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Research Article
Effect of Beetroot Juice (*Beta vulgaris*) on Growth Performance, Blood Profile and Carcass Characteristics of Broiler Chicken

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Abstract

Objective: This study was carried out to determine the effect of beetroot juice (*Beta vulgaris*) as an additive on the performance, carcass characteristics and blood profile of broiler chicken. **Materials and Methods:** A total of 120 day-old Marshal broiler chicks were assigned to 4 treatments at 30 birds per treatment with 3 replicates of 10birds in a completely randomized design. Birds were kept in movable pens with feed and water offered *ad libitum*. Beetroot juice was administered in the bird's drinking water every other day at 0 mL (T1), 10 mL (T2), 20 mL (T3) and 30 mL (T4) for 8 weeks. Different parameters measured included: feed intake, weekly weight gain, mortality rate, dressing percentages and blood parameters using standard procedures. Results were subjected to one-way ANOVA. **Results:** Significant differences ($p<0.05$) were observed in the average daily feed intake and the average daily weight gain. Birds in T4 had the best feed conversion ratio of 1 .65. Treatments effects on packed cell volume (PCV), hemoglobin (Hb) and red blood cells (RBC) were significant ($p<0.05$) with T4 having the highest values of 40.33%, 11.96 g dL^{-1} and 3.82×10^6 uL respectively. Birds in T3 had the highest value (4.0%) of monocytes, while those in T1 had the lowest value (2.33%). Birds in T1 had the highest value of Eosinophil (4.33%) while birds in T4 had the lowest (0.33%). Serum biochemical parameters were significantly different ($p<0.05$); birds in T4 had the lowest glucose (150.58 mg dL^{-1}), cholesterol (82.54 mg dL^{-1}) and triglyceride (122.29 mg dL^{-1}) values. With the exception of eviscerated liver and heart percentages, no differences were observed in the carcass characteristics. **Conclusion:** Findings from the study indicated that inclusion of beetroot juice *(Beta vulgaris*) in the drinking water of broiler chicken at 30ml can improve the growth performance, PCV, RBC and Hb and also reduce the Glucose, Cholesterol and Triglyceride levels of birds.

Key words: broiler, beta vulgaris, carcass characteristics, blood profile, biochemical parameters

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The Poultry industry produces high-quality proteins for human nutrition, it is a source of income for the community in many countries and hence it is therefore very important in economic development of any country[1]. In Nigeria, the demand for broiler meat is increasing rapidly, driven by increased income, population growth and urbanization. Broiler farming seems to be a considerable part of meat production and consumption in the country. Broiler production has grown dramatically in the past two decades; these improvements are largely due to numerous researches and breeding programs which further enhanced feed utilization and growth rate. Feed is the key constituent of overall costs of poultry farming; responsible for about 70-80% of the total expenses on the cost of poultry production[2]. The awareness for feed additives has increased over the last decade. Feed additives are clusters of nutrient and non-nutrient composites which help in improving the efficiency of feed utilization and consequently reducing the high cost of feed. These additives have established a great consideration as feed supplements for numerous purposes in poultry production throughout the recent years[3]. In the past, antibiotics were regularly used as feed additives. Currently, use of antibiotics is not only restricted but also their practice in livestock and poultry industry have been prohibited in many countries due to modification of natural gut microbiota and drug resistance in microorganisms and humans.

Natural growth promoters such as prebiotics, probiotics, enzymes and plant extracts etc., can be used to feed the broilers without any adverse effect on the performance of birds[4]. The beneficial properties of bioactive plant constituents in animal nutrition may include; stimulation of appetite and feed intake, enhancement of endogenous digestive enzyme secretion, stimulation of immune responses, antibacterial, antiviral and antioxidant action[5].The prospect of achieving food security and relative self-sufficiency in animal protein supply in a rapidly growing population calls for increased production of meat animals, notably poultry, which are currently produced at subsistence level. Poultry birds as good sources of animal protein, can readily convert feed to meat and eggs.

Herbs and natural products are cheaper and can be used as alternative feed additives to enhance performance of poultry birds[6]. Beetroot (*Beta vulgaris*) a native of the Mediterranean region from the family of Chenopodiaceae, is otherwise known as garden beet, table beet or red beet. It is commonly known for its dark red color; however the colour may also range from white to yellow and candy cane red depending on the variety[7]. Beetroot is very rich in antioxidant and it makes an excellent dietary supplement, being not only rich in minerals, nutrients and vitamins but also has unique phyto-constituents. Several parts of this plant are used in medicinal system as anti-oxidant, anti-depressant, anti-microbial, anti-fungal, anti-inflammatory, diuretic, expectorant and carminative[8-10]. It is one of the natural food which boosts the energy in athletes as it has one of the highest nitrates and sugar content[11]. Beetroot is a biennial plant that is cultivated for its thick flashy roots in early spring. It is mostly grown in the northern states of Nigeria. The deep red roots of beetroot are eaten either boiled or roasted as a cooked vegetable, or cold as a salad after cooking and adding oil and vinegar, or raw and shredded, either alone or combined with any salad vegetable. The young leaves can be added raw to salads, while the mature leaves are commonly served boiled or steamed and they have taste and texture similar to spinach[12].

