

Effect of early feeding of diluted diets on haematology and serum chemistry of exotic and improved local chicks

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Target Audience: *Animal Nutritionist, Geneticist, Physiologist and Poultry farmers*

Abstract

An experiment was conducted to evaluate the haematology and serum biochemistry of exotic and improved local chicks fed different diluted diets at early age (0 – 4 weeks). Two hundred (200) day old chicks (exotic and improved local genotype) were used for this study. The chicks were wing tagged and grouped at random based on genotypes to four dietary treatments. The diets were; commercial diets (CD) as Control, CD + 20% wheat offal (CDW), CD + 20% palm kernel cake (CDP) and CD + 20% processed baobab seed meal (CDB). At four weeks of age, blood samples were taken from the chicks for serum and haematological assay. The results indicated that packed cell volume, white blood cell, red blood cell, lymphocyte, neutrophil, monocyte, eosinophil and basophil were similar ($p < 0.05$) irrespective of the chicks' genotype and across the dietary treatments. Significant ($p < 0.05$) variations existed in haemoglobin value between the strains and across the dietary treatment (2.45 to $8.80 \times 106g^{dl^{-1}}$). Alanine aminotransferase and uric acid were not significantly influenced ($p > 0.05$) by genotypes and diets, but glucose, protein, albumin, cholesterol, alkaline phosphatase, aspartate aminotransferase, creatinine, high density lipoprotein, low density lipoprotein and triglycerol significantly ($p < 0.05$) varied. Dilution of chicks' diets should be discouraged because it had a significant negative effect on haemoglobin and caused significant variations in chicks serum chemistry.

Keywords: Chicks, Diet Dilution, Strains, Haematology, Serum Chemistry.

Description of the Problem

As human population continues to grow, with the greatest growth expected in countries that are already suffering from chronic hunger and malnutrition, there is need to ensure food safety for all and especially the more susceptible sector of human population (1). Growth in human population has led to continuous and increasing demand in poultry products and geometric growth in poultry production, thus putting more pressure on feed and feeding of chickens and created an increase in demand for poultry feed in the

developing countries which suggest that alternative feed resources must be identified and properly evaluated (2).

The potential of poultry industry in alleviating the challenges of low availability of animal protein for human consumption in developing countries is being hampered by high cost of production (3). This is because feed cost accounts for about 70% of the total cost of poultry production and is thereby considered a major determinant of the profitability, sustainability and development of the poultry enterprise (4, 5 and 6). The uses of

several by products and industrial waste have been one of the panaceas for high feed cost in developing countries and several authors have looked in the direction of different industrial by-products and those classified as waste such as pineapple waste, bambara groundnut waste product, poultry waste, chicken offals, rice bran, wheat offal, castor oil bean, kolanut husk, rumen content, sunflower seed cake, shrimp waste meal, etc. in order to solve the problem of high cost and non-availability of feed ingredient for animals (7, 8, 9, 10, and 11). Research emphases are also on the potentials of ignored and under-exploited trees, shrubs and their products that are native to Africa (12 and 13) as protein and energy source; baobab (*Adansonia digitata* L.), and its seed belongs to such category.

The utilization of fibrous feed ingredient as alternative feed stuffs in poultry production is not new but the inclusion level at various ages and physiological conditions varies. Researchers are working tirelessly to ensure safety and appropriate use of these by products as shown in the work of (14) where the preference of farmers to different agro-industrial by-products (AIBs) and the maximum tolerance level in broiler chicken diets were reported, and (15) where the graded level of including some agro-industrial by-product into poultry diets and ways of improving their utilization were stated. Despite all that has been reported about their usage, high cost of commercial/ complete feed during the off seasons used to push a lot of small scale and backyard poultry farmers to indiscriminate dilution of complete diet with any available cheaper source of fibre without given due consideration to the adverse effect it might have on well-being and general performance of the chickens.

