http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 9 (15): 2892-2896, 2006
ISSN 1028-8880

Heritability Estimates and the Interrelationships of Body Weight and Shank Length in Rhode Island Red and White Chickens

[1]M. Kabir, [2]O.O. Oni, [1]G.N. Akpa and [2]I.A. Adeyinka
[1]Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria
[2]National Animal Production Research Institute, Shika-Zaria, Nigeria

Abstract: Data on body weight and shank length measurement of 361 birds from 5 hatches, one week apart were analysed to obtain heritability estimates for body weight and shank length at 20, 30 and 40 weeks of age, as well as to establish the genetic and phenotypic correlations between the traits. The mean values for body weight at various ages showed good performance of all birds. The heritability estimates observed for body weight and shank length decreases with increasing age of birds. This observation agreed with the reports of some workers and disagreed with the findings of others. Differences however, in heritability estimates could be attributed to differences in method of estimation, breed, environmental effects and sampling error due to small data or sample size. There were positively high genetic and phenotypic correlations between body weight and shank length at these ages. The coefficient of genetic correlation (r_g) ranged between 0.582 and 0.645, while the coefficient of phenotypic correlation (r_p) ranged between 0.613 and 0.816. High and positive genetic and phenotypic correlations between body weight and shank length suggest that it was possible to predict body weight of live Rhode Island chickens on the basis of their shank length measurement, as an aid to farmers in areas where sensitive weighing scales are not readily available.

Key words: Rhode Island chicken, heritability, correlation, body weight, shank length

INTRODUCTION

The live body weight of any animal is an important variable that determines the market value of that animal. The exact time at which the animal is ready for slaughter can be assessed on the basis of its body weight and general development.

Reports on body weight and linear body measurements had been documented and was found useful in quantifying body size and shape (Ibe, 1989; Ibe and Ezekwe, 1994). Linear body measurements have been used to predict live weights in poultry (Chhabra *et al*., 1972; Monsi, 1992; Okon *et al*., 1997; Gueye *et al*., 1998), rabbit (Ekanno and Ibe, 2006), goat (Hassan and Ciroma, 1992; Ozoje and Herbert, 1987), sheep (Kandasamy and Gupta, 1983) and cattle (Orheruata and Olutogun, 1994). Body weights are shown to be influenced by maternal effect or dominance or both effects, up to maturity as indicated by consistently higher heritability estimates from dam variance component as opposed to those from sire components. Adeyinka *et al*. (2004) reported moderate heritability for body weights at various ages, but observed high heritability estimates for body weight at 56 days of age and finally suggested that selection for body weight at this age will improve body weight in subsequent generations. Chambers (1990) observed that heritability for body weight of broilers tends to increase with age. Oni *et al*. (1991) reported heritability estimates of 0.413 and 0.044, 0.387 and 0.279 for body weight at 16 and 20 weeks in two strains of chicken.

Prado-Gonzalez *et al*. (2003) reported positively low to moderate (0.07 to 0.21) additive direct heritability for 8 and 16 weeks old chickens and explained that low heritability could mean that dominance, epistatic and environmental effects are more important than genetic additive effects on body weight of Creole chicks. Differences in heritability estimates could be attributed to method of estimation, breed, environmental effects and sampling error due to small data set or sample size.

The use of shank length to predict live weight in poultry (Chhabra *et al*., 1972) is particularly important where scales are not readily available, as is the case in most African rural farming communities and meat markets (Mani *et al*., 1991; Nesamvumi *et al*., 2000).

Corresponding Author: Dr. Isaac Adetunji Adeyinka, National Animal Production Research Institute, Shika-Zaria, Nigeria
Tel: +2348068163290

This study is therefore carried out to determine the genetic and phenotypic relationship between body weight and shank length in two strains of Rhode Island chickens selected for Part-Year egg production as measured at 20, 30 and 40 weeks of age.

