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# Phenotypic correlations between biologic markers and growth traits in Arbor acres broiler chicken strain

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**Abstract**

*The study was conducted to determine the correlations between biologic markers, haematological indices and growth traits in Arbor Acres broiler strain. A total of 120 Arbor acres strain were used for the experiment which lasted for 56 days. The birds were raised in separate deep litter pens. Data collected include biologic markers: hemoglobin (Hb), packed cell volume (PCV), white blood cell (WBC), red blood cell (RBC), mean cell volume (MCV), mean cellular hemoglobin (MCH), mean cellular hemoglobin concentration (MCHC) and biochemical parameters include: blood glucose (GLU) and total serum protein(PRT). Growth traits include: body weight (BW), body length (BL), shank length (SL), keel length (KL), wing length (WL), breast width (BWD) and drumstick length (DSL). The result obtained showed that MCHC in week 4 it associated significantly with breast length (rp=0.989) and keel length (rp= -0.986), whereas in week 6, serum protein, MCH, PCV, WBC and RBC proved significant markers based on their significant association (P<0.05;P<0.01) with SL (rp=0.975), KL (rp=0.981), DSL (rp= -0.982; -0.989) and BL (rp= -0.991). In week 8, Hb, WBC, MCV, MCH and MCHC proved to be useful markers for selecting keel length, breast length, body length, body length and thigh width in Arbor Acre. Highest correlation was observed between WBC and BL (rp= -0.991) and between MCH and breast length (rp= 0.991) in the 6th week. Due to the limited associations observed in week 4, it may be more reliable to apply the biologic markers in selection programs, starting at the 6th week for Arbor Acres broiler strains. This study advocates that highly polymorphic DNA-based markers which are more reliable should be attempted for improving body weight of broilers.*

**Keywords:** Broiler chickens, strain, Arbor Acres, phenotypic, markers, growth traits

## Introduction

Broiler chicken is suitable for consumption by high blood pressure and coronary heart disease patients. Despite these merits and great potentials of broiler chicken, their genetic improvement has not been pursued with the vigour it deserves in our local environment. Selection of individuals based on the presence or absence biologic markers which have definite association with quantitative trail loci (QTLs) needs to be pursued vigorously. This is the concept of Maker-Assisted Selection (MAS), which is the process of using marker information in the selection of individuals to become parents for future generations. The measurements of the amount of various biochemical constituents of blood have been used in the evaluation of the physiological status of animals (Solomon *et al.,* 2005). Because of the potential of broiler birds to produce high-nutritive meat, the massive production of different strains is cropping up every day in the market, and some of these strains have been found to have stunted growth and related to obvious

loss to the farmers. This problem may be genetic and environmental. The aim of animal breeders is to integrate linked markers for QTL into the breeding program in marker assisted selection (MAS) (Neuner *et al.,* 2008). MAS can be used either by linking MAS disequilibrium or through gene assisted selection in the livestock breeding industry (Dekkers, 2004). Optimal selection should be based on information from markers genotypes combined with information on animal's phenotype. Marker-assisted selection (MAS) can increase the rate of genetic response in the range of 5% to 64% in animal breeding populations depending on the trait being selected and marker and quantitative trait loci (QTL) information.These identified markers will be highly useful for the selection plans as well as useful for checking the success of traditional selective breeding programs (Liu, 2001). Therefore it is imperative to determine those economic traits which associate with some biologic markers. The objective of the study was therefore to identify various biologic markers which are associated with important quantitative traits in Arbor Acres broiler strain.

## Materials and methods

### Experimental site

This study was conducted at the Poultry Unit of the Teaching and Research Farm of the Michael Okpara University of Agriculture, Umudike, Abia State, located on latitude $05^0$29N, longitude $07^0$29E and at an altitude of 122m above sea level. It lies within the humid rainforest zone of West Africa which is characterized by long duration of rainfall (April-October) and short dry season (November-march). Average rainfall is 2169.8mm in 148-155 rain days. Average ambient temperature is $26^0$C with a range of $22^0$C and $30^0$C. Its relative humidity ranges from 50 to 95%. These meteorological data is from the metrological station at the National Root Crops Research Institute, Umudike, Abia State.