In evaluating any unconventional feed resources, (16) reported that it is important to check the effects of such feed resources on the health status of the livestock and stated that

haematological constituents which reflects the physiological responsiveness of animals should be evaluated as the influence of the diet on haematological traits is very strong (17, 18). It was stated by (19) that blood plays an important role in the transportation of nutrients, metabolic waste products and gases around the body. Moreover, blood represents a means of assessing clinical and nutritional health status of animals (20). The haemato-biochemical profiles are most commonly used in nutritional studies for chickens (21) and other birds like pigeon (22), guinea fowl (23), bronze turkey (24) and Japanese quail (25). The full blood count examines mostly the cellular components of blood whereas biochemical testing focuses on its chemical constituents (26). It has been shown that data from blood profiles could be exploited in the improvement of chicken stocks (27). In addition, blood parameters help diagnose specific poultry pathologies and might serve as basic knowledge for studies in immunology and comparative avian pathology (28).

The study on the changes in blood characteristics of livestock have been widely reported, particularly in regard to detecting the health status from diseased or stressed animals exposed to different toxicants and metabolic stress. Since a lot of farmers are into high dilution of complete feed as a result of high cost in price of conventional feed ingredients (inflation and recession), without given due consideration to the consequences of creating nutritional imbalance on the blood parameters of the chickens which was reported to be a good indicator for determination of the health status of the chickens. This research is therefore designed to examine the haematological and serum biochemical indices of exotic and improved local genotypes of chicks fed with complete diets (formulated to meet the nutrient requirements of chicks) and those diluted with certain percentage of processed Baobab seed meal, Wheat offal and

palm kernel cake as a cheaper sources of feed ingredients.

Materials and Method

Experimental Designs, Experimental Diets and Management of Experimental chicks

A total of two hundred (200) chicks used for this study consist of one hundred (100) day old of improved local chicks genotype purchased from the Kwara State University Farm (Malete, Kwara State) and 100 exotic day old chicks genotype (ISA Brown) purchased from Yammfy Farms (Ilemona, Kwara State) in a 2 x 4 factorial experimental design. Two (2) chicks genotypes were used i.e the exotic and improved local, and they were fed four (4) different types of diets; the Complete Diets (CD), Complete Diets diluted with processed Baobab seed meal (CDB), diluted with wheat bran (CDW) and diluted with palm kernel cake (CDP), the diluents were selected based on their availability and cheaper cost during the experimental period. The chicks were grouped randomly according to genotypes with 25 chicks per treatments which was replicated 5 times consisting of 5 birds per replicate. The birds were housed in a well-ventilated poultry cage partitioned to house each replicate throughout the experimental period. The experimental diets were; complete diets (CD) used as the Control, CD + 20% wheat offal (CDW), CD + 20% palm kernel cake (CDP) and CD + 20% processed baobab seed meal (CDB). The complete diet was manipulated to accommodate 20% of the diluent as shown in Table 1 and fed during the first four weeks of chicks' age. Sample of the experimental diets were subjected to proximate analysis using the procedure outlined by Association of Official Analytical Chemists (29) and the results were as shown in Table 2. Routine management and Vaccination programme necessary for the chicks were duly followed as described by (4).

Haematological and Serum Chemistry Analysis

At the fourth week of age, two birds were randomly selected per replicate making a total of 4 birds per treatment. Blood samples were collected through brachial vein puncture using sterilized needle, and 5ml disposable syringe was used for withdrawal of 5ml of blood from the vein of each chick after local disinfection with methylated spirit; 2ml out of the withdrew blood were placed inside labeled bottles containing Ethylene Diamine Tetra Acetic-acid (EDTA). The blood samples were properly shaken to mix with the EDTA in order to prevent coagulation. 3ml of blood sample for serum biochemical indices were dispensed into labelled bottle (without EDTA) and the blood sera were separated by centrifuging for 15 minutes at 10 revolutions per minutes (rpm) after which the sera was decanted into a well labeled bottle for further analysis. Blood samples for haematology, were analyzed for the following parameters namely; Red Blood Cell (RBC), Packed Cell Volume (PVC), Haemoglobin (Hb), White Blood Cell (WBC) as well as differential count of Neutrophil, Basophil, Eosinophil, Lymphocyte and Monocyte according to (30). Serum biochemical indices parameter taken were serum total protein, creatinine, blood glucose level, albumin, globulin, blood urea, alkaline phosphate, aspartate aminotransferase, alanine aminotransferase, cholinesterase, creatinine kinase were determined according to (31). Lipid fractions were obtained by the kit method using Agappe kit. The fractions include the Total Serum Cholesterol, Triglyceride, High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL). Glucose level was determined by the use of O-Toluidine method; total protein and albumin by biuret method of (32). Alkaline phosphate, enzyme transaminase were analyzed spectrophotometrically by using commercially available diagnostic kit (Randox^R test kit) as