MATERIALS AND METHODS

The experiment was carried out at the poultry breeding unit of the National Animal Production Research Institute (NAPRI) Shika-Zaria. Shika is geographically situated between latitude 11° 12' N and longitude 7° 33' E at an altitude of 640 M above sea level (Akpa *et al*., 2002). It is located 22 km northwest of Zaria city and is vegetationally in the northern guinea savannah zone of Nigeria. The Shika climate is characterized by a well defined dry and wet seasons. The dry season lasts from mid-October to April and consists of a period of low relative humidity with strong, cold and dry northeast harmattan winds. Thereafter, the hot and dry weather follows with overcasting fine dust particles. The wet season begins in late April/early May and ends in late September/early October. The total annual rainfall ranges from 617 to 1365 mm with a 50-year average of 1041 mm and most of the rains fall between July and September (Oni *et al*., 1991).

The birds used in this study comprised of two strains of Rhode Island breeder hens (which herein shall be referred to as strain A-male line having red plumage-and strain B-female line with white plumage- for convenience). The stock was composed of 361 birds made up of 166 male line and 195 female line. They were brooded and reared to 18 weeks of age in deep-litter floor pens. Floor space allowed per bird varied from 0.15 to 0.50 m^2 depending on age of bird. Throughout the experimental period feed and water were provided to all birds *ad libitum*. From 0-8 weeks old, chicks were fed chick mash containing 20% CP and 2722 Kcal ME kg^{-1}, then from 8-18 weeks grower ration containing 16% CP and 2737 Kcal ME kg^{-1} was fed and from 18 weeks onward breeder mash was given. All rations were formulated and mixed at the feed mill of the institute (NAPRI). They were then randomly placed in individual cages and monitored up to 40 weeks of age. The following traits were recorded: body weight in kilograms at 20, 30 and 40 weeks of age and shank length in centimeters at 20, 30 and 40 weeks of age.

The genetic parameters were estimated using the hatch adjusted data from a model whereby the variance component was partitioned into those due to Sire, Dam or Environment. The model fitted was of the Nested design (Henderson, 1963), in which a sire was mated to several dams with each mating producing several offspring. The statistical model used is as follows:

$$Y_{ijk} = \mu + a_i + b_{ij} + e_{ijk}$$

Where, Y_{ijk} is the record of the k^{th} progeny of the j^{th} dam mated to i^{th} sire, μ is the common mean, a_i is the effect of i^{th} sire, b_{ij} is the effect of the j^{th} dam mated to i^{th} sire, e_{ijk} is the uncontrollable environmental and genetic deviations attributable to the individual (all error terms were assumed to be random, normal and independent with expectation equal to zero).

RESULTS

The mean body weight for male line ranged between 1.262±0.044 kg at 20 weeks to 2.539±0.025 kg at 40 weeks. The mean shank length values obtained for male line ranged between 10.434±0.145 cm at 20 weeks to 12.688±0.063 cm at 40 weeks of age (Table 1).

For female line however, the mean body weight values ranged between 1.144±0.054 kg at 20 weeks to 2.486±0.042 kg at 40 weeks of age. The corresponding mean shank length values were 9.735±0.190 cm at 20 weeks and 12.497±0.117 cm at 40 weeks of age (Table 1).

Heritability for body weight and shank length: The heritability estimates in the male line observed at 20, 30 and 40 weeks for body weight were 0.892±0.331, 0.677±0.288 and 0.559±0.232, while the estimates for shank length were 0.505±0.260, 0.630±0.269 and 0.318±0.203, respectively. The estimates obtained in the female line across all ages were 0.700±0.350, 0.562±0.290 and 0.420±0.214 for body weight, while 0.420±0.245, 0.353±0.224 and 0.302±0.211 were the heritability values for shank length (Table 1).

Correlation between body weight and shank length: The genetic correlation between body weights at different ages varies in magnitude and direction depending on the age considered. Table 2 showed the correlation between body weight and shank length at different ages. In the male line, the body weight at 20 weeks was found to be positive and highly correlated with body weight at 30 weeks (0.839) and 40 weeks of age (0.731), respectively. Similarly, body weight at 30 weeks was positively correlated (0.557) with that at 40 weeks. The corresponding values observed in the female line for body weights at 20 and 30 weeks (0.759) was positive and high and a correlation coefficient of 0.602 was obtained between age 20 and 40 weeks. While the association for body weights between 30 and 40 weeks in the female line yielded correlation coefficient of 0.538). Body weight was found to be positively correlated with shank length at 20 weeks (0.799), 30 weeks (0.735) and 40 weeks (0.624), respectively for male line. While the corresponding values obtained for the female line were 0.789, 0.703 and 0.636 at 20, 30 and 40 weeks of age (Table 3).

