Nigerian J. Anim. Sci. 2018, 20 (2): 16-25

Correlations between blood markers and growth parameters in establishing marker bank for Black colour Nigerian local Turkey

[1]Nosike, R.J., *[2]Onunkwo, D.N., [1]Ezike, J.C., [1]Amaraduruonye, W., [1]Obasi, E.N., [1]Obike, O.M. [1]Nwakpu, O. F., [1]Ibe, S.N. and [1]Oke, U.K.

[1]Department of Animal Breeding and Physiology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
[2]Department of Animal Nutrition and Forage science, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

***Corresponding Author:** donunkwo1@gmail.com.*

***Target audience:** Poultry producers, Animal breeders, Researchers and Animal Physiologist.*

Abstract

A total of 26 day-old random-bred Nigerian local black phenotype turkey poults were used to generate another 86 day-old F_1 poults in the study to determine quantitative traits and biologic markers. The Nigerian local turkeys were obtained as base population and used to generate F_1 progeny. Growth parameters namely; body length (BDL), shank length (SHL), keel length (KLL), breast width (BW), wing length (WGL) and drumstick length (DSL) were measured. Biologic markers, namely packed cell volume (PCV), haemoglobin (Hb), white blood cell (WBC), red blood cell (RBC), total blood protein (TBP), blood glucose (BGC) and rectal temperature (RT) were determined. Body weight, growth parameters and markers had significant ($p<0.05$) relationship. The marker bank showed that markers common to the black phenotype were PCV, WBC and Hb. These could be used in Marker-Assisted Selection (MAS) for the black turkey variety studied. It was therefore, concluded that for rapid improvement of these traits, the markers such as BPT, RT, RBC, BGC, WBC, PCV and HB could be used to enhance growth. The present findings could assist in the design of long-term genetic improvement programmes for turkey production in Nigeria using the marker bank for MAS.

Keywords: *Black local turkey, blood markers, marker bank, growth parameters*

Description of problem

Local breeds of animals possess genes relevant for their survival and adaptation to their environment and local breeding goals. Animal protein consumption for normal physical and mental development is low in Nigeria. Currently, total poultry population in Nigeria is estimated to be about 172 million out of which chicken is estimated at 160 million, guinea fowl (8.3 million), ducks (1.7 million) and local turkeys (1.05 million) (1). Although turkeys were introduced in Africa several decades back by the Christian missionaries, till date turkey farming has achieved very little progress and low popularity (2). Indigenous poultry species are hardy and generally adapt favourably to the local environment (3). The potential of local turkeys cannot be overlooked, considering the huge foreign exchange implication of the importation of improved exotic stock (4) and also genotype - environment interaction which leads to considerable loss of fitness of the exotic stock (5). The carcasses of turkey contain a high percentage of protein, low saturated fats, low cholesterol, high methionine and essential amino acids required for complete protein usage than chicken. Turkey has an advantage over chickens and guinea fowls with high feed conversion ratio, hardiness and less susceptibility to common poultry diseases and parasites (4).

Indigenous birds are usually raised as scavengers in open yards, scratching and picking on the grounds (6). Village poultry production systems can be improved and transformed from subsistence to semi-commercial production systems to increase food security and family income especially among the rural populace and disadvantaged members of the community. Turkey (*Meleagris gallopavo*) is becoming popular in Nigeria due to its capacity to expand the poultry subsector and help to supply meat and eggs.

In spite of all these attributes of the local turkey, its production has remained very low compared to other poultry species. Local turkeys have poor growth performance (7). Information about the local ecotypes of turkey and their characterization is scarce in available literature. The local breeds of animals in Nigeria deserve improvement in their genetic profile and physiological status (8). Markers are pieces of identifiable heritable spot on a chromosome and can be an expressed region of DNA or a segment of DNA with no known coding function. A biomarker indicates a change in expression or state of a protein that correlates with the risk or progression of a disease, or with the susceptibility of the disease to a given treatment. Biomarkers are characteristic biological properties that can be detected and measured in parts of the body like the blood or tissue. Blood has been reported to be a fast and readily available means of assessing clinical and health status of animals (9).