The evaluation of potential alternatives to antibiotic use in Antibiotic-Free (ABF) Programs is currently an important topic in poultry industry and research. Therefore, the development of feed additives that support broiler performance in ABF programs is of interest. This study was conducted to assess the efficacy of beetroot juice as alternative in Antibiotic Free Programs and its effects on growth performance, blood profile and carcass characteristics in broilers.

MATERIALS AND METHODS

Sourcing and processing of beetroot: Fresh beetroot was sourced and purchased from a local market in Lagos state, Nigeria. Beetroot was washed and peeled. It was further cut into smaller cubes in half, to enhance easy placing of chunks into the juicing machine for juice extraction.

Location of the study: The experiment was conducted at the Teaching and Research Farm of Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Ogun State. Ilishan-Remo is in the rain forest of South Western Nigeria with mean rainfall of 2400 mm. It falls on latitude of 6°54'N from the equator and longitude 3°42'E from the Greenwich Meridian and the mean annual temperature is about 27°C.

Experimental birds and designs: A total of 150 day-old Marshall Broiler chicks were procured from a reputable hatchery. They were brooded together for one week and thereafter 120 of the birds were randomly assigned into four

treatments on a weight equalization basis. Birds on each treatment were further divided into 3 replicates of 10 each in a completely randomized design. Feed and water were provided *ad libitum* all through the experimental period of 56 days.

Experimental diets and treatments: Starter and finisher standard diets were formulated and fed to the birds[13]. The analysis of the diet is as shown in Table 1. This indicates that the diets can supply the required nutrients for the birds. The four experimental treatments included graded levels of beetroot juice in drinking water were as follows: T1: water+antibiotic additive, T2: water +10 mL beetroot Juice per liter of water, T3: water +20 mL beetroot Juice per liter of water, T4: water +30 mL beetroot Juice per liter of water.

Feeding and management procedures: All the experimental birds were reared in well-ventilated moveable cages and kept under uniform management conditions. The formulated diets and water were supplied to the birds *ad libitum* throughout the study period. Each cage was 5×4 ft. which was for 20 birds. The cages were washed and disinfected using germicide as disinfectant and kept vacant for two weeks prior to the arrival of the chicks. The experimental birds were vaccinated but not medicated due to the nature of the experiment.

Growth and blood parameters evaluation: Each bird was weighed at the beginning of the experiment and at the end of every week to determine weight gain. Daily feed intake was recorded within each group to determine the total feed intake from the beginning to the end of the experiment. Total weight gain and total feed intake were used to determine feed conversion ratio. Record of mortality was kept as they occur, to determine the survivability rate. At the end of the 6th week, 5ml of blood samples were collected from 2 birds per replicate for hematological and serum biochemistry analysis. The birds were bled by the wing vein using hypodermic needle with syringe into 2 collection bottles containing ethylene diamine tetra acetic acid (EDTA) as an anti-coagulant while the other for serum collection had no anti-coagulant. The parameters measured were red blood cell, packed cell volume, hemoglobin and white blood cell. Serum biochemical indices investigated were included total protein, globulin, albumin and albumin: globulin ratio, glucose, cholesterol, creatinine and triglyceride.

Carcass quality evaluation: At the end of the experiment, 2 birds of each replicate were randomly selected. The selected birds were starved overnight and their fasted live weights were recorded. Birds were slaughtered by using sharp knife on the jugular vein according to Ojewola and Longe[14]. Birds were defeathered and eviscerated and the respective weights were taken. The thigh, wing, breast, drumstick and the organs (gizzard, liver and heart) weight were recorded.

Table 1: Nutrient composition of supplied ration

Nutrient	Broiler starter (0-21)	Broiler finisher (22-56)
Moisture (%)	10.00	11.00
Energy (kcal.)	3100.00	3150.00
Protein (%)	22.00	21.00
Fat (%)	5.00	5.00
Ash (%)	4.00	4.00
Lysine (%)	1.30	1.40
Methionine (%)	0.65	0.60
Phosphorus (%)	0.75	0.75
Calcium (%)	1.20	1.20

Data collection and Statistical analysis: Data regarding feed intake were recorded on daily basis. Weight gain was calculated on weekly basis by subtracting weight of the respective week from the last week weight. The FCR was calculated by dividing the feed intake by weight gain. The data collected on various parameters were subjected to one-way ANOVA using the SPSS software (SPSS, Inc., IBM, Chicago, Illinois, USA)[15]. Treatment means were tested using the Duncan's multiple range test and Differences of $p<0.05$ were considered statistically significant.