Table 1: Least Square Means (±SE) and heritability estimates (±SE) for body weight and shank length at different ages for two strains of Rhode Island chickens

Traits	Strain	Age (week)	Mean±SE	h^2±SE
Body weight	A	20	1.262±0.044	0.892±0.331
	B	20	1.144±0.054	0.700±0.350
	A	30	2.054±0.029	0.677±0.288
	B	30	2.010±0.052	0.562±0.290
	A	40	2.539±0.025	0.559±0.232
	B	40	2.486±0.042	0.420±0.214
Shank length	A	20	10.434±0.145	0.505±0.260
	B	20	9.735±0.190	0.420±0.245
	A	30	11.717±0.078	0.630±0.269
	B	30	11.346±0.113	0.353±0.224
	A	40	12.688±0.063	0.318±0.203
	B	40	12.497±0.117	0.302±0.211

Table 2: Coefficients of phenotypic correlation (r_p) among body weights at different ages

	Body weights at		
Traits	20 weeks	30 weeks	40 weeks
Body weight at 20	-	0.759	0.602
Body weight at 30	0.840	-	0.538
Body weight at 40	0.730	0.557	-

Table 3: Coefficients of phenotypic correlation (r_p) of body weight against shank length at different ages for strain A and B

	Strain	
Traits	A	B
Body weight and shank length at 20 weeks of age	0.799	0.789
Body weight and shank length at 30 weeks of age	0.735	0.703
Body weight and shank length at 40 weeks of age	0.624	0.636

DISCUSSION

Mean performance and heritability: The mean body weight and shank length observed in this study at all ages for both strains (male and female line) were high and show good performance for all the birds. Malik *et al.* (1997) reported mean shank length of 7.08 cm for cocks and 6.89 cm for hens with body weight of 1.57 kg in males and 1.02 kg in females, respectively. In a similar work, Chhabra *et al.* (1972) gave 7.18 cm and 759.42 g for mean shank length and body weight in 10 weeks old broiler chickens. The results of this study further agreed with the research of Ansah *et al.* (1980), Ebangi and Ibe, (1994), Sharma *et al.* (1996) and Padhi *et al.* (1999).

The results of heritability obtained in this study for body weight and shank length showed a declining trend as birds grow older. This trend supported the findings of Singh *et al.* (1988) who worked on broiler breeders and Prado-Gonzalez *et al.* (2003) who reported similar decreasing heritability values (0.21, 0.20, 0.13 and 0.07) with increasing age of birds (4, 8, 12 and 16 weeks). The observation however, disagreed with the findings of Chambers, (1990) who reported that heritability for body weight of broilers tends to increase with age. Oni *et al.* (1991) reported heritability estimates of 0.413 and 0.044, 0.387 and 0.279 for body weight at 16 and 20 weeks in two strains of Rhode Island chickens. Ebangi and Ibe, (1994) reported heritability estimate of 0.41±0.19 for body weight and 0.58±0.12 for shank length. Hernandez and Segura, (1994) reported 0.87 for body weight and 0.51 for shank length, respectively.

Differences in heritability estimates could be attributed to method of estimation, breed, environmental effects and sampling error due to small data or sample size. Environmental (high temperature and humidity) and poor management conditions are known to increase the residual variance and decrease the heritability estimate. The heritability estimates for both body weight and shank length range from low to highly heritable (Pirchner and Krosigk, 1973; Kumararaj *et al.*, 1991; Chaudhary *et al.*, 1996).

Correlation between body weight and shank length: Chhabra *et al.* (1972) reported highly positive correlation (0.8614) for live body weight and shank length at 20 weeks of age. The results of this study was consistent with the findings of other researchers; Jull and Glazener (1946), Sovsky *et al.* (1979), Reddy *et al.* (1993) and Malik *et al.* (1997). The results further supported the assertions of Chhabra *et al.* (1972) that the association between body weights and shank lengths was positively higher in younger birds than in older ones.

Clayton and Robertson (1966) reported highly positive genetic correlation (0.84) between body weight at 12 and 20 weeks of age. Oni *et al.* (1991) also reported a highly positive genetic correlation (0.88 and 0.98) between Juvenile body weight (16 and 20 weeks of age) in two strains of Rhode Island birds. In a similar study, Sani *et al.* (1991) reported low coefficient of 0.09 between body weight at 18 weeks and body weight at 32 weeks, respectively.

