International Journal of Animal and Livestock Production Research
Vol. 5, No.1, pp.1-9, 2021
Print ISSN: ISSN 2059-903X
Online ISSN: ISSN 2059-9048

THERMOTOLERANCE TRAITS AND MORTALITY LEVELS OF THREE STRAINS OF BROILERS IN HUMID TROPICS

***Fadare, A.O. and Famuyide H.O.**
Department of Animal and Environmental Biology, Adekunle Ajasin University, Akungba-Akoko Nigeria

ABSTRACT: *The tolerance of three temperate breeds of broilers to tropical heat condition was evaluated at the poultry unit of Department of Animal and Environmental Biology, Adekunle Ajasin University, Akungba-Akoko, Nigeria. One hundred and fifty (150) day-old broiler chicks comprising of Arbo acre, Cobb and Marshall breeds were raised under the same management condition for 8 weeks.Thermotolerance traits were measured and mortality of the broilers were recorded. Analysis of variance showed that Cobb broiler strain had the least cloacal temperature (40.89±0.03°C) followed by Arbo acre (41.06±0.05°C) while Marshall Broiler strain had the highest cloacal temperature (41.55 ± 0.06°C). Cobb strain also had the lowest respiratory rate (51.16 ± 0.15 breath/min).The respiratory rate of Marshall strain (56.80± 0.45 breath/min) was significantly higher than that of Arbo acre strain (54.63 ± 0.24 breath/min) . Marshall Strain had the highest pulse rate (73.50 ± 0.70 beats/min) while the least pulse rate (66.40 ± 0.47 beats/min) was found in Cobb breed. The least heat stress index was recorded for Cobb breed. The effect of strain was also significant on the mortality levels of the broilers. Marshall Strain had the highest total mortality percentage followed by Arbo acre while the least total mortality percentage was recorded for Cobb breed. The effect of age was significant on all the parameters studied ($p<0.05$).Young broilers were less tolerant to heat stress than older broilers. Mortality percentage also reduces with advance in age. The effect of sex was also significant on the thermotolerance traits. Females' broilers were less tolerant to thermal stress. In conclusion, there was genetic variation in the thermotolerance traits of broilers. Cobb strain tolerated heat stress better than Arbo acre and Marshall Strain in the humid tropics.*

KEY WORDS: heat tolerance, mortality, strain, broiler,

INTRODUCTION

Heat stress is one of the major challenges facing the poultry industry in tropical and sub-tropical regions (Al-Tamini *et al.*,2019). It results from a negative balance between the net amount of energy flowing from the animal body to its surrounding and the amount of energy produced by the animal. This imbalance may be caused by variations of combination of environmental factors (temperature, air movement and humidity) and the animal metabolic rate (Lara and Rostagno, 2013). Birds, like mammals are homoeothermic, they produce heat to maintain a relatively constant body temperature and may permit certain variations within their temperature range Adedeji *et al.* (2015). For birds to perform at the optimum capacity they need to be in homeostasis with their

Vol. 5, No.1, pp.1-9, 2021

Print ISSN: ISSN 2059-903X

Online ISSN: ISSN 2059-9048

environment through the maintenance of thermobalance. (Zerjal *et al.* 2013) Broiler birds are very sensitive to high environmental temperature. (Attia *et al* 2018). Heat tolerance of strains selected for rapid growth is lower than that of slow growing strains and the continuous selection for fast growth seems to be associated with increased susceptibility of broiler chickens to heat stress (Soleiman *et al*., 2011)

Thermal stress has negative effects on the productivity and welfare of poultry (Guerreiro *et al.* 2004). It causes negative effects on the growth performance, immunosuppression and livability contributing to a decrease in productivity (Nassar and Elsherif, 2018; Attia *et al*. 2017). Al-Fataftah and Abu-Dieyeh (2007) reported that heat stress decreases the consumption of feed. Heat stress affects water intake (Bruno *et al*.,2011) and growth performance (Abu- Dieyeh 2006). The investigation of Attou and Homrani (2017) showed that thermal stress reduces body weight, lowers feed conversion ratio, and increases mortality in broilers. According to Roushdy *et al.* (2018), thermal stress decreased the dressing percentage in broilers. Radwan *et al.* 2018 and Attia *et al*. (2017) also reported that heat stress has adverse effect on dressing yield and carcass traits. Heat stress has adverse effects on immune system Mashaly *et al.* (2004) . Bartlett and Smith (2003) observed that broilers subjected to heat stress had lower levels of total circulating antibodies as well as lower specific IgM and IgG levels both during primary and secondary humoral response. Thermal stress has adverse effect on heamatological and immunological traits of broilers (Attia *et al*., 2017).The stress caused by heat affects broilers which may cause significant mortality rates (Vale *et al*. 2010). The reports of Guerreiro *et al*. 2004 and Keambou *et al.* (2014) also showed that heat stress increases morbidity and mortality of broilers

