Relationship between markers and quantitative traits in the Nigerian local chicken

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Abstract

A 20-week experiment was conducted to determine the relationship between markers and some quantitative traits in the Nigerian Local chicken. A total of fifty normal female chickens, about 16-18 weeks of age were used for the study. Data were collected bi-weekly on physiological and biochemical markers (packed cell volume, erythrocyte sedimentation rate, leucocyte count, blood haemoglobin, blood glucose, rectal temperature) and quantitative traits (egg weight, shell thickness, Haugh unit, body weight, short term egg production) from each bird. The association between each identified marker and the quantitative traits was determined using Pearson's product moment correlation coefficient. Rectal temperature showed significant ($P < 0.05$) positive association with shell thickness and body weight. Packed cell volume showed significant ($p < 0.05$) positive association with Haugh unit. However, significant ($p < 0.01$) negative association was found between rectal temperature and Haugh unit. Packed cell volume showed significant ($p < 0.01$) negative association with shell thickness and egg weight ($p < 0.05$). Other markers did not show any significant association with the quantitative traits studied. The results of this study suggest that since packed cell volume and rectal temperature showed definite association with important quantitative traits, they should be included in the marker bank that could be used by animal breeders and producers in marker assisted selection.

Keywords: Correlation, markers, Nigerian local chicken, quantitative traits.

Introduction

In many developing countries of the world, including Nigeria, the domestic fowl plays a major role in supplying the population with egg and meat, which are highly nutritious and popularly consumed. Despite their economic importance and large number (144 million) Rim(1992), the Nigerian local chicken has not been fully exploited for the purpose of genetic improvement

The Nigerian local chicken is characterized by poor growth and small body size, which are not desirable in a competitive economic situation (Ibe, 1990, Ebangi and Ibe, 1994). The local chickens of Nigeria are exposed

to extremes of weather, diseases and parasites, which partly account for their poor productive performance. However, they can be made more productive by improving them genetically and also by improving their production environment.

A plausible approach to genetic improvement of the Nigerian local chicken is selection of individuals based on genetic, physiological and biological markers, which have definite association with important quantitative traits. This approach is termed Marker-Assisted Selection (MAS). Markers may be genetic, physiological or biochemical. Genetic markers are short DNA sequences which

have slight differences between individuals, such as single base change (Single Nucleotide Polymorphism, SNP), Single Short Repeats (SSR), or Short Tandem Repeats (STR), etc (Fulton, 2008). Variations in certain physiological and biochemical parameters and even gene products among individuals are also being exploited as markers. The incorporation of information on markers that are linked to Quantitative Traits Loci (QTL), together with phenotypic information in a genetic evaluation procedure, would increase the accuracy of evaluation and therefore selection (Mrode, 2005). Marker-assisted selection allows for the accurate selection of specific DNA variations that have been associated with a measurable difference or effect on traits (Alison, 2006), and enhances breeding programmes by direct selection on genes or genomic regions that affect economic traits (Dekkers and Hospital, 2002). The current challenge is to find markers for various economic traits that will be useful in marker-assisted selection for rapid genetic improvement of those traits.

The objectives of this study are to identify physiological and biochemical markers, which may be associated with important Quantitative Trait Loci (QTL) in the Nigerian local chicken, and to establish a marker bank to aid in the genetic improvement of quantitative characters through MAS.

Materials and Methods

Location of study

The experiment was carried out at the Poultry Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria, located at latitude 5°28' N and longitude 7°31' E on an altitude of 122m above sea level. The area is

characterized by 7-10 months annual rainfall from February to October, and short period of dry season from November to January.

Experimental population and management

A total of sixty normal female local chickens about 16-18 weeks of age were sourced locally from farmers. The birds were quarantined for one month to allow them to stabilize. During this period, they were dewormed and vaccinated. They were housed in deep litter pens and were fed *ad libitum* with commercial growers mash containing 14.5% Crude protein, 4.8% fat, 7.2% Crude fat, 8% ash, 0.8% Calcium and other nutrients. Water was given *ad libitum*. After the first egg was dropped the birds were weighed and transferred to cages, with approximately 2025cm² of floor space per bird. They were housed individually and fed commercial layers mash containing 17% crude protein, 4.0% fat, 5.0% crude fibre, 12.9% ash, 3.8% calcium and other nutrients. Their short term egg production was monitored for a period of 4 months.

