^a
SL	2.676^a	8.70^a	22.98^a	24.77^b	86.22^a	34.10^a	38.99^a
WL	2.798^a	8.60^a	22.20^a	25.81^b	80.95^a	30.95^b	38.71^a
Between periods	**	NS	*	**	NS	NS	NS
1	2.508^a	8.38^a	21.87^a	32.14^a	85.03^a	33.43^a	38.85^a
2	2.921^b	8.92^a	23.17^b	22.31^b	81.17^a	31.26^a	38.82^a

Means within each column, having different superscript are significantly different
P X B: Period X breed, NN: Naked neck, SL: Saudi local breed, WL: White leghorn
Average temperature of period 1 = 40 c (33.8-42.5 c), representing the months of Jun., July., Sep. and Oct
Average temperature of period 2 = 25 c (21.4-29.5 c), representing the months of Nov., Dec., Jan., Feb., Mar. and Apr
*Significant, p<0.05, **Significant, p<0.01. NS not significant, p>0.05

Table 2: Effect of seasonal temperature on some chemical constituents of the chickens blood

Treatments	Glucose Mg/dl	Total protein Mg/dl	Blood urea nitrogen Mg/dl	Total bilirubin Mg/dl	Uric acid Mg/dl	Creatinine Mg/dl
P X B	NS	NS	NS	NS	NS	NS
1 NN	241.5±12.1	6.54±0.7	1.17±0.62	0.33±0.13	12.12±0.5	3.15±0.4
1 SL	232.4±11.8	5.30±0.4	0.97±0.64	0.34±0.12	8.40±0.6	3.08±0.4
1 WL	231.2±13.1	4.90±0.4	1.20±0.73	0.29±0.22	7.94±0.9	3.18±0.5
2 NN	267.5±17.1	5.38±0.3	1.59±0.70	0.44±0.16	7.57±0.8	2.90±0.5
2 SL	269.7±13.6	5.37±0.3	1.44±0.63	0.43±0.19	7.98±1.1	2.79±0.5
2 WL	264.5±14.5	5.16±0.3	1.67±0.63	0.36±0.15	8.16±1.1	2.79±0.6
Among breeds	NS	NS	*	**	NS	NS
NN	255.32^a	6.04^a	1.37^{ab}	0.38^a	9.80^a	3.02^a
SL	253.50^a	5.33^a	1.21^b	0.38^a	8.20^a	2.92^a
WL	248.38^a	4.99^a	1.42^a	0.32^b	8.01^a	3.02^a
Between periods	**	NS	**	**	NS	**
1	235.06^a	5.51^a	1.12^a	0.32^a	8.53^a	3.14^a
2	267.31^b	5.30^a	1.56^b	0.41^b	7.41^a	2.83^b

Means within each column, having different superscript are significantly different
P X B: Period X breed, NN: Naked neck, SL: Saudi local breed, WL: White leghorn
Average temperature of period 1 = 40 c (33.8-42.5 c), representing the months of Jun., July., Sep. and Oct
Average temperature of period 2 = 25 c (21.4-29.5 c), representing the months of Nov., Dec., Jan., Feb., Mar. and Apr
*Significant, p<0.05, **Significant, p<0.01. NS not significant, p>0.05

Table 3: Effect of seasonal temperature on some chemical constituents of the chickens blood