RESULTS

Effect of beetroot juice on growth performance: The growth performance of broiler chicken is shown in Fig. 1. The results indicated that T4 birds had higher final body weight (2110 g) and best weight gain (1712 g) while birds in T2 had the lowest final body weight (1826 g) and least weight gain (1423 g). However, the highest feed intake (3103 g) was obtained from birds of T1 followed by the birds in T4 (2830 g) while the feed intake of birds in T2 and T3 were not significantly different (2595 and 2580 g respectively). Figure 2 shows that the birds in T4 had the best FCR and the higher FCR (2.01)was observed for birds fed on control diets.

Blood profile: Table 2 shows the hematological parameters. The Packed Cell Volume values of the experimental birds ranged from 28.32-40.33,the haemoglobin values ranged from 9.43-11.96, RBC values ranged from3.27-3.82, while the WBC values ranged from 15.1-16.40, the platelet values ranged from 12.6-14.0. The lymphocytes, neutrophils and monocytes values ranged from 65.33-66.23; 22.66-27.37; 2.33-4.00 respectively. Eosinophil and Basophil values ranged from 0.33-4.33 and 0.00-0.33 respectively. All the values obtained were within the recommended standards for broiler chickens

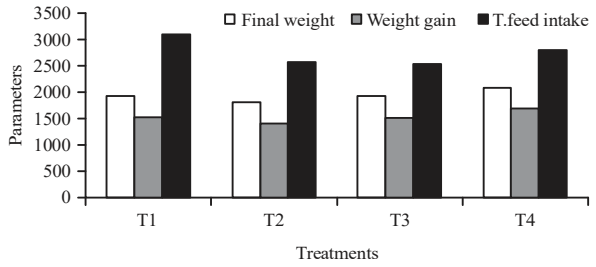

Fig. 1: Effect of beetroot juice on performance characteristics of broiler chickens

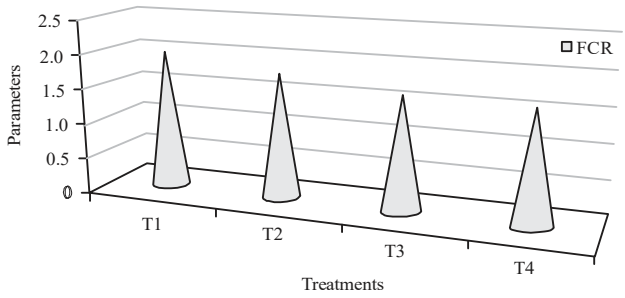

Fig. 2: Effect of beetroot juice on feed conversion ratio of birds

except for platelet, eosinophil and basophils. Figure 3 shows that the values obtained for the glucose ranged from 157.65-200.00, cholesterol value ranged from 82.54-141.14 while the triglyceride values ranged from 122.29-188.13. As the inclusion level of *beta vulgaris* juice extract increased, the value of glucose, cholesterol and triglyceride decreased.

Carcass parameters: Table 3 shows effect of graded level of beetroot juice on carcass characteristics of broiler chicken.

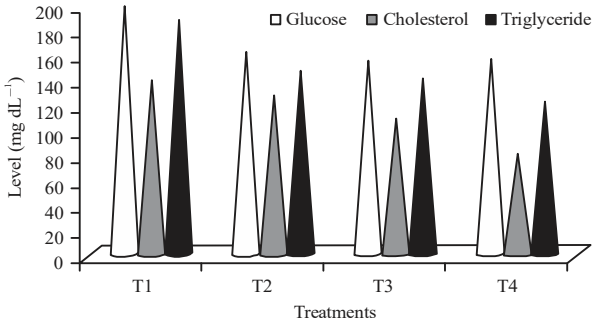

Fig. 3: Effect of beetroot juice on glucose, cholesterol and triglyceride of broiler chickens

Table 2: Effect of graded level of beetroot juice on hematological parameters of broilers

	Treatment					
Parameters	T1 (0.0)	T2 (10.0)	T3 (20.0)	T4 (30.0)	SEM	Range
PCV	28.33^{c}	36.33^{b}	38.66^{ab}	40.33^{a}	29.01	24.90-45.2
Hemoglobin	9.43^{c}	10.60^{b}	11.53^{ab}	11.96^{a}	0.27	7.40-13.1
Red blood cells	3.27^{c}	3.40^{bc}	3.50^{b}	3.82^{a}	0.13	1.58-4.10
White blood cells	15.10	15.20	15.60	16.40	2.17	9.20-31.0
Platelet	14.00	13.10	12.60	12.40	4.04	15.00-45.0
Lymphocytes	66.23	66.66	65.33	66.33	1.15	43.90-67.7
Neutrophils	22.66	27.37	24.37	23.33	0.92	15.60-32.8
Monocytes	2.33^{b}	3.00^{ab}	4.00^{a}	3.33^{ab}	0.27	0.06-9.10
Eosinophil	4.33^{a}	3.33^{ab}	3.00^{ab}	0.33^{b}	0.64	6.25-9.66
Basophil	0.33	0.00	0.00	0.33	0.11	2.50-5.36