described by (33). The haematological assay and serum biochemical indices were carried out at University of Ilorin Teaching Hospital (UITH).

Statistical Analysis

Data obtained were subjected to Multivariate General Linear Model Analysis of (36) and significant differences of the means were separated by Duncan multiple range test of the same package.

Results and Discussion

The effects of different diluted diets on the haematology parameters of exotic and improved local chicks are as shown in Table 3. It was observed that there were no significant ($p > 0.05$) effects of diluted diets on the chicks genotype used for this study. PCV and Haemoglobin were significantly ($p < 0.05$) different across different diluted diets fed to the chicks and between the two genotypes studied (improved local and exotic chicks) while other parameters such as WBC, RBC, Lymphocytes, Neutrophils, Monocytes, Eosinophil and Basophils obtained were not significantly ($p > 0.05$) affected by chicks genotypes and across different diluted diets fed to the chicks. Though, significant ($p < 0.05$) variations existed in PCV value obtained across the dietary treatments with $CDW > CD > CDB > CDP$, and ranged from 26.50 to 36.25%, it was also significant ($p < 0.05$) between the two genotypes of chicks studied but the values were within the normal range of PCV reported for chickens by (37). However, no significant interactions were recorded in this study when the chicks' genotype and different diluted diet fed were considered for haematological parameters throughout the experimental period.

Values obtained here corroborate that of (38) where 26.1- 29.5% PCV were reported for the Nigerian indigenous chicken and those of (39) where 27.38 - 34.60% PCV were

obtained in Fayoumi, Assil and local chickens in Sylhet region of Bangladesh. It also fell within the range of PCV (35. 21 to 40.70%) reported by (40) for the native chicken of Kashmir. The PCV values obtained in the present study were in accordance with 26.38 reported for 5weeks old broilers by (41). Haemoglobin values obtained for the chicks fed diluted diets in this study (2.45 – 3.80 g/dl) were below the range of 7.4 to 13.1 g/dl established for normal values for chickens as stated by (37) and values of 6.3 to 7.8 g/dl reported for Hb by (42), and 8.7 to 9.3 g/dl for Hb by (38) when it was determined in Nigerian indigenous chicken. Lower Hb values obtained in this study did not affect the physical appearance of the chicks, but it is an indication that the chicks were suffering from anaemia.

The RBC of chicks fed the diluted diets ($1.80 - 2.25 \times 10^6/\text{mm}^3$) fell below the range of established values of $2.8 \times 10^6/\text{mm}^3$ reported by (44) but within the range of 1.58 to $4.1 \times 10^6/\text{mm}^3$ reported by (37) for healthy domestic chickens. The RBC values of $2.35 \times 10^6/\text{mm}^3$ have been reported by (2), $2.84 \times 10^6/\text{mm}^3$ by (43) and $3.0 \times 10^6/\text{mm}^3$ by (44) had been reported for exotic chickens, while (40) reported 2.98 to $3.2 \times 10^6/\text{mm}^3$ RBC for the native chicken of Kashmir. However, the results obtained here were slightly higher than a minimum of $1.5 \times 10^6/\text{mm}^3$ reported by (42), though (42) reported a range of 1.5 to $2.6 \times 10^6/\text{mm}^3$, while 2.39 to $2.94 \times 10^6/\text{mm}^3$ were reported by (38) for local chicken. The WBC value of chicken fed diluted diets ($8.90 - 10.68 \times 10^6/\text{mm}^3$) obtained here were not significantly ($p < 0.05$) different and their values were lower, but fell within the normal range of 9.20 to $31.0 \times 10^6/\text{mm}^3$ reported by (44); (37) and (45) for healthy domestic chickens, it was however higher than $6.95 \times 10^6/\text{mm}^3$ minimum, and lower than $18.65 \times 10^6/\text{mm}^3$ reported by (42) and (38) for healthy Nigerian local chicken.