Data collection

Data were collected from 50 birds that came into lay, two weeks after the first egg was dropped.

Blood sample collection and analysis

Blood samples from each bird were collected bi-weekly from the brachial vein using sterile syringes and needles. Immediately after collection, they were transferred into sets of sterile bottles containing 5mg of anticoagulant (3g: 7g mixture of potassium oxalate and sodium fluoride) for the determination of haematological parameters. Packed cell volume (PCV; haematocrit) of each sample was determined by the micro haematocrit method. Erythrocyte sedimentation rate (ESR) was determined using Westergreen method. White blood cell count (WBC) was

carried out using haemocytometer. Blood glucose concentration was determined using spectrophotometer at wavelength of 680 nm. Haemoglobing (Hb) concentration was determined using Sahli's method (Benjamin, 1978).

Egg parameters

Eggs were collected twice daily, in the morning (0900hr) and in the afternoon (1500hr). Total number of eggs laid per bird was recorded. Eggs were weighed individually using electronic scale (SPU 601, 600g). Each egg was later carefully opened and the content poured onto a flat plate. A tripod micrometer was then used to measure the height of the albumen midway between the yolk and the edge of the albumen. Haugh unit was calculated (according to Haugh, 1937) using the formula:

$$HU = 100 \log_{10} [h - 1.7w^{0.37} + 7.6]$$

Where HU= Haugh unit

H= observed albumen height (mm)

W= observed weight of egg (g)

Shell thickness was measured using micrometer screw gauge. The membrane from each egg was removed and measurement taken from three points on each shell. The average shell thickness was then determined.

Rectal temperature

Rectal temperature for each bird was measured using a digital thermometer (CE0197). This was done by inserting the sensor tip into the rectum and the highest temperature displayed recorded.

Statistical analysis

Statistical analysis of data on markers and quantitative traits was performed using Statistical Package for the Social Sciences (SPSS). Association between the different markers and quantitative traits was determined using Pearson's product

moment correlation coefficient (r).

Results and Discussion

Descriptive statistics of quantitative traits and markers

The means and the standard error of the means of the bi-weekly measurements on quantitative traits are shown in Table 1. Table 2 shows the means and standard error of the means of measurement on markers.

Egg weight

Egg weight ranged between 26.20g and 48.50g. Nigerian local chickens are characterized by small sized eggs. The mean egg weight increased with age, with 31.15g and 40.49g at 22 and 30 weeks, respectively. This observation is in agreement with the reports of Danilov (2000), Silversides and Scott (2001), and Abanikanda *et al* (2007)

Shell thickness

Shell thickness ranged between 0.28mm and 0.36mm. The mean shell thickness did not vary from week 22 to week 30. This result disagrees with report of Peterson (1965) and Roland (1976) that egg shell thickness usually decrease with age.

Haugh unit

Haugh unit ranged between 61.51 and 90.32. The mean Haugh units increased from week 22 to week 30. The mean values of Haugh unit (78.54–79.84) in this study were higher than the values reported by Esonu *et al* (2004) for commercial exotic layers. This suggests the superiority of egg quality of the Nigerian local chicken.

Body weight

At 22 weeks of age, body weight ranged between 0.85 and 1.45kg, with mean of 1.08kg. At 30 weeks of age, body weight ranged between 1.05 and 1.51kg with mean of 1.23kg. The mean body weight increased with age. The mean body weight observed in this study was in agreement with earlier reports (Ibe, 1990; Oluyemi and Roberts,

Table 1: Descriptive statistics of the bi-weekly measurement on quantitative traits.