Thermotolerance is an important trait in poultry production.The ability of an animal to maintain homeostasis under heat stress is a valuable trait in the sub- tropical and tropical region (Isidahomen *et al.*, 2012). Exotic chicken are less tolerant to heat stress than the local breeds which are well adapted to the climatic condition (Keambou *et al.* 2014; Isidahomen *et al.*, 2012). There is a need to raise genetic lines (breeds) that can withstand hot climatic conditions (Duanginda *et al*., 2017). Lara and Rostagno (2013) also advocated for genetic selection of strain with increased capacity of coping with heat stress apart from ameliorating methods for the stress. This study was therefore carried out to determine the thermotolerance and mortality levels of Marshall, Cobb and Arbo acre breeds of broilers raised in tropical condition.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Poultry unit of the Department of Animal and Environmental Biology, Adekunle Ajasin University Akungba-Akoko, Ondo State. . Akungba–Akoko is located in Akoko South West Local Government Area of Ondo state, Nigeria. The area lies in the south western region of Nigeria (7º 28ˈ and 5º43ˈ) according to Geographical Positioning System (GPS) and has the following environmental condition: ambient temperature of 27^{0}C and relative humidity of 46mm Hg.

Experimental animals and management

One hundred and fifty (150) day-old broiler chicks comprising of Arbo acre, Cobb and Marshall breeds were used for the study. The chicks were brooded for four weeks using charcoal stove as source of heat. They were fed with broiler starter mash diet containing 2700Kcal/kg metabolizable energy and 23% crude protein from day old to 4 weeks of age. They were later fed with broiler finisher diet containing 2950Kcal/kg metabolizable energy and 20% crude protein. The birds had free access to clean water throughout the period of the experiment. The vaccination schedule for gumboro and lasota vaccines were strictly adhered to and adequate medical attention was given to unhealthy birds.

Data collection

Cloacal temperature

This was taken on the broiler using a digital thermometer. The sensory tip was disinfected and inserted into the cloacal at the display of L^{o}C by the thermometer. This was removed after the sound of the thermometer alarm signal. The displayed body temperature was then recorded.

Respiratory rate

This was determined by counting the number of movements of the abdominal region per minute.

Pulse rate

This was determined for each broiler by placing the fingertips on the femoral arteries of the thigh for one minute.

Heat Stress index (HIS)

HIS was derived from the relationship between pulse rate and respiratory rate together with their normal average values. The formula is as follows:

H= (AR/AP) * (NP/NR)

H= Heat stress index

AR= Average respiratory rate value

AP= Average pulse rate value

NP= Normal pulse rate value

NR= Normal respiratory rate value

(Oladimeji *et al* ., 1996)

Mortality percentage

Dead birds from each strain were identified with their sex, isolated from each flock and buried. The percentage mortality was calculated as a ratio of dead birds to live birds .

$$\text{Mortality \%} = \frac{\text{Number of dead broilers}}{\text{Total number of live broilers}} \times 100$$

Vol. 5, No.1, pp.1-9, 2021
Print ISSN: ISSN 2059-903X
Online ISSN: ISSN 2059-9048

Statistical analysis
Data obtained from the measurements were subjected to analysis of variance (SAS 2010).

RESULTS AND DISCUSSION

The means and standard error of means of the thermotolerance traits as affected by strain presented on Table 1 shows that there was significant difference ($p<0.05$) in the cloaca temperature, respiratory rate, pulse rate and heat stress index of broiler chicken. Cobb broiler strain had the least cloacal temperature value (40.89±0.03°C) followed by Arbo acre (41.06±0.05°C) while Marshall broiler strain had the highest cloacal temperature value (41.55 ± 0.06°C). Radwan *et al (*2018) also reported the significant effect of strain on heat tolerance of broilers. When the physiological mechanism of a bird fails to negate the excessive heat load, the cloacal temperature increases.Cloacal temperature and respiratory rate are important heat stress indicators.

Cobb strain also had the lowest respiratory rate (51.16 ± 0.15 breath/min). This was in line with the report of Roushdy *et al*. (2018) that indicators of heat stress was less prominent in Cobb broiler chicken. The respiratory rate of Marshall strain(56.80± 0.45 breath/min) was significantly higher than that of Arbo acre strain(54.63 ± 0.24 breath/min) . The increase in the respiratory rate during heat stress enables the bird to dissipate excess body heat (Al Fataftah and Abu- Dieyeh, 2007).