One plausible approach to genetic improvement of animals is selection of individuals based on the presence or absence of genetic and biologic markers which have definite association with quantitative trait loci (QTLs) such as for body weight gain and linear body parameters. This is the concept of marker-assisted Selection (MAS), which is the process of using marker information in the selection of individuals to become parents for future generations. Actually, many characters in domestic animals are not independent of each other; rather they tend to be associated (10). The marker-assisted selection (MAS) technique is an important application of genetic engineering to animal breeding (11). The objective of the study was therefore to establish Marker Bank of Black turkey phenotype based on age for turkey breeders and poultry producers using marker- assisted selection (MAS).

Materials and Methods

Study area

The study was conducted at the Poultry Unit of the Teaching and Research Farm of the Michael Okpara University of Agriculture, Umudike, Abia State. Umudike is located on latitude 05^0C 28′ North and 07^0C 32′East and lies at an altitude of 122 m above sea level. This area is situated within the tropical rainforest zone of West Africa which is characterized by long duration of rainfall (April - October) and short period of dry season (November-March). Average rainfall is 2169.8mm in 148 – 155 rain days. Average ambient temperature is 26^0C with a range 22^0C and 30^0C. Its relative humidity ranges from 50 to 90%. These meterological data were obtained from the meteorological station at the National Root Crops Research Institute, Umudike Abia State.

Management of the base population and production of F_1 birds

A total of 26 day-old local turkeys of Black phenotype were obtained from a reputable hatchery. They were reared to generate F_1 progeny with clear plumage colour differentiation for the study. At time of breeding, 2 Toms and 12 hens of black turkey phenotype were used for mating. Random mating was used for the mating scheme within each identified group by selecting sexually active males for the females in the ratio of 1:6 for egg production. Eggs produced by the base population turkeys were collected on a daily basis, identified appropriately with indelible ink markers and set in the incubator on weekly basis. Total number of eggs laid was 128 and stored for less than 7 days in crates with large

end up. The laying period was between 25 and 30 weeks of age. The incubator was Cabinets incubator type with relative humidity of 80%, temperature of 55^0C proper ventilation and turning suitable for hatchable eggs. The eggs were hatched weekly in batches. The numbers of progeny (F1) poults produced were 86.

Brooding and rearing of F_1 poults

70 day-old F_1 poults hatched by the black turkey were used in the study. They were brooded for a period of 2 weeks after which they were transferred to small compartments for a period of 4 weeks and finally to deep litter pens at 6 weeks of age. Dry wood shavings were used as litter material. Fresh clean water was given *ad libitum* to the poults during this period. Routine management operations such as washing of the water and feed troughs were carried out on daily basis. The birds were given routine vaccination. Prophylactic antibiotics and anticoccidial drugs were administered to the birds periodically. However, the birds were dewormed and acaricide sprayed to check worms and ectoparasites.

Feed was provided in adequate quantity to the poults and drinking water was given *ad libitum.* Poults (0-6 weeks) were fed *ad libitum* with starter mash containing 28% crude protein and 2800kcal ME/kg. Growing turkeys (7-24 weeks) were fed growers mash (20% crude protein and 3000 kcal ME/kg). All nutrient composition is as labeled

Data collection

Parameters measured:

Body weight (BWT) (g): Body weight was measured weekly using a top loading 20kg-CAMRY scale with a sensitivity of 10g.

Body length (BDL): the distance between the bases of the neck to the tip of the pygostyle.

Shank length SHL): length of the tarso-metatarsus from the hock 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-humerus joint. **Breast width (BW):** region of the largest breast expansion when positioned ventrally. **Drumstick length (DSL):** length of the femur bone.

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

Biologic markers

A total of 24 - black local turkey phenotypes were selected 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 turkeys into labeled test tubes, containing anti-coagulant (heparin) and another test tube with no anti-coagulant for determination of biochemical markers. It was done immediately after the skin had being damped with alcohol to disinfect the area and expose the vein. Determination of markers was done bi-weekly for 20 weeks.

Determination of biologic markers

The following biologic markers were determined: Packed cell volume (PCV), Haemoglobin (Hb), White blood Cell (WBC), Red Blood Cell (RBC), Total Blood Protein (TBP), Blood glucose (BGC) and Rectal temperature (RT).