***Experimental birds and their management***

A total of 120 day-old Arbor Acresbroilers were obtained for the study. The birds were given routine vaccination for broilers during the period of the experiment. Prophylactic antibiotics and anticoccidial drugs were administered to the birds periodically via drinking water. The birds were also dewormed and acaricide sprayed to check worms and ectoparasites.

The birds were brooded on floor pens. The brooding period lasted four weeks. After brooding the birds were housed in eight pens with 15 birds per pen to avoid overcrowding. From brooding through rearing, maximum comfort for the chicks was ensured. Commercial feed was provided in adequate quantity to the chicks twice a day, namely 8.30am and 2.30pm and drinking water was given *ad libitum*. Chicks (0-4 weeks) were fed *ad libitum* with starter mash containing 21-22% crude protein and 2950-2900kcal ME/kg. Finishers (5-8Weeks) were fed 19% crude protein and 3000 Kcal ME/Kg. individual identification of the bird was done marking with indelible marker or wing banding.

***Determination of biologic markers***

A total of 64, four week-old Arbor Acres broiler strain were selected in $4^{th}$, $6^{th}$ and $8^{th}$ weeks of age and used for biologic marker studies.

***Collection of blood samples***

Blood samples (2mL) were collected aseptically with sterile syringe and needle from the wing vein of the different strain of broilers into labeled test tubes, containing anti-coagulant (heparin) and another test tube with no anti- coagulant for determination of biochemical markers. This

was done immediately after the skin had been damped with alcohol to disinfect the area and expose the vein. Determination was done bi-weekly for three times of blood sample collection.

***Biologic markers***

Packed cell volume (PCV) was determined by the micro haematocrit method by Dacie and Lewis (1999), Hemoglobin (HB) was determined using the Cyanomethaemoglobin method as described by Jain (1986), White blood cell (WBC) was determined using a microscope with improved Neuberger hawmacytometer as described by Jain (1986). Red Blood Cell was determined using a microscope with Neuberger haemacytometer as described by Jain (1986).

Total Blood protein (PRT) was measured by using the standard Biuretmethod as described by Lawrence (1986) Blood glucose (GLU) was obtained by the process described by Barker and Silverton (1976).

$$MCV = \frac{\text{Haematocrit value x 10}}{\text{Erythrocyte count}}$$

$$MCH = \frac{\text{Haemoglobin } L^{-1} \text{ x 10}}{\text{Erythrocyte count}}$$

$$MCHC = \frac{\text{Haemoglobin } L^{-1} \text{ x 100}}{\text{Haematocrite value}}$$

***Growth traits***

**Body Weight (BW):** Body weight (g) was obtained using a top loading kitchen scale with sensitivity of 20g.

**Body length (BDL):** the distance between the base of the neck and pygostyle.

**Shank length (SHL):** Length of the taros-metatarsus from the joint to the metatarsal pad.

**Keel length (KLL):** The length of the keel bone from the V- joint to the end of the sternum.

**Wing length (WGL):** Distance between the tip of the phalanges and the coracoids-homeruns joints.

**Breast width (BW):** Region of largest breast expansion when positioned ventrally.

**Drumstick length (DSL):** Length of the femur bone

The above parameters except BWT were measured weekly using a tailor's 'cm' tape. The measurements were taken on the birds before feeding in the morning.

***Statistical analysis***

Numerical data were analyzed using Special Packed for Social Sciences (SPSS) (SPSS, 2004). Statistical analysis of the data on different biologic markers and the quantitative traits were carried out to establish the relationship between each marker and the quantitative traits using the Pearson's Product Moment Correlation Coefficient (r).