Traits*	N	Minimum	Maximum	Mean	SEM
EW(g) 22	50	28.30	48.15	38.15	0.480
24	50	26.20	48.50	39.52	0.426
26	50	26.30	46.30	40.14	0.467
28	50	29.82	47.30	40.48	0.435
30	50	28.66	46.40	40.49	0.400
ST(mm) 22	50	0.28	0.36	0.31	0.003
24	50	0.28	0.35	0.31	0.002
26	50	0.28	0.35	0.31	0.003
28	50	0.29	0.35	0.31	0.002
30	50	0.28	0.35	0.31	0.002
HU 22	50	69.14	90.32	78.54	0.695
24	50	64.27	87.87	78.55	0.788
26	50	67.31	88.46	79.15	0.600
28	50	69.40	87.49	79.30	0.571
30	50	61.51	88.57	79.84	0.667
BW(kg) 22	50	0.85	1.45	1.08	0.017
30	50	1.05	1.51	1.23	0.014
EggNo.120	50	42	63	49.94	0.733

*EW = egg weight, ST = shell thickness, BW = body weight, HU = Haugh unit, EggNo.120 = short-term egg production (for a period of 120 days).

2000; Fayeye *et al.* 2006) that Nigerian local chickens are relatively small in body size.

Short-term egg production

The short-term egg production ranged between 42 and 63 eggs. The mean egg number was 49.9 ± 5.18 eggs. This value was higher than the value (48.5 ± 4.1 eggs) reported by Nwosu and Omeje (1983) for Nigerian local chickens.

Packed cell volume

Packed cell volume ranged between 20 and 32%. The lowest value was below the lower limit of the normal range for chicken (25.0–45.0) reported by Mitruka and Rawnsbey (1977) and Ross *et al.* (1978). The highest value observed was above the lower limit and below the upper limit of the normal range. The mean value for PCV increased with age. The variation is in agreement with

the findings of Newell and Shaffner (1950), Mones *et al.* (1983) and Simarakis *et al.* (2004).

Blood Haemoglobin (Hb)

Blood haemoglobin values recorded in this study were within normal range (7.0–13.0) reported by Mitruka and Rawnsbey (1977), and Ross *et al.* (1978). The mean blood haemoglobin increased with age. This result corroborates the report of Islam *et al.* (2004).

Erythrocyte sedimentation rate (ESR)

The values of ESR were between 4.5 and 9.0. This result is contrary to the report of Islam *et al.* (2004) that ESR in the local chicken was negligible. The result of this study shows that ESR decreases with age. This is in line with the report of Sturkie (1976) and Kundu *et al.* (1993).

Table 2: Descriptive statistics of bi-weekly measurement on markers.

Markers*	N	Minimum	Maximum	Mean	SEM	
PCV(%)	22	50	20.00	32.00	24.76	0.362
24	50	20.00	32.00	23.92	0.407	
26	50	20.00	30.00	24.62	0.300	
28	50	23.00	30.00	25.66	0.224	
30	50	23.00	29.00	25.82	0.171	
ESR(mm/hr)	22	50	5.00	9.00	6.76	0.172
24	50	5.00	8.00	6.44	0.125	
26	50	5.00	8.00	6.22	0.099	
28	50	5.00	8.00	6.24	0.088	
30	50	4.50	7.50	5.50	0.090	
Hb(g/dl)	22	50	7.50	11.55	9.26	0.142
24	50	7.70	11.25	9.30	0.129	
26	50	7.65	11.70	9.67	0.132	
28	50	8.10	11.25	9.68	0.109	
30	50	7.50	11.25	9.77	0.112	
BGC(mg/100ml)	22	50	90.52	164.12	198.88	2.158
24	50	91.86	171.14	113.29	2.489	
26	50	90.22	178.44	120.87	3.305	
28	50	94.54	167.24	122.97	2.288	
30	50	91.56	184.70	123.52	2.326	
WBC($10^5/\text{mm}^3$)	22	50	2.01	3.39	2.63	0.054
24	50	1.97	3.60	2.62	0.056	
26	50	2.07	3.26	2.57	0.051	
28	50	2.01	3.21	2.55	0.042	
30	50	2.11	3.22	2.53	0.042	
RT($^{\circ}\text{C}$)	22	50	39.00	41.20	39.93	0.077
24	50	39.30	40.90	40.03	0.049	
26	50	39.30	40.90	39.98	0.055	
28	50	39.30	40.90	40.02	0.045	
30	50	38.70	41.20	40.06	0.078	

*PCV= packed cell volume, ESR= erythrocyte sedimentation rate, Hb= blood haemoglobin, BGC= blood glucose concentration, WBC= white blood cell count, RT= rectal temperature.