• ***Packed cell volume (PCV)****:* Packed cell volume was determined by the micro haematocrit method by (12). The packed cell volume was measured by using capillary tubes. The tubes were filled with blood to 3/4 and sealed with crystaceal. The tubes were then centrifuged at 3000rpm for five minutes in microhaematocrit (Model EBA 20) centrifuged and Packed Cell Volume was estimated from the reader.

• ***Haemoglobin (Hb)****:* Haemoglobin was determined using the cyanomethaemoglobin

method as described by (13). Haemoglobin concentration was determined using Spin-react haemoglobin-drabkin kit. In this method haemoglobin was oxidized by potassium ferric oxide into cyanomethaemoglobin by potassium cyanide. The intensity of absorbance of cyanomethaemo-globin is proportional to hemoglobin concentration.

• ***White blood cell (WBC):*** White blood Cell was determined using a microscope with improved Neubauerhaemacytometer as described by (13).

White blood cell (WBC) count was determined by diluting 0.02 ml of blood sample with physiological solution (0.38 ml Turks) and loaded on to the Neubauer counting chamber, and all cells on the four corner squares were counted using a light microscope at x10 magnifications. The number of cells counted for each blood sample was multiplied by 50 to obtain the total white blood cell count per microlitre of blood and counting the number of WBC using an improved Neubeurhaematocyto-meter with the aid of a microscope.

• ***Red blood cell (RBC)***: Red Blood Cell was determined using a microscope with improved Neubauerhaemacytometer as described by (13). Red blood cell (RBC) count was determined by diluting 0.02ml of blood sample with physiological solution (4ml Heyem's) in a clean test tube to make a 1:200 dilution of the blood sample. The diluted blood sample was loaded on to the Neubauer counting chamber, and all red cells on the five corner groups of 16 small squares in the central area of the Neubauer chamber was counted using a light microscope at x40 magnifications. The number of cells counted for each blood sample was multiplied by 10,000 to obtain the total red blood cell count per microlitre of blood.

• ***Total blood protein (TBP)****:* The total plasma protein was measured by using the standard Biuret method as described by (14), which is based on the reaction between the peptide bonds of protein and Cu^{2+} (from copper sulfate solution) that produces a blue-violet colored complex in alkaline solution. The measurements were done using the Biuret method (CHRONOLAB) where 100 ml of blood plasma and standard protein solution were diluted into 500 ml of the Biuret reagent in a test tube. The Biuret reagent without a sample being added was used as a blank. After mixing, the test tubes were left to stand for 30 minutes and thereafter the absorbance was read using spectrophotometer (Cecil 2000, UK) at a wavelength of 540 nm.

The calculation of the total protein was done using the following formula.

$$\text{Conc. of protein (g/100ml)} = \frac{\text{Absorbance of Sample-Absorbance of Blank}}{\text{Absorbance of Standard - Absorbance of Blank}} \times \text{Conc. of Standard (g/100ml)}$$

The values of total plasma proteins obtained were expressed in g/dl.

• ***Blood glucose (BGC)****:* Blood glucose (BGC) determination was by the process described by (15). The serum glucose is determined based on the type of colour the product of hydrolysis emits. Hydrolysis of serum glucose produces bright coloured substances. The intensity of the colour is proportional to the concentration of glucose in the blood. The colour principle leads to the calculation of glucose as follows:

$$\text{Glucose (g/dl)} = \frac{\text{Absorbance of Sample-Absorbance of Blank}}{\text{Absorbance of Standard-Absorbance of Blank}} \times \text{Conc. of Standard}$$

• ***Rectal temperature (RT)****:* The rectal temperature of the turkeys was measured via the rectum using a digital thermometer (0.1^0C) by inserted into the rectum of the birds for a minute as previously described by (16).

Statistical analysis

Data obtained were statistically analyzed with (17). Phenotypic correlations between quantitative traits and markers were determined for the black turkeys using the

Pearson's Product-Moment Correlation Coefficient (r) as described by (18).

The correlations that showed significant were used to develop a marker bank template where black turkeys could be selected at a given age for improvement of particular trait(s) of interest.