**Results and discussion**

***Correlations between quantitative traits and biologic markers in Arbor acres broiler strain in week 4***

The correlation between quantitative traits and biologic markers in Arbor Acres strain in week 4 is presented in Table 1. Table 1 shows the correlations between body parameters and biologic markers in Arbor Acres, broiler strain in week 4. Significant ($P<0.05$) positive correlation was observed between mean corpuscular hemoglobin concentration (MCHC) and breast length (BRL) ($rp=0.989$) and a significant ($P<0.05$) negative correlation between MCHC and keel length (KL) ($rp= -0.986$) in Arbor Acres. The association shows that an increase in MCHC was associated with an increase in breast length and a decrease in keel length or vice versa. Morphometric measurements such as length and height are related to bone growth and are closely related to body weight of growing animals (Essien and Adesope, 2003).

**Table 1: Correlations between quantitative traits and biologic markers in Arbor Acre s strain in week 4**

| Trait/Marker | HB | PCV | WBC | RBC | GLU | PRT | MCV | MCH | MCHC |
|---|---|---|---|---|---|---|---|---|---|
| **BW** | -0.302 | -0.405 | 0.299 | -0.426 | 0.256 | -0.335 | 0.280 | 0.229 | 0.016 |
| **BRL** | 0.700 | -0.313 | 0.705 | 0.041 | 0.792 | 0.612 | 0.746 | 0.835 | 0.989* |
| **TWD** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **SL** | -0.429 | 0.064 | -0.289 | -0.122 | -0.343 | -0.391 | -0.314 | -0.371 | -0.501 |
| **KL** | -0.550 | 0.501 | -0.839 | 0.161 | -0.904 | -0.446 | -0.870 | -0.934 | -0.986* |
| **BL** | -0.868 | -0.388 | -0.006 | -0.639 | -0.123 | -0.862 | -0.059 | -0.187 | -0.590 |
| **WL** | 0.640 | 0.667 | -0.422 | 0.759 | -0.332 | -0.686 | -0.382 | -0.279 | 0.122 |
| **DSL** | 0.077 | 0.424 | -0.435 | 0.352 | -0.420 | 0.128 | -0.429 | -0.409 | -0.267 |

***. Correlation is significant at the 0.05 level (2 -tailed); Hb Hemoglobin; PC - Packed Cell Volume; WBC -White Blood Cell; RBC -Red Blood Cell; GLU -Glucose; PRT -Protein; MCV -Mean Cell Volume; MCH -Mean Cell Hemoglobin; MCHC -Mean Cell Hemoglobin Concentration)***

The positive association observed between MCHC and breast length is therefore favorable. The reduction in keel length may be due to genetic reasons. Previous investigators had reported that differences in growth pattern are under genetic control, and that variations exist within species (Carborg*et al*., 2003). High phenotypic correlations existing between traits with one another may suggest a pleiotrophic gene action and gene linkage effects (El-Labban, 1999). The implication is that any selection programme to improve the significantly correlated biologic markers will lead to improvement in the associated body parameters.

The other biologic markers including Hb, PCV, WBC, RBC, glucose, protein, MCV and MCH did not show any significant association with body parameters in week 4. Strikingly, the thigh width revealed no association with all the biologic markers (rp=0.00). Breast length also showed potentially high positive association, though, not significant, with MCH (rp=0.835). Similarly, the keel length showed potential negative associations with WBC (rp=-0.839), glucose (rp=-0.904), MCV (rp=-0.870) and MCH (rp=-0.934). These potential associations may become significant given the application of suitable environmental factors. According to Essien and Adeyemi (1999) the realization of the full growth potentials of strains is largely expected to depend on the nutritional and climatic variables subject to the genotypic traits which in turn set a ceiling on their productive capacity.

For improvement programmes to be successful, a breeder must take into consideration the interrelationships between body weight and other body conformation traits (Olawumi, 2014).

*Correlations between quantitative traits and biologic markers in arbor acre at wk 6*

The correlations between quantitative traits and biologic markers in Arbor Acre strain in week 6 are presented in Table 2. Significant positive correlation ($P<0.05$) was observed between serum protein and SL (rp=0.975), MCH and KL (rp=0.981) and significant ($P<0.01$; $P<0.05$) negative correlations between PCV and DSL (rp= -0.982), WBC and BL (rp= -0.991) and RBC and DSL (rp=-0.989) in Arbor Acre.