The lymphocytes were the most numerous and frequent WBC type followed by eosinophil and the monocytes. (46) reported the same trend that corroborates what was obtained in this study and described the lymphocytes as the most numerous WBC in chickens and turkeys. The lymphocytes (28.75 – 39.00 %) and monocytes (0.00 – 0.75%), which were granulocytes of WBC, fall below the normal range from 47.2 to 85.0% and 0.06 to 5.0% respectively for a healthy chicken reported by (44) and (37). Lymphocytes which are implicated in antibody production, because they are reactive cells in inflammation and delayed hypersensitivity (45), while basophils are responsible for the elaboration of histamines and heparin in circulating blood and eosinophil functions in phagocytosis, although values obtained for these three hematological parameters were lower than normal range earlier reported for chickens, it did not pose any threat to the life of the chicks at this initial stage, but the sustainability of this threat less effect cannot guarantee if feeding of diluted diets continue as the chicks grow older.

The PCV and RBC values obtained in this study indicated that the chicks health status were not really affected and they had normal metabolic rate, but lower value reported for Hb is a pointer to the fact that the chicks blood is in an anaemic state and lacks enough red blood cells, most especially the improved local genotype and when both genotypes were fed CDP, this might be due to the destabilization of nutritional content of the diet recommended for chicks by additions of cheaper fibre source as a diluents to the complete feed. RBC has been stated to carries the respiratory pigments (36) i.e. the haemoglobin, therefore the normal value obtained for RBC in this study indicated the presence of a quantity that is enough for circulation and showed ability of the chicks to withstand respiratory stress despite been fed diluted diets.

This study revealed that, although feeding of chicks with diluted diets which is of poor standard compared to their normal diet could make them have a normal value for some of the haematological parameters measured, but not all the values were within the normal range. Lower values were obtained for haemoglobin count, lymphocytes, monocytes and basophils. Significant effect of diluted diets on PCV and haemoglobin could be as a result of the fact that these two parameters are important pointer to health status of chickens and could be easily affected by nutritional inadequacies. The availability of the nutrients in the diluents incorporated into the complete diets also varied according to diluent type, composition and the level of anti-nutritional agents present in the diluents and this will contribute to the variations observed in blood parameters across the dietary treatment and the tolerance level by the genotype studied.

Table 4 showed the effects of feeding different diluted diets on serum chemistry of exotic and improved local chicks. It was observed that, there were significant ($p < 0.05$) differences between the exotic and improved local chicks in some of the parameters measured for the serum chemistry with the exotic chicks having significantly ($p < 0.05$) higher value, while AST, ALT and uric acid value were numerically but not significantly ($p > 0.05$) different. The glucose concentration was highest in the chicks fed the control (CD) diet and lowest in chicks fed commercial feed and palm kernel cake (CDP) during the experimental period, this corroborate the findings presented earlier where the chicks fed CDP had the lowest haemoglobin value. The serum protein was lowest in chicks fed complete diet diluted with Baobab seed meal (CDB) and highest in chicks fed complete diet with Wheat offal (CDW), while chicks fed CD showed a significantly ($p > 0.05$) similar serum protein with those fed complete diet diluted

with palm kernel cake (CDP) and wheat offal (CDW) .

Alkaline Phosphatase (ALP) has the most diverse value as none of the chicks fed different diluted diets had similar value. The ALP concentration in the serum was highest in chicks fed CDW and lowest in chicks fed CDB during the early stage of life (0-4weeks). AST and Triglycerol showed similarity in pattern of significance in CD, CDW, and CDP but lower in concentration significantly ($p < 0.05$) in chicks fed complete diets diluted with processed baobab seed meal (CDB). The chicks genotypes and diet interaction for serum chemistry was not significant ($p > 0.05$) in most of the parameters measured, except in ALP concentration where significant ($p < 0.05$) effect on chicks genotype and dietary treatment was recorded. Table 5 shows the result of interaction between the chicks genotype and different diluted diet on the ALP content of the serum chemistry evaluated. The concentration was lowest in the local chicks genotype that were fed complete diet with processed Baobab seed meal (CDB) and was highest in exotic chicks genotype that were fed complete diet with wheat bran (CDW) at early age.