Results and Discussion

Correlations between quanti-tative traits and biologic markers in black turkey

The correlations for establishing the marker bank are given in Tables 1, 2, 3, 4, 5,6,7,8and 9

Table 1: Correlations between markers and quantitative traits at week 7

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	-0.632	0.037	0.015	0.129	-0.120	-0.080	-0.176
PCV	-0.722	-0.812	0.121	0.122	0.211	0.635	-0.659
WBC	-0.207	-0.363	0.684	-0.129	0.279	0.523	-0.602
RBC	-0.818*	-0.742	-0.050	0.134	0.164	0.505	-0.587
Hb	-0.690	-0.832	0.171	0.070	0.263	0.670	-0.703
BPT	-0.064	0.945*	-0.586	0.415	-0.720	-0.974**	0.874
BGC	0.068	-0.490	-0.045	-0.844	0.837	0.342	-0.604

**BWT=Body weight, BDL=Body length, SHL=Shank length, KLL=Keel length, BRW=Breast width, WGL=Wing length, DSL=Drumstick length, RT = Rectal Temperature, PCV = Packed Cell Volume, WBC = White Blood Cell, HB =Haemoglobin Concentration, RBC = Red Blood Cell, BPT = Blood Protein, BGC=Blood Glucose.* *Correlation is significant at (P<0.05)

** Correlation is significant at (P<0.01)

Table 2: Correlations between markers and quantitative traits at week 9

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	-0.831*	-0.580	0.943*	-0.774	-0.813	-0.163	-0.480
PCV	-0.288	0.330	0.316	-0.050	-0.518	-0.489	0.371
WBC	-0.655	0.231	0.441	-0.188	-0.661	0.207	0.185
RBC	-0.811*	-0.373	0.953*	-0.764	-0.846	-0.323	-0.343
Hb	-0.693	0.054	0.716	-0.421	-0.833	-0.349	0.086
BPT	0.288	0.097	-0.322	0.350	0.202	-0.062	0.218
BGC	0.336	-0.404	0.228	-0.442	0.223	-0.955*	-0.428

*See Table 1 for meaning of traits/markers abbreviations

*Correlation is significant at (P<0.05)

Table 3: Correlations between markers and quantitative traits at week 11

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	0.425	-0.327	-0.150	-0.157	0.100	-0.108	-0.144
PCV	-0.126	-0.035	-0.224	0.450	-0.847	0.042	0.260
WBC	0,074	-0.506	-0.292	-0.207	0.383	-0.643	-0.792
RBC	0.250	-0.714	-0.367	0.067	-0.428	-0.632	-0.524
Hb	-0.162	-0.110	-0.173	0.395	-0.799	-0.103	0.117
BPT	0.562	-0.268	0.074	-0.191	-0.042	0.067	0.123
BGC	-0.113	-0.287	-0.449	0.465	-0.858	-0.249	-0.060

*See Table 1 for meaning of traits/markers abbreviations

Table 4: Correlations between markers and quantitative traits at week 13

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	-0.304	0.549	-0.622	-0.069	0.055	0.173	0.518
PCV	0.188	-0.200	0.382	0.615	0.780	-0.026	0.363
WBC	-0.752	-0.362	-0.147	-0.361	0.283	-0.703	0.374
RBC	0.080	0.786	-0.242	0.442	0.508	0.237	0.771
Hb	0.174	-0.220	0.463	0.546	0.734	-0.144	0.316
BPT	-0.091	-0.637	0.044	-0.654	-0.861	-0.111	-0.936*
BGC	-0.079	0.313	-0.399	0.549	0.721	0.382	0.777

*See Table 1 for meaning of traits/markers abbreviations
*Correlation is significant at (P<0.05)

Table 5: Correlations between markers and quantitative traits at week 15

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	0.835*	-0.002	-0.199	-0.507	-0.018	-0.474	-0.373
PCV	0.445	-0.149	-0.756	-0.261	-0.203	0.711	0.107
WBC	0.811*	-0.213	-0.175	-0.275	-0.224	0.008	-0.584
RBC	0.588	-0.415	-0.247	-0.729	0.323	-0.433	-0.239
Hb	0.540	-0.029	-0.794	-0.271	-0.258	0.656	0.112
BPT	-0.586	-0.618	-0.185	0.004	0.268	0.704	0.299
BGC	0.519	-0.177	-0.894*	-0.731	0.177	0.299	0.329