In conclusion, the heritability estimates observed for body weight and shank length decreases with increasing age of birds. This observation disagrees with the reports from some researchers on one hand and was at par with the findings of other workers on the other. These differences in the observed heritability estimates was

attributed to differences in the method used for estimation, breed, environmental effects and sampling error due to small data or sample size. In addition, environmental (high temperature and humidity) and poor management conditions are known to increase the residual variance and decrease the heritability estimate.

In conclusion therefore, this study showed that highly positive relationship exists between body weight and shank length of live Rhode Island chickens which suggest the use of shank length measurement to predict body weight at any given age, at least as an aid to farmers in areas where sensitive weighing scales are not readily available.

ACKNOWLEDGMENT

The authors are grateful to the Director, National Animal Production Research Institute, Shika, Zaria, for sponsoring this work and for the permission to publish it. The technical assistance of Messrs Sule A., Mathias B. and Deshi K. is also acknowledged.

REFERENCES

Adeyinka, I.A., E. Adejoh, B.Y. Abubakar, A.A. Sekoni and F.O. Abeke, 2004. Genetic parameter estimates of body weights and linear measurements in a population of naked neck broiler chickens. Proc. 29th Ann. Conf. Nig. Soc. Anim. Prod., 29: 40-43.

Akpa, G.N., J.O. Ifut and F. Mohammed, 2002. Indigenous management of dystocia in ruminant livestock of northern guinea savannah of Nigeria. Nig. J. Anim. Prod., 29: 264-70.

Ansah, G.A., D.C. Crober, R.B. Buckland, A.E. Sefton and B.W. Kennedy, 1980. Artificial insemination of individual caged broiler breeders. I. Reproductive performance of males in relation to age and strain of females. Poult. Sci., 59: 428-437.

Chambers, J.R., 1990. Genetics of Growth and Meat Production in Chickens. In: Crawford, R.D. (Eds.). Poult. Breed. Gen. Elsevier, Amsterdam, The Netherlands, pp: 559-643.

Chaudhary, M.L., N.P.S. Bajwa, G.S. Brah and J.S. Sandhu, 1996. Variance component analysis of cross-and pure-bred egg type chickens. Ind. J. Poult. Sci., 3: 18-22.

Chhabra, A.D., K.L. Sapra and R.K. Sharma, 1972. Shank length, growth and carcass quality in broiler breeds of poultry. Ind. Vet. J., 49: 506-511.

Clayton, G.A. and A. Robertson, 1966. Genetics of changes in economic traits during the laying year. Brit. Poult. Sci., 7: 143-151.

Ebangi, L.A. and S.N. Ibe, 1994. Heritability of semen quantity, concentration and motility in White Rock Roosters and their genetic correlation with rate of gain. Poult. Sci., 44: 1527-1529.

Ekanno, E.C. and S.N. Ibe, 2006. Prediction of body weight of the rabbit at different stages of growth using linear body measurements. Nig. J. Anim. Prod., 33: 3-8.

Gueye, E.F., A. Ndiaye and R.D.S. Branckaert, 1998. Prediction of mature body weight on the basis of body measurement in mature indigenous chickens in Senegal. Livestock Research for Rural Development 10 (3) http://www.cipav.org.co/irrd/html.

Hassan, A. and A. Ciroma, 1992. Body weight measurement relationships in Nigerian Red Sokoto goats. In: Small Ruminants Research and Development in Africa. Rey, B., S.H.B. Lebbie and L. Reynolds (Eds.), Proceedings of the 1st Biennial Conference of the Small Ruminants Research Network, ILRAD, Nairobi, Kenya. 10-14th December, 1990. ILCA (International Livestock Centre for Africa) Nairobi, Kenya, pp: 491-497.

Henderson, C.R., 1963. Selection index and expected genetic advance. Statistical genetics and plant breeding. Nat. Acad. of Sci. National Resources Council. Publ. pp: 982. Washington DC.

Hernandez, E.Y. and J.C. Segura, 1994. Estimacion del indice de herencia para peso al nacer en pollos cuello desnudo Universidad y ciencia, 11: 121-24.