Blood glucose concentration (BGC)

The mean BGC increased with age, with 108.88 and 123.53mg/100ml at 22 and 30 weeks, respectively. The variation in BGC of birds may be due to feed, time of sampling and present status of birds (Fudge, 2000). However, the mean values of BGC recorded in this study were below

the value ($194 \pm 4\text{mg}/100\text{ml}$) reported by Alfred and Roehrig (1970) for broilers at 3 weeks of age.

White blood cell count (WBC)

The mean values of WBC recorded in this study were higher than values reported by Simaraks *et al* (2004) and Madubuike and Ekenyem (2006) for broiler chickens. The

values were also higher than those of Iheukwumere *et al* (2006) for Nigerian indigenous chickens. The mean values of WBC count decreased with age. The variability in WBC may be due to many factors, such as individual disposition of birds, stress, and immune status as well as the time of blood sampling during the day (Maxwell and Robertson, 1998; Fudge, 2000).

Rectal temperature (RT)

Rectal temperature varied between 38.7°C and 41.2°C. Mean rectal temperature was between $39.93 \pm 0.55^\circ\text{C}$ and $40.06 \pm 0.55^\circ\text{C}$. Richards (1970), cited by Sturkie (1976) reported a deep body temperature of 41.5°C for the domestic chicken. Mcnat (1966), cited by Sturkie (1976), reported body temperatures of 41.2, 42.2 and 42.1°C for domestic turkey, pigeons and ducks, respectively.

Correlation between markers and quantitative trait at 22 weeks

The correlations between egg weight (EW) and the markers studied were very low and non-significant ($P>0.05$). The implication is that these physiological and biochemical parameters cannot serve as reliable markers for EW at 22 weeks.

Correlations between shell thickness (ST) and the markers were also low and non-significant ($P>0.05$). This implies that

incorporating these markers in MAS will not yield any substantial genetic gain in ST at this age.

Correlations between Haugh unit (HU) and the markers were also non-significant ($P>0.05$). This means that no substantial gain is possible by using these markers in MAS for genetic improvement of HU at 22 weeks.

Correlations between body weight (BW) and the markers, except RT, are low and non-significant ($P>0.05$). This implies that no substantial genetic gain in BW at 22 weeks can be obtained by incorporating the markers in MAS at this age. However, the correlation between BW and RT was positive and significant ($P<0.05$), indicating that incorporating RT in MAS will result in genetic gain in BW at 22 weeks.

Correlations between markers and quantitative traits at 24 weeks

Correlations between markers and quantitative traits at 24 weeks are given in Table 4. With the exception of correlations between PCV and ST and between RT and HU, which were negative and significant ($F < 0.01$), the other correlations were non-significant ($P>0.05$). The implication is that higher PCV and RT values are associated with lower ST and HU values, respectively, indicating that PCV and RT can be incorporated in MAS for the improvement

Table 3: Correlations between markers and quantitative traits at 22 weeks

	EW	ST	HU	BW
PCV	-0.092	-0.158	-0.023	-0.042
ESR	-0.007	-0.119	-0.155	-0.135
HB	0.046	-0.107	-0.275	0.011
BGC	0.043	0.110	0.070	0.094
WBC	-0.139	-0.008	-0.150	-0.064
RT	0.034	0.237	0.007	0.295

* $p<0.005$

Table 4: Correlations between markers and quantitative traits at 24 weeks

	EW	ST	HU
PCV	-0.145	-0.369**	0.058
ESR	-0.072	0.176	0.133
HB	0.006	-0.162	-0.119
BGC	-0.257	0.166	-0.104
WBC	-0.176	0.056	0.017
RT	0.201	0.204	-0.386**

**P<0.01

of ST and HU, respectively. There were no reports in available literature on correlations between the markers and quantitative traits studied.