*See Table 1 for meaning of traits/markers abbreviations
*Correlation is significant at (P<0.05)

Table 6: Correlations between markers and quantitative traits at week 17

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	-0.464	-0.056	0.548	-0.14	0.413	0.203	0.135
PCV	0.618	-0.150	0.892*	-0.861	-0.405	-0.483	0.540
WBC	0.950*	-0.11	0.259	-0.805	-0.537	-0.379	0.218
RBC	0.811	-0.361	-0.183	-0.672	-0.453	-0.158	-0.294
Hb	0.761	0.425	0.509	-0.677	-0.280	-0.261	0.509
BPT	-0.615	-0.003	0.436	0.177	0.480	0.253	0.105
BGC	0.837*	-0.273	0.445	-0.980*	-0.371	-0.224	0.064

*Correlation is significant at (P<0.05)

Table 7: Correlations between markers and quantitative traits at week 19

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	-0.119	-0.131	0.449	0.172	0.562	0.359	0.378
PCV	0.068	0.215	-0.210	0.013	0.962**	0.207	0.082
WBC	-0.670	0.536	0.553	0.434	-0.294	-0.190	-0.544
RBC	-0.114	0.035	0.566	0.049	-0.313	0.466	0.088
Hb	0.077	0.157	-0.082	0.020	-0.880	0.355	0.039
BPT	0.230	-0.318	-0.324	0.025	0.851	0.078	0.553
BGC	0.615	-0.673	0.577	-0.641	-0.135	0.925*	0.604

*See Table 1 for meaning of traits/markers abbreviations
*Correlation is significant at (P<0.05), ** Correlation is significant at (P<0.01)

Table 8: Correlations between markers and quantitative traits at week 21

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	-0.265	0.633	0.681	0.411	0.033	-0.948*	0.294
PCV	0.515	-0.390	-0.679	-0.105	-0.274	0.890*	-0.224
WBC	-0.057	-0.662	-0.064	-0.090	-0.080	0.487	-0.882*
RBC	0.242	0.538	0.311	0.825	-0.705	-0.437	-0.265
Hb	0.563	-0.382	-0.645	-0.053	-0.263	0.888*	-0.230
BPT	0.061	-0.632	-0.627	-0.437	-0.139	0.824	-0.443
BGC	0.785	-0.336	0.028	0.495	-0.010	0.595	-0.467

*See Table 1 for meaning of traits/markers abbreviations
*Correlation is significant at (P<0.05)

Table 9: Correlations between markers and quantitative traits at week 23

Traits* Markers*	BWT	BDL	WGL	KLL	SHL	BRW	DSL
RT	-0.599	-0.004	0.110	-0.632	0.726	-0.462	0.040
PCV	-0.150	0.304	0.169	-0.135	0.610	-0.341	0.864
WBC	0.092	-0.477	0.364	-0.196	-0.153	-0.307	-0.423
RBC	0.695	0.840	-0.055	0.569	-0.295	0.528	0.764
Hb	-0.850*	-0.302	-0.187	-0.432	0.726	-0.439	0.070
BPT	0.456	0.858	0.640	-0.286	0.425	-0.244	0.861
BGC	0.249	0.605	0.740	-0.641	0.474	-0.408	0.321

*See Table 2 for meaning of traits/markers abbreviations
*Correlation is significant at (P<0.05)

Marker bank for marker assisted selection (MAS) in black phenotype

The established marker bank for black local turkey phenotype is given in Table 10.