The positive associations show that an increase in serum protein and MCH was correspondingly associated with an increase in shank length and keel length respectively; whereas, the negative associations showed that an increase in PCV and WBC were correspondingly associated with a decrease in drumstick length and body length respectively or vice

**Table 2: Correlations between quantitative traits and biologic markers in Arbor Acres at week 6**

| Trait/Marker | HB | PCV | WBC | RBC | GLU | PRT | MCV | MCH | MCHC |
|---|---|---|---|---|---|---|---|---|---|
| **BW** | 0.492 | 0.795 | 0.347 | 0.654 | -0.274 | 0.352 | -0.550 | -0.336 | -0.384 |
| **BRL** | -0.071 | 0.153 | 0.193 | -0.155 | 0.343 | 0.498 | 0.335 | 0.504 | 0.318 |
| **TWD** | -0.489 | -0.142 | -0.770 | -0.057 | 0.518 | 0.867 | -0.517 | -0.603 | 0.386 |
| **SL** | -0.771 | -0.452 | -0.744 | -0.533 | 0.886 | 0.975* | 0.092 | 0.025 | 0.808 |
| **KL** | -0.082 | -0.299 | 0.392 | -0.510 | 0.146 | -0.336 | 0.930 | 0.981* | 0.274 |
| **BL** | -0.813 | -0.631 | -0.991** | -0.478 | 0.726 | 0.704 | -0.162 | -0.371 | 0.658 |
| **WL** | 0.276 | 0.504 | 0.437 | 0.216 | 0.004 | 0.338 | 0.061 | 0.291 | -0.041 |
| **DSL** | -0.931 | -0.982* | -0.685 | -0.989* | 0.867 | 0.348 | 0.704 | 0.512 | 0.925 |

***. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed); *See Abbreviations as in Table 1 above.***

versa. The high phenotypic correlations existing between the significantly correlated parameters may suggest a pleiotrophic gene action and gene linkage effects (El- Labban, 1999). The implication is that any selection programme to improve the significantly correlated biologic markers will lead to improvement in the associated body parameters. Therefore, manipulating these biological markers could help in improving the shank length, keel length, drumstick length and body length in the Arbor Acre. Potential associations though not significant were also revealed between Hb and BL (rp= -0.813), Hb and DSL (rp= -0.931), glucose and SL (rp= 0.886), glucose and DSL (rp= 0.867), protein and TWD (rp=0.867), MCV and KL (rp= 0.930), MCHC and SL (rp=0.808) and MCHC and DSL (rp= 0.925) in the Arbor Acre strain. The significant associations established in this strain in week 6 varied from the result of week 4. Akram *et al*. (2012), found significant differences in body length, keel length, drumstick circumference and shank circumference with the advancement in age. Akram *et al.* (2012) reported that as the age advances body length, keel length, drumstick length and shank length increases. Kozaczyoski (1999) also observed that the body length, keel length, drumstick length, shank length of poultry birds at different ages increased with age. This may be responsible for the differences in the degree of association between week 4 and week 6.

Abdulraheem *et al.* (2015) undertook a study in broilers chicks, with the aim of investigating the relationship between some morphometric and blood profile in order to identify markers capable of improving body weight. According to the authors, the relationship between blood profile with body weight and breast girth showed that there was no significant relationship. This agrees with the findings of this study for Arbor Acre The authors reported that body weight recorded negative correlations with PCV (-0.177), Hb (-0.487), WBC (-0.195) MCV (-0.103), MCHC (-0.192) which does not agree with the result obtained in the Arbor Acre strain. The variation among strains shows genetic diversity. Genetic diversity plays an important role in animal selection and improvement and it is detected at three levels: morphological, protein and DNA (Das and Deb, 2008). The variation in results may also be due to differences in breed. Durai *et al.* (2012) conducted a study on haematological profile and erythrocyte indices of different breeds of poultry and observed variation in results which was suggested to be due to differences in breeds. The significant correlation observed in

serum protein in the Arbor Acre strain in week 6 may be due to the influence of age. Among numerous factors that can influence the level of plasma protein in broilers, age of the birds seems to be one of the most important factor; higher values are generally found in adult birds compared to young birds (Silva *et al*., 2007).