Correlations between markers and quantitative traits at 26 weeks.

Table 5 presents correlations between markers and quantitative traits at 26 weeks. With the exception of PCV and RT each of which has a significant correlation with ST, no other correlation was significant. The correlation between PCV and ST was negative, indicating that higher PCV are associated with lower ST values. The correlation between RT and ST was positive, indicating that high RT values are associated with low ST values. Both PCV

and RT may be incorporated in MAS for improvement of ST.

Correlations between markers and quantitative traits at 28 weeks

Correlations between markers and quantitative traits at 28 weeks are shown in Table 6. With the exception of correlations between PCV and HU, and between RT and ST which were positive and significant ($P < 0.05$ and $P < 0.01$, respectively), no other correlations were significant. High PCV and RT values are associated with high HU and ST, respectively and the markers can be used in MAS for the improvement of HU and ST, respectively.

Correlations between markers and quantitative traits at 30 weeks

Correlations between markers and quantitative traits at 30 weeks are presented

Table 5: Correlations between markers and quantitative traits at 26 weeks.

	EW	ST	HU
PCV	-0.260	-0.392**	0.089
ESR	-0.043	0.184	-0.017
HB	-0.017	-0.217	0.076
BGC	-0.162	-0.260	-0.115
WBC	-0.147	-0.011	0.260
RT	-0.098	0.291*	-0.025

*P<0.05

**P<0.01

Table 6: Correlations between markers and quantitative traits at 28 weeks.

	EW	ST	HU
PCV	-0.241	-0.164	0.343*
ESR	0.161	0.067	-0.256
HB	0.213	-0.106	-0.236
BGC	0.001	0.033	0.097
WBC	-0.208	0.031	0.005
RT	-0.048	0.461**	-0.075

*P<0.05

**P<0.01

in Table 7. Correlation between EW and PCV was negative and significant ($P < 0.05$). The negative association implies that the higher the PCV value, the less the EW. Hence selection for low PCV value will result in higher EW. Although the correlations between PCV and EW were negative in earlier ages, they were not significant. Significant ($P < 0.05$) negative correlation was found between RT and EW, implying that the lower the value of RT, the higher the EW. RT showed a significant ($P < 0.05$) negative correlation with HU. Hence, RT can be incorporated in MAS for the improvement of both EW and HU at 30 weeks. Pair wise correlations between the markers and BW and EggNo120 were non-significant ($P > 0.05$), implying that the markers cannot be used in MAS for the genetic improvement of the two quantitative traits at 30 weeks. There was no report in the available literature on the

association between these markers and the quantitative traits studied.

Conclusion and Recommendation

Among the markers studied, rectal temperature had significant positive association with body weight in week 22, negative association with Haugh unit in week 24, positive association with shell thickness in week 26 and 28, and negative association with egg weight and Haugh unit in week 30. Packed cell volume had significant negative association with shell thickness in week 24 and 26, positive association with Haugh unit in week 28, and negative association with egg weight in week 30. No other marker had significant association with the quantitative traits studied.

Since rectal temperature showed definite association with body weight, Haugh unit, shell thickness and egg weight, and packed cell volume showed definite association with shell thickness, Haugh unit, and egg

Table 7: Correlations between markers and quantitative traits at 30 weeks.

	EW	ST	HU	BW	EggN.120
PCV	-0.349*	-0.219	0.161	-0.233	-0.100
ESR	0.099	0.159	-0.022	0.062	-0.253
HB	0.064	-0.197	-0.225	0.018	-0.052
BGC	0.007	0.012	0.082	0.046	-0.092
WBC	-0.247	-0.008	0.144	-0.040	0.144
RT	-0.286*	0.051	-0.329*	0.051	0.053

*p<0.05

weight, the two markers may be included in the marker bank that will be useful to animal breeders and producers in marker-assisted selection for genetic improvement of those associated quantitative traits in the Nigerian local chicken. Finally, there is need for more investigation in these areas, since little has been done about these markers.

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