At 7 weeks of age, high body length (BDL) and breast width (BRW) values may be brought about by selecting black turkeys with high blood protein (BPT) and low BPT values respectively. To improve BRW, black turkeys with low blood glucose (BGC) at 9 weeks of age should be selected. Also high wing length (WGL) values can be obtained when the

turkeys with high RT and RBC are selected at week 9. Genetic improvement could be achieved in drum stick length (DSL) at 13 weeks if black turkeys with high blood protein are selected. Black turkeys with low values of BPT at 15 weeks of age will bring about high values of WGL if selected. At 17 weeks of age selection of black turkeys with high values of white blood cells (WBC) and packed cell volume (PCV) may bring about genetic improvement in BWT and WGL respectively. This result is in agreement with the report of (8) that high WBC can bring about high values of body weight

Table 10: Marker Bank for MAS of black local turkey

Age (weeks)	Quantitative Trait*	Biologic Marker(s)**	Significant (r)
7	BDL	BPT	+
	BRW	BPT	-
9	WGL	RT,RBC	+,+
	BRW	BGC	-
	BWT	RT, RBC	-, -
13	DSL	BPT	-
15	WGL	BPT	-
	BWT	RT,WBC	+, +
17	BWT	WBC,BGC	+, +
	WGL	PCV	+
	KLL	BGC	-
19	SHL	PCV	+
	BWT	BGC	+
21	BRW	RT,PCV,HB	-,+,+
	DSL	WBC	-
23	BWT	HB	-

**BWT=Body weight, BDL=Body length, SHL=Shank length, KLL=Keel length, BRW=Breast width, WGL=Wing length, DSL=Drumstick length, RT = Rectal Temperature, PCV = Packed Cell Volume, WBC = White Blood Cell, HB =Haemoglobin Concentration, RBC = Red Blood Cell, BPT = Blood Protein, BGC=Blood Glucose.* + = positive correlation, - = negative correlation.*

in rabbits at week 16. Also selection of black turkeys with low BGC will bring about high values in keel length (KLL) at 17 weeks. Selection of black turkeys with high PCV and BGC values at 19 weeks may bring about genetic improvement (high values) in shank length (SHL) and BWT respectively. Rabbits with low values of WBC at 20 weeks of age could fast-track high values of HG if selected. Genetic improvement (high values) could be achieved in BRW at 21 weeks if black turkeys with high values of PCV and haemoglobin (Hb) and low values of RT are selected in MAS. Also selection of black turkeys with low values of WBC could bring about improvement (high values) of DSL. At 11 and 23 weeks there was no significant correlation among any of the markers and QTLs studied.

The marker bank specifically showed the importance of blood protein (BPT) as a predominant marker for four different quantitative traits (BDL, BRW, DSL and WGL) at three different ages (7, 7, 13 and 15) weeks of age for black phenotype (Table 10). This may be attributed to the state of a protein that correlates with the risk or progression of a disease, or with the susceptibility of the disease to a given treatment. Blood glucose (BGC) and packed cell volume (PCV) ranked second in its importance as a marker for three different quantitative traits (BRW, KLL and BWT) at 9, 17 and 19, and (WGL, SHL and BRW) at 17, 19 and 21 weeks respectively. White blood cells (WBC) and rectal temperature (RT) then followed as markers for two quantitative traits each as (BWT and DSL) at 17 and 21 and (WGL and BRW) at 9 and 21 weeks of age respectively. The marker bank also showed that Red blood cells (RBC) and Haemoglobin (Hb) are markers for one quantitative trait each as (WGL) at 9 and (BRW) at 21 weeks of age respectively.

Marker bank for MAS in improvement of body weight of local turkey

Marker banks for the improvement of body weight in black turkey phenotype using the various Markers studied are presented in Table 11. The selected markers are those, which had significant positive phenotypic correlation with body weight for the black turkeys. (Tables 1, 2, 3, 4, 5, 6, 7, 8 and 9).

Table 11: Marker bank for improvement of body weight

Phenotype	Marker bank
Black	RT, RBC, WBC, BGC, Hb

*RT = Rectal Temperature, WBC = White Blood Cell, Hb =Haemoglobin Concentration, RBC = Red Blood Cell, BGC=Blood Glucose.

The markers common in the study for improvement of BWT were RT, WBC and BGC. These could be used in MAS for the improvement of body weight of black turkey phenotype. The relationships, on which the choice of markers was based, were phenotypic. Consequently, the indicated markers will result in the desired genetic improvement of body weight, if environmental influence is negligible.