Treatments	Cholesterol Mg/dl	Triglycerides Mg/dl	Calcium Mg/dl	Phosphorus Mg/dl	Sodium Mg/dl	Potassium Mg/dl
P X B	NS	*	NS	NS	NS	NS
1 X NN	113.2±20	897.8±57	24.32±2.0	4.78±0.9	367.6±15	20.1±1.5
1 X SL	114.1±20	863.1±50	23.80±1.9	4.07±1.1	369.4±14	19.5±1.5
1 X WL	120.8±12	985.8±206	23.34±1.8	4.65±0.9	366.1±16	19.2±1.5
2 X NN	112.1±10	1003.1±96	25.00±2.3	5.08±0.8	374.4±11	18.8±1.4
2 X SL	115.7±10	1042.5±206	25.37±2.4	4.70±0.9	370.1±10	18.7±1.0
2 X WL	113.6±11	887.7±182	24.26.1.8	5.24±0.7	371.9±12	18.8±1.2
Among breeds	NS	NS	NS	*	NS	NS
NN	112.77^a	954.50^a	24.61^a	4.97^a	370.47^a	19.60^a
SL	114.77^a	1029.67^a	24.69^a	4.45^b	369.73^a	19.14^a
WL	117.59^a	918.35^a	23.68^a	4.96^a	368.75^a	19.07^a
Between periods	NS	NS	**	**	**	**
1	115.65^a	931.54^a	23.81^a	4.50^a	367.80^a	19.63^a
2	113.92^a	978.68^a	24.96^b	5.01^b	372.11^b	18.78^b

Means within each column, having different superscript are significantly different
P X B: Period X breed, NN:Naked neck, SL: Saudi local breed, WL: White leghorn
Average temperature of period 1 = 40 c (33.8-42.5 c), representing the months of Jun., July., Sep. and Oct
Average temperature of period 2 = 25 c (21.4-29.5 c), representing the months of Nov., Dec., Jan., Feb., Mar. and Apr
*Significant, p<0.05, **Significant, p<0.01. NS, not significant, p>0.05

reported similar results. However, Shawer *et al.* (1984) reported a highly significant breed effect on WBCs in SL as compared with WL. The counts of this study were found to be slightly higher in NN breed than those of SL and WL breeds. This result disagreed with Shawer *et al.* (1984). Average counts of the three breeds were significantly higher in summer period compared to the counts in winter period. No significant breed effect was found on MCV, neither was any significant interaction nor period effect. However, numerically there was an indication that cold weather reduced the MCV, regardless of the breed (Table 1). These results were consistent with findings of Ladokun *et al.* (2008), who found that there were no significant differences between genotypes in the mean values of WBC, MCV and MCHC. The MCH value of this study was found to be significantly higher in SL than those of the NN and WL breeds. This result agreed with Shawer *et al.* (1984). No significant difference in MCHC was found among breeds or periods or their interactions (Table 3). The mean values of the MCHC of NN, SL and WL breeds at summer period were 40.34, 40.35 and 37.51, respectively. El-Bahy and Nadia (1994) reported that MCHC of naked neck breed was 25.80%.

Data on Table 2 showed no significant effect of breed or period X breed on serum glucose. However, there was a tendency for NN hens to have the highest serum glucose during the hot season. Regardless of breed or season, average glucose level of the breeds was significantly higher in winter period. It was possible that birds during winter period try to release more glucose in blood to cover for the extra energy needed to maintain their body temperature. Kotby and Bakir (1987) reported lower glucose level during winter in growing chicks. Total protein data showed no significant differences among breeds or between periods (Table 2). Similar findings were reported by Ladokun *et al.* (2008) and El-Safty *et al.* (2006) who found no significant differences in total protein, albumen, urea, glucose and cholesterol of the genetic groups. However, numerically there was a tendency for the NN hens to have the highest total protein value during the hot season. Shawer *et al.* (1984) reported that the baladi (local) chickens surpassed leghorn in total serum protein. Research of Crawley *et al.* (1980) showed that total protein values were higher during summer than those obtained during winter.

Blood urea nitrogen (BUN) was significantly affected by breed (Table 2). It was noticed that the WL breed had the highest value and significantly different from the SL breed. Average blood urea nitrogen (BUN) level of the breeds was significantly higher in winter period. The increase in BUN during the winter could be attributed to the increased level of protein catabolism due to higher feed intake.