Table 1. Thermotolerance traits and Mortality % as affected by strain

Parameters	Cobb	Marshall	Arbor acre
Cloacal Temperature (°C)	40.89 ± 0.03^c	41.55 ± 0.06^a	41.06 ± 0.05^b
Respiratory rate (breath/min)	51.16 ± 0.15^c	56.80 ± 0.45^a	54.63 ± 0.24^b
Pulse rate (beat/min)	66.40 ± 0.47^c	73.50 ± 0.70^a	70.84 ± 0.53^b
Heat Stress index	1.74 ± 0.02^c	2.14 ± 0.03^a	1.98 ± 0.05^b
Mortality (%)	4.00 ± 0.00^c	12.00 ± 0.00^a	6.00 ± 0.00^b

^{abc} Mean on the same row with different superscripts are significantly ($p< 0.05$) different.

Vol. 5, No.1, pp.1-9, 2021
Print ISSN: ISSN 2059-903X
Online ISSN: ISSN 2059-9048

Heat loss mechanism begins to shift to panting when the environmental temperature reaches more than 25^{o}C . Birds have to increase their evaporative losses to maintain body temperature and therefore start to breath more rapidly and panting. (Azoulay *et al*., 2011). The pulse rate values ranged from 66.40 ± 0.47 beats/min to 73.50 ± 0.70 beats/min . Marshall strain had the highest pulse rate while the least pulse rate was found in Cobb strain as presented on Table 1. Genetic variation accounted for the differences in the cloaca temperature, pulse rate and respiratory rate. The heat stress index is an indicator of thermotolerance. The lower the index , the better the animal is able to maintain homeostasis in hot condition (Isidahomen *et al*., 2012). The heat index of broiler chicken was significantly ($p<0.05$) affected by breed. Cobb strain also had the least heat index. Cobb strain tolerated heat stress better than Arbo acre and Marshall breed. Radwan *et al*. (2018) reported that Cobb strain tolerated heat stress than Ross breed. (Al-Batshan 2002) also reported that strain of broilers have significant effect on heat tolerance as Hubbard strain are more susceptible to heat stress than Isa strain. The effect of strain was also significant on the mortality levels of the broilers. Marshall strain had the highest total mortality percentage followed by Arbo acre while the least total mortality percentage was recorded for Cobb strain in this study as shown on Table 1. Awobajo *et al*. (2007) reported that mortality rate in broiler is significantly affected by strain and that Arbor acre strain had higher mortality rate than Anak strain

Table 2 shows the means and standard error of means the thermotolerance traits as affected by age. The effect of age was significant on all the parameters studied ($p<0.05$). The least cloacal temperature (40.42±0.03^{o}C) was recorded in the first two weeks of life (0-2weeks) of the broilers. The cloacal temperature increases with age and the highest cloacal temperature was recorded at 6-8 weeks. The respiratory rate and pulse rate followed the same pattern as the cloacal temperature. The least respiratory rate (53.33 ± 0.15 breath/min) and pulse rate (65.60± 0.12 beats/min) were recorded for the broilers in the first two weeks of life and these increase with advance in age as presented on Table 2. However, heat stress index (the relationship between pulse rate and respiratory rate together with their normal average values) decreases with advance in age . The highest heat stress index was estimated for broilers at 0-2 weeks while the least was recorded at 6-8 weeks. The work of Al-Batshan (2002) also showed that age of broilers had significant effect on heat tolerance. Older broilers are more tolerant to heat stress when compared with young broilers. Mortality percentage was significantly($p<0.05$) affected by age. The percentage reduces with advance in age. The highest mortality percentage was recorded in the first 2 weeks while the least was recorded at 6-8 weeks. This corroborated the report from the investigation of Shepelo and Maingi (2014) which showed that mortality were highest in the first 2 weeks (0-14 days) and this decreases as the broilers advance in age. According to Yerpes *et al*. (2020), the first week of life of broiler chick is a sensitive period where many of the chicks system and organs are considered immature. During this period, stress factors negatively influence chick physiology and welfare .