Conclusions and applications

1. Phenotypic correlation between the quantitative traits and some markers were positive and significant, though not high. However, a meaningful indirect selection can be achieved by improving the quantitative traits using the markers; due to significant correlation established between the two.
2. The present findings could assist in the design of long-term genetic improvement programme for turkey production in Nigeria using the marker bank for Marker-assisted selection. The attendant effect will be an increase in the number of quality birds, thereby assisting in bridging the animal protein gap in poor developing countries.
3. Black phenotype should be engaged in further studies to ascertain the age at which selection can be made for a particular quantitative trait.

References

1. FAOSTAT (2011). Food and Agricultural Organization of the United Nations http://faostat.fao.org/default.aspx. Accessed July 19, 2011.

2. Singh R. and Sharma, D. (2005). *Turkey and Guinea fowl: Role in Indian poultry production.* Central Avian Research Institute, Izatnagar.
3. Ikeobi, C. O. N. (2003). *Family Poultry Production.* An invited paper presented at the World Food Day / Open Day Celebration of the World Poultry Science Association, Nigeria Branch held at the University of Agriculture, Abeokuta on October 16, 2003.
4. Ibe, S.N. (1990). Utilising local poultry gene resources in Nigeria. *Proceedings of the 4th World Congress on Genetics Applied to Livestock Production,*14:51-53.
5. Oluyemi, J. A. and Oyenuga, V. A. (1971).A preliminary evaluation of the Nigerian indigenous fowls as table birds.*Proc. Agric. Soc. of Nigeria* 8: 22-25.
6. Ravi-Kumar, M., Bothra, T. and Ashok, K. (2002). Backyard poultry for socio-nutritional security of rural and tribal masses. *Poultry. Planner* 4:10-11.
7. Zahrudden, O., Ahemen, T. and Aliyu, P.I. (2011). Breeding characteristics of turkeys (*Meleagris gallapavo*) in parts of Jos Plateau. *Proc. 36thConfr. Nig. Soc. Anim. Prod.* 13-16th March, 2011. Univ. of Abuja, Nig. Pp 29-32.
8. Nosike, R.J., Nwachukwu, E.N., Ibe, S.N., Obike, O.M. and Okoro, V.M.O. (2013). Relationship between biologic markers and quantitative traits in the domestic rabbit. *Proc. 40th Confr., Nig. Soc. Anim. Prod.* Rivers State Univ. of Science and Tech., Port Harcourt, Nig. Pp. 62-65.
9. Maxwell, M. H, Robertson, G.W., Spence, S. and McCorquodale, C.C. (1990). Comparison of haematological values in restricted and *ad libitum*-fed domestic fowls: White blood cells and thrombocytes. *British Poultry Science* 33: 399-405.
10. Ibe, S.N. (1998). *An Introduction to Genetics and Animal Breeding*. Longman Nig. Plc. Lagos. Pp 92-93.
11. Montaldo, H.H. (2006). Genetic engineering applications in animal breeding. Pontificia Universided Católica de Valparaiso-Chile. *Electronic Journal of Biotechnology. http:// www. ejbiotechnology.info/content/vol9/issue2/full/4/index.html*
12. Dacie, J.V. and Lewis (1999*). Practical haematology* (7th Ed) ELBS with Churchill Livingstone, England, Pp. 15-16.
13. Jain, C.N. (1986). *Shaulms Veterinary haematology* 4th ed. Lea and Feabriger, Philadephia.
14. Lawrence, M. S. (1986). *Amino acids and proteins. In: Textbook of Clinical Chemistry*. Tiezt, N. W. *(editor).* W. B. Saunders Company, US. Pp. 519-618.
15. Barker, F. J. and Silverton, R.E. (1976). *Introduction to medical laboratory technology*, 5th Edition. Butterworth and Co. Publishers Ltd, London. Pp.540-621.
16. Yahav, S. (2000). Domestic fowl: strategies to confront environmental conditions. *Avian and Poultry Biology Reviews.*11:81-95.
17. SPSS (2011). Statistical Package for Social Sciences. SPSS Inc. (16.0), 444 Michigan Avenue, Chicago.
18. Snedecor, G.W., and Cochran, W.G. (1980). *Statistical method*. (8th Ed). Ames, Iowa, U.S.A., The Iowa State University Press.