The data presented in (Table 2) revealed no significant interaction between period and breed. In general, serum total bilirubin of the three breeds was significantly lower in summer period. Bilirubin content of WL serum was the lowest and significantly different from the other breeds. Likewise, the interaction between breed and period was not significant on blood uric acid. However, average uric acid of the breeds was slightly lower in winter period. It seems that birds were excreting more nitrogen as uric acid in the summer period.

Table 2, also revealed no significant interaction between period and breed on blood creatinine. However, average blood creatinine of the three breeds was significantly higher in summer period. Numerically creatinine was found to be higher in WL breed than those of the SL and NN breeds in summer period.

Cholesterol level in the blood had no significant effect on the interaction between period and breed (Table 3). Likewise, average cholesterol level of the three breeds was numerically higher in period 1 (hot). Cholesterol level was found to be numerically lower in NN breed than that of SL and WL breeds in summer and winter periods. The results of the present investigation were in agreement with those reported by Ladokun *et al.* (2008) and Elagib *et al.* (2012), who proved that genotype has no significant effect on blood cholesterol.

Average total serum calcium of the three breeds was significantly lower in summer period compared to that in winter period. Similar results were obtained by Elagib *et al.* (2012). Numerically, calcium level was found to be higher in NN breed than those of the SL and WL breeds in summer period (Table 3). Shawer *et al.* (1984) reported no significant effect of breed on blood calcium between SL and WL breed. Likewise, Elagib *et al.* (2012) provided evidence that plasma total protein, inorganic phosphorus, uric acid, sodium and potassium were significantly ($p<0.05$) different among three ecotypes. Average serum phosphorus of the three breeds was significantly lower in period 1 (Table 3). Vo *et al.* (1978) found that plasma phosphorus decreased with increasing ambient temperature from 21-35°C. The average phosphorus level of the SL breed was significantly lower than those of the NN and WL breeds. The levels of total serum phosphorus of NN, SL and WL breeds in summer period were; 4.78, 4.07 and 4.65 mg/100 mL, respectively. Total serum sodium and potassium in Table 3, showed no significant interaction between period and breed. However, average serum sodium of the three breeds was significantly lower in summer period, while average serum potassium of the three breeds was significantly higher in summer period. Numerically sodium level was found to be lower in WL breed than those of the SL and NN breeds, while potassium level was higher in NN than those of the SL and WL in summer period. Shawer *et al.* (1984) found a significant breed effect on total serum sodium and potassium in SL as compared to the white leghorn.

Conclusion: It was concluded that most of the blood parameters in this study were not affected by breed of

the chicken, however, the effect of season was evident on RBC, PCV, WBC, glucose, BUN, total bilirubin, creatinine, calcium, phosphorus, sodium and potassium. Most of these traits were lower in the summer season except WBC which was much higher. This study can be used as a comparative study to a future research in this area.

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REFERENCES

Albokhadaim and Ibrahim, 2012. Hematological and Some Biochemical Values Of indigenous chickens in A-Ahsa, Saudi Arabia during summer season. Asian J. Poult. Sci., 6: 138-145.

Attia, F.M., N.F. Abd El-Hakim and S.E. El-Sharkawy, 1978. Effect of diet, season and sex on blood cholesterol and glucose in Fayoumi chickens. Agric. Res. Rev., 56: 35-45.

Elagib, Hind A.A., D.A. Abuaglla, Ahmed, Khalid Mohammed Elamin and Huwaida E.E. Malik, 2012. Blood Biochemical Profile of Males and Females of Three Indigenous Chicken Ecotypes in Sudan. J. Vet. Adv., 2: 568-572.

El-Bahy and M.A. Nadia, 1994. Productivity of two local domestic fowl breeds under semi-tropical conditions. M.Sc. thesis, Fac. of Agric., Cairo Univ., El-Fayoum, Egypt.

El-Safty, S.A., U.M. Ali and M.M. Fathi, 2006. Immunological parameters and laying performance of naked neck and normally feathered genotypes of chicken under winter conditions of Egypt. Int. J. Poult. Sci., 5: 780-785.