Conclusion and Applications

This research revealed that:

1. The haemoglobin value of the exotic and improved local genotypes of chick fed diluted diets were below the normal range of values reported for chickens and continuous feeding of such diets could result into anaemic conditions.
2. Feeding of diluted diets to chicks significantly affected their PCV, while WBC, RBC, Lymphocytes, Neutrophils, Monocytes Eosinophil and Basophil values were not significantly affected;
3. The serum chemistry of the exotic and local chicks genotype used for this study showed a wide range of significant ($p < 0.05$) differences with the values obtained for glucose, protein, albumin, cholesterol, ALP, Uric acid, creatinine, HDL, LDL, triglyceride in the exotic genotype higher than those obtained for the improved local chicks genotype;
4. Farmers are advised to feed diets with adequate nutrient contents and avoid unnecessary dilution of diets with cheaper fibre sources.
5. This study should serve as a reference point to discourage poultry farmers (small, medium scale farmers, seasonal and backyard poultry keepers) and feed millers from diluting a complete diet, especially when dilution of complete diet is been considered as a means to save cost of feeding or to have more feed for chickens for a stated period of time as it could have negative effects on general well-being of the chickens and affect their health status significantly.

Table 1: Gross Composition of Experimental Diets (%)

Feed Ingredients	Complete diet	CD+20% PBSM	CD+20% PKC	CD+20% WO
Maize	50	40	40	40
Maize Bran	7	5.6	5.6	5.6
Soybean Meal	23	18.4	18.4	18.4
Groundnut Cake	6	4.8	4.8	4.8
Fish Meal	10	8	8	8
DCP	2	1.6	1.6	1.6
Limestone	1	0.8	0.8	0.8
Methionine	0.25	0.2	0.2	0.2
Lysine	0.25	0.2	0.2	0.2
Vitamin Premix	0.25	0.2	0.2	0.2
Common Salt	0.25	0.2	0.2	0.2
BSM	-	20	-	-
PKC	-	-	20	-
Wheat Offal	-	-	-	20
Total	100	100	100	100

CD=Complete Diet; PBSM= Processed Baobab seed meal; P=Palm Kernel Cake; WO= Wheat Offal.

Table 2. Proximate Composition of the Experimental Diets

DIETS	DRY MATTER (%)	MOISTURE CONTENT (%)	CRUDE PROTEIN (%)	FAT EXTRACT (%)	CRUDE FIBRE (%)	TOTAL ASH (%)
Complete (CD)	90.49	9.51	21.47	6.15	5.46	6.82
CD PBSM	91.50	8.30	18.19	7.04	9.82	10.60
CD PKC	91.32	8.68	16.66	4.69	8.32	8.17
CDWO	90.62	9.38	19.72	4.32	9.82	7.69
PBSM	92.05	7.95	20.12	11.49	10.50	6.09
PKC	90.40	9.60	14.66	7.49	13.40	8.26
WO	91.19	8.81	16.47	5.70	11.15	16.59

CD=Complete Diet; PBSM= Processed Baobab seed meal; P=Palm Kernel Cake; WO= Wheat Offal.

Table 3: Effect of Feeding Different Diluted Diets on Haematological Parameter of Exotic and Improved Local Chicks Genotype

	PCV (%)	WBC x10 ⁶ mm ³	RBC x10 ⁶ mm ³	Hb (gdl ⁻¹)	L (%)	N (%)	M (%)	E (%)	B (%)
GENOTYPE									
EXOTIC	35.88*	10.68	2.20	3.48*	33.63	64.25	0.63	1.13	0.38
LOCAL	28.38	9.80	2.00	2.88	34.38	62.75	0.38	1.75	0.38
DIETS									
CD	33.75 ^{ab}	10.48	2.15	2.95 ^{ab}	39.00	59.50	0.75	0.75	0.00
CDB	32.00 ^{bc}	10.93	2.20	3.50 ^{bc}	34.25	63.00	0.50	1.50	0.75
CDP	26.50 ^a	8.90	1.80	2.45 ^a	34.00	64.25	0.00	1.25	0.50
CDW	36.25 ^c	10.65	2.25	3.80 ^c	28.75	67.25	0.75	2.25	0.25
INTERACTION									
G x D	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.E.M	1.744	0.319	0.099	0.183	1.698	1.597	0.242	0.316	0.221