^{ab}Means on the same row with different superscripts are significantly different ($p<0.05$). SEM: Standard error of mean

Table 3: Effect of graded level of beetroot juice on carcass characteristics of broiler chicken

	Inclusion level of beetroot juice (mL L^{-1})				
Parameters	0.00	10.00	20.00	30.00	SEM
Live-weight (g)	1995.64	2013.84	1935.40	1797.22	43.99
Eviscerated (%)	73.14^{b}	75.88^{ab}	76.68^{a}	74.58^{ab}	0.57
Dress out (%)	67.19	68.54	69.13	66.97	0.66
Drumstick (%)	12.36	12.18	11.97	12.27	0.08
Thigh (%)	11.96	12.10	11.97	12.55	0.15
Breast (%)	29.79	31.38	30.46	31.77	0.36
Organ weight					
Liver (g)	23.33	23.00	25.00	24.33	0.58
Liver (%)	1.17^{b}	1.14^{b}	1.29^{ab}	1.34^{a}	0.03
Heart (g)	7.00^{b}	7.00^{b}	10.00^{a}	10.00^{a}	0.57
Heart (%)	0.35^{b}	0.34^{b}	0.51^{a}	0.55^{a}	0.03
Gizzard (g)	40.00	38.66	42.66	39.00	1.12
Gizzard (%)	2.01	1.93	2.20	2.16	0.59

^{ab}Means on the same row with different superscript are significantly different ($p<0.05$). SEM: Standard error of mean

The values obtained for all treatments were not significantly different, except those of eviscerated, liver and heart percentages. The dress out percentages ranged from 66.97-69.13.

DISCUSSION

The results obtained in this study was in agreement with the findings of Kumari *et al*.[16] who studied the effect of dietary supplementation of sugar beet, neem leaf, linseed and coriander on growth performance and carcass trait of Vanaraja chicken, they reported that birds fed with any of the herbs had significantly higher weight and weight gain ($p<0.05$) when compared with the control. The results of the current study further agreed with the reports of Kumari *et al*.[16], who stated that the chicken fed sugar beet had significantly better ($p<0.05$) FCR when compared with the control. The results of the present study contradict with the findings of Emam[17] who evaluated the nutritional benefits of sugar beet pulp as untraditional feedstuffs in Gimmizah chicken diets and observed that chickens fed diets devoid of sugar beet had significantly better ($p<0.01$) live weight and feed gain but the reports on FCR was in agreement with the present study. This contrast may be due to the fact that sugar beet, used in the study of Emam[17], may contain higher levels of anti-nutritional factors compared to the extracted juice used in this study which is expected to have higher values of proteins and micronutrients.

The results related to hematological parameters, obtained in this study, was in agreement with the findings of Koschayev *et al*.[18] who reported that all the hematological parameters of broiler chickens fed on dry beet pulp were within the normal range. The present study also agrees with the findings of Koschayev *et al*.[18] who observed significantly higher values ($p<0.05$) of RBC and Hb for birds fed on dry beet pulp.

Results of carcass evaluation was in agreement with the observation of Kumari *et al*.[16] who reported that dressing percentage was not significantly affected ($p>0.05$) by the inclusion of sugar beets. However, broilers whose diets were supplemented with sugar beet had improved carcass characteristics as reflected in the eviscerated percentage observed in this study.

CONCLUSION AND RECOMMENDATION

Beetroot juice in drinking water improved the growth performance; feed conversion ratio and the health status of broiler chickens without antibiotic prophylactic treatment. Also, the availability of beetroot in the local market and its low utilization as a vegetable in Nigeria is an advantage for its use in poultry nutrition. It is therefore recommended that beetroot can be used at 0.03% in broiler drinking water for better growth performance. An in-depth study of the beetroot in the diet of broiler chicken is needed.

SIGNIFICANCE STATEMENT

The study revealed the potential of *Beta vulgaris* juice in improving the growth performance and feed conversion ratio of broiler birds, which indicates the possibility of lower cost of production for poultry sector. Beetroot juice in drinking water can improve the growth performance and blood profile of broiler chickens without antibiotic prophylactic treatment. This study will help the researcher to uncover the critical area of the effect of beetroot juice on performance, as well as the blood profile of broilers which many researchers have not been able to explore. Thus, a new theory on the use of beetroot juice extract in broiler chicken can be achieved.

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