Crawley, S.W., R.D. Sloan and K.K. Hale Jr., 1980. Yields and composition of edible and inedible by-products of broilers processed at 6, 7 and 8 weeks of age. Poult. Sci., 59: 2243-2246.

Duncan, D.B., 1955. Multiple range and F-tests. Biomet., 11: 1-42.

Falta, A.A., A.K.I. Abd El-Moty and Kh. A. Mohamed, 1987. The effect of exposure at 40°C on the physiological response of the domestic fowl maintained at 16°C. Minia Res. and Rev., 383-398.

Gross, W.B. and H.S. Siegel, 1983. Evaluation of hetrophil/lymphocyte as a measurement of stress in chickens. Avian Disease, 27: 972-979.

Hocking, P.M., M.H. Maxwell and M.A. Mitchell, 1994. Haematology and blood composition at two ambient temperatures in genetically fat and lean adult broiler breeder females fed ad libitum or restricted throughout life. Br. Poult. Sci., 35: 799-807.

Ibraheem, A.S.S., 1987. Virginiamycin as growth promoter and its effect on physiological patterns of egg production in some local poultry breeds. M.V. Sc. Thesis, Faculty of Vet. Med. Cairo University.

Kotby, E.A. and A.A. Bakir, 1987. Genetic and environmental influence on some blood components in growing chicks. Agric. Reser. Rev., 65: 795-802.

Ladokun, A.O., A. Yakubu, J.R. Otite, J.N. Omeje, O.A. Sokunbi and E. Onyeji, 2008. Haematological and serum biochemical indices of Naked Neck and normally feathered Nigerian indigenous chickens in a Sub Humid tropical environment. Int. J. Poult. Sci. 7: 55-58.

Natt, M.P. and C.A. Herick, 1952. A new diluent for counting the erythrocyets and leucocytes of the chicken. Poult. Sci., 31: 735.

Oke, U.K., U. Herbert, C.O. Ebuzoeme and E.N. Nwachukwu, 2007. Effect of genotype on the haematology of Nigerian local chickens in a humid tropical environment In: Proc. 32nd Annual Conference of NSAP. Calabar, Nigeria 18th-21st March, pp: 123-125.

Pampori, Z.A. and S. Iqbal, 2007. Haemetalogy, serum chemistry and elecrocardiographic evaluation in native chicken of Kashmir. Int. J. Poult. Sci., 6: 578-582.

SAS institute, 2010. SAS/STAT® User's Guide: SAS Institute Inc., Cary, N.C.

Shawer, M.F., A.A. Al-Sobayel, H.A. Hussein and Hassan, 1984. A comparison of some blood biochemical and chemical constituents of Baladi and Leghorn chickens. Seventh symposium on the biological aspects of Saudi Arabia, Al-Qaseem, SA, 20-22 March, 1984: Program and Abstracts, 88-89.

Simaraks, S., O. Chinrasri and W. Aengwanich, 2004. Hematological, electrolyte and serum biochemistry values of the thai indigenous chickens (Gallus domesticus) in northeastern, Thailand. Songklanakarian J. Sci. Tecnol., 26: 425-430.

Soliman, E.B., 1988. The relationship between production and haemoglobical picture in layibg hen. M.Sc., Thesis Fac., Agric., Minia Univ., ElMinia, Egypt.

Tawfik, M.S.M., 1982. A study on heat tolerance of chicken in upper Egypt. Ph.D. Thesis, Faculty of Agric. Minia Univ., El-Minia, Egypt.

Van Kampen, E.J. and W.G. Zijstra, 1961. Clin. Cheim. Acta, 6: 538. International Committee of standardization in Hematology, 1967. Recommendation for hemoglobinometry in human blood. Br. J. Heamtol., 13: 71.

Vo, K.V., M.A. Boon and W.E. Johnston, 1978. Effect of three life time ambient temperature on growth, feed and water consumption and various blood components in male and female Leghorn chickens. Poult. Sci., 57: 798-803.