Ibe, S.N., 1989. Measurement of size and conformation in commercial broilers. J. Anim. Breed. Genet., 106: 461-469.

Ibe, S.N. and A.G. Ezekwe, 1994. Quantifying size and shape difference between Muturu and N'dama breed of cattle. Nig. J. Anim. Prod., 21: 51-58.

Jull, M.A. and E.W. Glazener, 1946. Rate of growth in progeny to 10 weeks in relation to shank length of parents. Poult. Sci., 25: 256-261.

Kandasamy, N. and D.C. Gupta, 1983. Studies on physical measurements, live weight and fleece weight in native and crossbred sheep in a semi-arid zone of India. Trop. Agric. (Trinidad), 60: 92-94.

Kumararaj, R.O., P. Kothandarahman and V. Waganathan, 1991. Comparison of heritability between purebredand crossbred layers. Ind. J. Poult. Sci., 26: 1-5.

Malik, B.N., P.K. Mishra and S.C. Mishra, 1997. Inheritance of 6-weak body weight breast angle, shank length and keel length in a broiler chicken. Ind. J. Poult. Sci., 32: 249-252.

Mani, R.I., A.R. Abdullah and R. Von Kaufmann, 1991. Comparison of scale weight to type estimates and their relationship with condition scores in Bunaji cattle. Nig. J. Anim. Prod., 18: 78-81.

Monsi, A., 1992. Appraisal of Interrelationships among live measurements at different ages in meat type chickens. Nig. J. Anim. Prod., 19: 15-24.

Nesamvumi, A.E., J. Malaudzi, N.D. Ramanyimi and G.J. Taylor, 2000. Estimation of body weight in Ngunni-type cattle under communal conditions. South African J. Anim. Sci., 30. http://www.sasas.co.za/sajas.html/

Okon, B., J.B. Ogar and O.O. Mgbere, 1997. Interrelationships of live body measurements of broiler chickens in a humid tropical environment. Nig. J. Anim. Prod., 24: 7-12.

Oni, O.O., B.Y. Abubakar and S.O. Ogundipe, 1991. Genetic and phenotypic associations of Juvenile body weights and egg production traits in 2 strains of Rhode Island chickens. Nig. J. Anim. Prod., 18: 66-69.

Orheruata, A.M. and O. Olutogun, 1994. Pre-and post-weaning phenotypic relationships between some N'dama cattle linear measurements in the tropics. Nig. J. Anim. Prod., 22: 76-82.

Ozoje, M.O. and U. Herbert, 1987. Linear measurements in West African Dwarf (WAD) and WAD Red Sokoto gaots. Nig. J. Anim. Prod., 24: 13-19.

Padhi, M.K., S. Senani, S.K. Saha and R.B. Rai, 1999. Effect of Naked-Neck gene on Juvenile growth performance of chicken in Andaman. Ind. Vet. J., 76: 610-612.

Pirchner, F. and C.M. Krosigk, 1973. Genetic parameters of cross and purebred poultry. Brit. Poult. Sci., 14: 193-202.

Prado-Gonzalez, E.A., L. Ramirez-Avila and J.C. Segura-Correa, 2003. Genetic parameters for body weight of Creole chickens from Southeastern Mexico using an Animal model. Livestock Rural Develop, 15: 1-6.

Reddy, B.L., R.P. Sharma, B.P. Singh and A.K. Dev Roy, 1993. Genetic parameters of Juvenile body weight and conformation traits. In: pea and single comb population and red Cornish. Ind. J. Poult. Sci., 28: 7-11.

Sani, R.S., J. Kumar and R.P. Singh, 1991. Genetic studies on economic traits in a flock of Rhode Island Red chicken under selection. Ind. J. Poult. Sci., 26: 6-11.

Sharma, D., D.C. Johari, M.C. Kataria, B.P. Singh, D.P. Singh and R.C. Hazary, 1996. Effect of long term selection on genetic parameters of economic traits in White Leghorn. AJAS., 9. 4: 455-459.

Singh, A., R.P. Singh and J. Kumar, 1988. Genetic analysis of production and reproduction traits in meat type chicken. Ind. J. Poult. Sci. 23:122–127.

Sovsky, J., R. Cihak and J. Jandal, 1979. Shank length and carcass quality of broiler. Anim. Breed. Abstr., 44: 1894-1894.