Table 2: Thermotolerance traits and Mortality % as affected by age

Parameters	0-2 weeks	2-4 weeks	4-6 weeks	6-8 weeks
Cloacal Temperature (°C)	40.42 ± 0.04[d]	41.12 ± 0.02[c]	41.32± 0.01[b]	41.56 ± 0.03[a]
Respiratory rate (breath/min)	53.33 ± 0.31[d]	55.17 ± 0.85[c]	63.67± 0.66[b]	65.81 ± 0.45[a]
Pulse rate (beat/min)	65.60 ± 0.20[d]	66.05 ± 0.35[c]	76.50± 0.61[b]	80.04 ±0.60[a]
Heat Stress index	1.99 ±0.02 [a]	1.86 ± 0.01[b]	1.72± 0.03 [c]	1.71 ±0.02[c]
Mortality (%)	12.00 ± 0.00[a]	6.00 ± 0.00[b]	2.00 ±0.00[c]	2.00 ± 0.00[c]

[abcd] Mean on the same row with different superscripts are significantly ($p< 0.05$) different.

The cloaca temperature, respiratory rate, pulse rate and heat stress index of broiler chicken of male and female broilers presented on Table 3 showed that female broilers had higher values for these physiological traits. Female broilers are less tolerant to thermal stress. Adedeji *et al*. (2015) also reported that chicken sex had significant effect on pulse rate and respiratory rate with females having higher physiological values.

TABLE 3: Thermotolerance traits and Mortality % as affected by sex

Parameters	Male	Female
Cloacal Temperature (°C)	40.66 ± 0.03[b]	41.10 ± 0.02 [a]
Respiratory rate (breath/min)	49.00 ± 0.20[b]	53.33 ± 0.41[a]
Pulse rate (beat/min)	66.80 ± 0.95[a]	66.00 ± 0.30[a]
Heat Stress index	1.67 ± 0.05 [b]	1.80 ± 0.06[a]
Mortality (%)	12.00 ± 0.00[a]	10.00 ± 0.00[a]

[a b] Mean on the same row with different superscripts are significantly ($P<0.05$) different

The total mortality percentage of male broilers was not significantly different from that of female broilers. Yerpes *et al*., (2020), however reported that chick mortality was significantly affected by gender and strain

CONCLUSION

Genetic variation existed in the thermotolerance traits of broilers. Cobb broiler strain had the least cloacal temperature value while Marshall broiler strain had the highest cloacal temperature. Cobb strain also had the lowest respiratory and pulse rate. The heat index of broiler chicken was significantly affected by breed. Cobb strain also had the least heat index. Cobb strain tolerated heat stress better than Arbo acre and Marshall breed. The effect of strain was also significant on the mortality levels of the broilers. Marshall strain had the highest total mortality percentage followed by Arbo acre while the least total mortality percentage was recorded for Cobb breed.

The effect of age was significant on all the parameters studied. Heat stress index reduces with age in broilers. Young broilers were less tolerant to heat stress than older broilers. Mortality percentage also reduces with advance in age. The effect of sex was also significant on the thermotolerance traits. Females broilers are less tolerant to thermal stress.

References

Abu-Dieyeh, Z.H.M. (2006) Effect of high temperature on growth performance of broilers. *International Journal of Poultry Science* 5:19-21

Adedeji, T.A., Amao, S.R., Ogundairo, O.M. and Fasoyin, O.A. (2015) Heat tolerance attributes of Nigerian locally adapted chickens as affected by strain and some qualitative traits. *Journal of Biology Agriculture and Health care* 5(17): 50-55

Al-Batshan, H.A. (2002) Performance and heat tolerance of broilers as affected by genotype and high ambient temperature. *Asian -Australian Journal of Animal Science* 15(10) :1502-1506

Al-Fataftah, A.A. and Abu-Dieyeh, Z.H.M. (2007) Effect of chronic heat stress on broiler performance in Jordan. *International Journal of Poultry Science* 6: 64-70

Al-Tamini, H., Mahmoud, K., Al-Dawood, A., Nusairat, B. and Khalaf, H.B. (2019) Thermotolerance of broiler chicks ingesting dietary betaine and or creatine . *Animals* 9: 742-755

Attia, Y.A., Al-Harthhi, M.A., Al- Sharfey, A.S., Rehab, Y.A. and Kim, W.K. (2017). Enhancing tolerance of broiler chickens to heat stress by supplementation with Vitamin C and or probiotics. *Annals of Animal Science* 17(4):1155-1169

Attia,Y.A., Al-Harthi, M.A. and El-Nagger, A. (2018). Productive physiological and immunological responses of two broiler strains fed different dietary regimes and exposed to heat stress. *Italian Journal of Animal Science* 17(3): 686-697

Attou, S. and Homran, A. (2017) New approach for adaptation to high temperatures and its effect on the thermal resistance of broilers reared in Western Algeria. *Livestock Research for Rural Development* 29(5):1-5

Awobajo, O.K,. Akinrolabu, R.T., Mako, A.A. Igbosanu, A.O. and Olatokunbo, O.T. (2007) The mortality rate of two different breeds of broiler after brooding stage to maturity. *Middle -East Journal of Scientific Research* 2(1):37-42.