Mean on the same column with different superscripts are significantly different at $p < 0.05$

CD = complete diet; CDB = complete diet + Processed Baobab seed meal; CDP = complete diet + palm kernel cake; CDW = complete diet + wheat offal; PCV = packed cell volume; WBC = white blood cell; RBC = red blood cell; Hb = Haemoglobin; L = Lymphocyte; N = Neutrophil; M = Monocyte; E = Eosinophil; B = Basophil; G = Genotype; D = Diet

Table 4: Effect of Feeding Different Diluted Diets on Serum Chemistry of Exotic and Improved Local Chicks

	Glucose mg/DL	Protein g/DL	Albumin g/DL	Ch Mm/L	ALP iu/L	AST U/l	ALT U/l	UA mg/Dl	Creatinine mg/DL	HDL Mm/L	LDL Mm/L	Triglycerol mg/DL
GENOTYPE												
EXOTIC	14.28*	54.74*	19.94*	1.65*	138.75*	57.50	29.75	1.25*	24.33*	1.49*	2.20*	2.98*
LOCAL	10.80	48.80	17.64	1.10	108.13	55.13	26.00	1.09	18.21	1.13	1.57	2.23
DIETS												
CD	13.30 ^c	54.63 ^{bc}	20.33 ^b	1.48 ^b	125.50 ^c	60.00 ^b	28.50	1.11	24.70 ^b	1.47 ^b	1.86 ^b	2.88 ^b
CDB	12.15 ^{ab}	44.38 ^a	16.83 ^a	1.16 ^a	94.25 ^a	47.50 ^a	23.50	1.20	19.08 ^a	1.03 ^a	1.47 ^a	1.51 ^a
CDP	11.65 ^a	51.23 ^b	17.73 ^{ab}	1.43 ^b	110.50 ^b	56.75 ^b	27.50	1.24	15.94 ^a	1.46 ^b	2.45 ^c	3.32 ^b
CDW	13.05 ^{bc}	56.85 ^c	20.28 ^b	1.45 ^b	163.50 ^d	61.00 ^b	32.00	1.25	25.36 ^b	1.28 ^{ab}	1.76 ^{ab}	2.70 ^b
INTERACTION												
G x D	NS	NS	NS	NS	S	NS	NS	NS	NS	NS	NS	NS
S.E.M	0.502	1.627	0.644	0.083	8.715	2.097	1.640	0.033	1.470	0.074	0.136	0.210

Mean on the same column with different superscripts are significantly different at $p < 0.05$

CD = complete diet; CDB = complete diet + Processed Baobab seed meal; CDP = complete diet + palm kernel cake; CDW = complete diet + wheat offal; Ch. = cholesterol; UA = Uric acid; ALP = Alkaline Phosphatase; AST = Aspartate Aminotransferase; ALP = Alanine Aminotransferase; HDL = High density lipoprotein; LDH = Low density lipoprotein; Genotype = G ; D = Diet.

Table 5: Effect of feeding different Diluted Diets on Alkaline Phosphatase (ALP) Content of Serum Chemistry of Improved Local and Exotic chick genotypes

	CD	CDB	CDP	CDW
EXOTIC	131.50 ^d	99.00 ^{ab}	121.00 ^{cd}	203.50 ^c
LOCAL	119.50 ^{bcd}	89.50 ^a	100.00 ^{abc}	123.50 ^d

Means with different superscripts are significantly different at $p < 0.05$

CD= complete feed; CDB = complete feed + 20% Baobab seed meal; CDP = complete feed + 20% palm kernel cake; CDW = complete feed + 20% wheat offal

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