*Correlations between quantitative traits and biologic markers in arbor acre at week 8*

The correlations between quantitative traits and biologic markers in Arbor Acre Strain in week 8 are presented in Table 3. Significant ($P<0.05$) positive associations were observed in Arbor Acres between Hb and KL (rp= 0.904), MCV and BL (rp= 0.887), MCH and BRL (rp= 0.991), MCHC and BRL (rp= 0.917), MCHC and TWD (rp= 0.897) and MCHC and KL (rp= 0.929); whereas a significant negative association was observed between WBC and BRL (rp= -0.884), WBC and BL (rp= -0.939).

**Table3: Correlations between quantitative traits and biologic markers in Arbor Acre at week 8**

| Traits/$_{Marker}$ | HB | PCV | WBC | RBC | GLU | PRT | MCV | MCH | MCHC |
|---|---|---|---|---|---|---|---|---|---|
| BW | 0.310 | -0.583 | -0.811 | -0.648 | 0.423 | -0.712 | 0.449 | 0.775 | 0.821 |
| BRL | 0.572 | -0.314 | -0.884* | -0.624 | 0.315 | -0.293 | 0.734 | 0.991** | 0.917* |
| TWD | 0.858 | 0.209 | -0.396 | -0.032 | .0776 | -0.236 | 0.208 | 0.744 | 0.897* |
| SL | 0.595 | 0.389 | -0.256 | -0.020 | -0.003 | 0.696 | 0.506 | 0.544 | 0.398 |
| KL | 0.904* | 0.237 | -0.414 | -0.031 | 0.773 | -0.152 | 0.242 | 0.785 | 0.929* |
| BL | 0.257 | -0.498 | -0.939* | -0.810 | -0.036 | -0.425 | 0.887* | 0.877 | 0.669 |
| WL | -0.034 | -0.118 | -0.343 | -0.360 | -0.320 | -0.172 | 0.533 | 0.269 | 0.035 |
| DSL | -0.086 | -0.019 | -0.315 | -0.360 | -0.704 | 0.533 | 0.718 | 0.247 | -0.135 |

***. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed); *See Abreviations as in Table 1 above.***

These associations show that an increase in Hb and MCHC was associated with an increase in keel length. An increase in MCH and MCHC coupled with a decrease in WBC were associated with an increase in breast length; an increase in body length was associated with an increase in MCV and a decrease in WBC. More so, an increase in MCHC was associated with an increase in thigh width.

Other potential associations in the Arbor Acres at week 8 include the association between MCH and BL (rp= 0.877) and between MCHC and BW (rp= 0.821). The results showed that Hb, MCV, MCHC and WBC could serve as useful biological markers for measuring and improving keel length, body length, and breast length and thigh width in Arbor Acre at the finisher phase.

The implication is that any selection programme to improve the significantly correlated biologic markers will lead to improvement in the associated body parameters.

## Conclusion

The study has revealed correlations between biologic markers and quantitative traits in Arbor Acres strain of broiler. Hematological parameters could provide information not only for diagnostic and management purposes, but could also be incorporated into breeding programs for genetic improvement.

Mean corpuscular hemoglobin concentration (MCHC) could serve as a useful marker in week 4 to improve breast length and keel length. In week 6, serum protein, MCH, PCV, WBC and RBC proved to be markers to improve SL, KL, DSL and BL. In week 8, Hb, WBC, MCV, MCH and

MCHC proved to be useful markers for selecting keel length, breast length, body length, body length and thigh width in Arbor Acres broilers. This study advocates that highly polymorphic DNA-based markers which are more reliable should be attempted for improving body weight of broilers.

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