Azoulay, Y., Druyan, S., Yadgary, T., Hadad, Y. and Cahaner A. (2011) The variability and performance under hot conditions of featherless broilers versus fully feathered broilers. *Poultry Science* 90: 19-29

Bartlett, J.R. and Smith, M.O. (2003) Effects of different levels of zinc on the performance and immunocompetence of broilers under heat stress. *Poultry Science* 82: 1580-1588

Bruno, L.D.G., Majorka, A., Macari ,M., Furlan, R.L. and Givisiez, P.E.N. (2011) Water intake, behaviour of broiler chicken exposed to heat stress and drinking from bell and or nipple drinker. *Revista Brasileira de Ciencia Avicola* 13:147-152

Duanginda, M., Nunim, S., Duangdaen, C. and Boonkum, W. (2017) Hsp70 genotype and heat tolerance of commercial and native chickens reared in hot and humid conditions. *Brazilian Journal of Poultry Science* 19 (1):7-17

Guerreiro, E.N., Giacheto P.F., Givisiez, P.E.N., Ferro, J.A. Ferro, M.I.T. and Gabriel, J.E. (2004) Brain and Hepatic Hsp70 protein levels in heat acclimated broiler chickens during heat stress. *Revista Brasileira de Ciencia Avicola* 6:201-206

Isidahomen, C.E., Njidda, A.A. and Olatunji, E.A.(2012) Heat tolerance traits among local and exotic chickens in Southern Nigeria. *Journal of Agriculture and Veterinary Science* 1 (6):31-36

Keambou, T.C. Hako-Touko, B.A., Mboumba S., Mezui-Mezui, T., Toukala, J.P., Boukila, B. and Manjeli Y (2014) Resistance of local chicken and commercial broiler breeds to chronic heat stress in tropical environment: Effect on blood and physiological parameters. *International Journal of Applied Poultry Research* 3(2):28-32

Lara, L.J. and Rostagno, M.H. (2013) Impact of heat stress on poultry production *Animals* 3: 356-369

Mashaly, M.M. Hendricks G.L, Kalama, M.A., Gehad A.E, Abbas, A.O.and Patterson, P.H.(2004) Effect of heat stress on production parameters and immune responses of commercial laying hens. *Poultry Science* 83: 889-894

Nassar, F.S. and El-Sherif, H.R. (2018) Increasing heat tolerance in broiler by using thermal manipulation during embryonic development. *Approaches in Poultry, Dairy and Veterinary Sciences* 5(4):447-449

Oladimeji, B.S., Osinowo, O.A., Alawa, J. and Hambolu, J.O. (1996) Estimation of average values for pulse rate, respiratory rate,rectal temperature and development of heat stress index for adult Yankasa sheep. *Bulletin of Animal Health and Production* 45:105-107

Roushdy, E.M., Zaglool, A.W. and El- Tarabany, M.S. (2018) Effects of chronic thermal stress on growth performance indices and the expression of Hsp70, growth hormone and superoxide dismutase genes in two broiler strains. *Journal of Thermal Biology* 74 : 337-343

Radwan, L.M., Mahrous, M.Y. Alsenosy, N.K. and El-Sabry, M.I. (2018) Interaction between heat stress and early age on muscle development and related gene expression in two strains of broiler chicken *Asian Journal of Animal and Veterinary Advances* 13:309-315

Print ISSN: ISSN 2059-903X
Online ISSN: ISSN 2059-9048

SAS (2010). Statistical Analysis System. SAS Stat. Version 12. SAS Institute Inc. Gary NC 27513, U.S.A.
Shepelo, G.P. and Maingi, N. (2014) Major causes of poultry mortality in Nairobi and its environs established from autopsies. *Kenya Veterinarian* 38(1): 32-42
Soleimani, A.F., Zulkifli, I., Omarr, A.R. and Raha, A.R. (2011). Physiological response of three chicken breeds to acute heat stress. *Poultry Science* 90(7): 1435-1440
Vale, M.M., Moura, D.J., Naas, I.A., Pereira, D.F. (2010) Characterization of heat waves affecting mortality rates of broilers between 29 days and market age. *Brazilian Journal of Poultry Science* 12(4) 279-285
Yerpes, M., Lonch, P. and Manteca, X. (2020) Factors associated with cumulative first week mortality in broiler chicks. *Animals* 10: 310-322
Zerjal, I., Gourichon, D., Rivet, B. and Bordas, A. (2013) Performance comparison of laying hens segregating for the frizzle gene under thermoneutral and high ambient temperature. *Poultry Science* 92: 1474-1485