Effect of Maize Substitution with Fermented Sugarcane Tops on Growth Performance and Lipid Profile of Broiler Chickens

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ABSTRACT

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| High cost of feed production has been a persistent thorn in the flesh of the Nigerian poultry production sector. The cost of maize, a vital source of carbohydrate in feed formulation has skyrocketed. The study revealed the potential of using Lacto bacillus fermented sugarcane tops (FST) as maize replacement in broiler feed formulation. Alkaline treated sugarcane tops sample was fermented using *lactobacillus* at pH 7 and temperature of 300C for 7 days to enhance its nutritional composition for inclusion in broiler feed formulation. Five diets were prepared with five different levels of FST as maize replacement, namely 0% FST (A), 25% FST (B), 50% FST (C), 75% FST (D), and 100% (E). Two hundred and fifty broiler chicks purchased from certified sale outlets in Katsina state were divided into five groups in a completely randomized design. The experimental broilers were given the formulated diet for eight consecutive weeks. At the end of the feeding trial, the Broilers were subjected to growth performance and lipid profile assessment. Broilers that received the A diet exhibited a significantly higher (p < 0.05) growth performance. However, LDL-cholesterol was significantly (p<0.05) influenced by FST. There is also an observed improved lipid metabolism as indicated by the reduced total cholesterol, triglycerides, and low-density lipoprotein LDL- cholesterol and the increased high-density lipoprotein HDL-cholesterol. In conclusion FST replacement improves the lipid profile in the experimental Broilers. The findings underscore the viability of fermented sugarcane tops as a sustainable and cost-effective substitute for maize in poultry diets. |

*Keywords: Vegetables, Children, Heavy metals, Katsina, Banditry, Cattle rustling, Population*

1. INTRODUCTION

The goal of poultry production research is to reduce production costs while preserving poultry comfort and enhancing performance and product quality (1Egbune and Tonukari, 2023). The Nigerian poultry production has been limited by the exorbitant cost of feed production which gulps up to 80% of total production cost, an ugly scenario affecting the level of chicken survival and the profitability of poultry farming (2; 3; 4). Katsina State in northern Nigeria the study area, has of recent witnessed a rise in the prevalence of banditry and kidnapping that has led to a decrease in agricultural production, leading to a continuous increase in the cost of food stuffs including the raw materials for poultry feed (5). In feed production, maize is the carbohydrate source of choice, but its availability and affordability is usually affected by the supply chain leading to its demand usually exceeding its supply with a resultant increase of above 2000% over the last 2 decades (4). This gloomy condition has resulted to the high cost of poultry feeds and a sharp rise in poultry production cost. As a boomerang effect feed producers are left with no option but to scout for alternatives that will substitute for the conventional feed raw materials but at the same time maintaining quality and standards. Several initiatives have been implemented, such as finding cheaper and locally available materials as partially substitutable energy source instead of maize in poultry feed formulations (6).

The world generates a large volume of agro-waste byproducts that might be beneficial alternative feedstuffs (1). Sugarcane top a major byproduct of the sugar industry may likely be a suitable contender. It is often left in the field unutilized after harvest. It is generally highly palatable, and contain a high amount of fibre and nutrients that make it a suitable contender for use in animal feed (7; 8; 9).

Sugarcane tops have very potential to be used for feed because of the large amount of them. Efforts to use sugarcane by-products have been done a lot, but they are still not optimal. The use of sugar cane tops as feed requires an appropriate technology approach to increase its added nutritional value. One strategy that can be done is to use it as fermented feed (10). Many previous studies have shown that feeding fermented feed had beneficial effects on growth performance in chickens (11; 12; 13).

Fermentation, one of the most ancient and economical methods of food preparation in the world, is defined as a technology in which microorganisms' growth and metabolic activities are used to preserve foods. It is an inexpensive process that requires comparatively little energy, and therefore it is the main strategy for food production in some cultures (14). It is a process that enhances the nutritional value of food by enhancing the quality of proteins, improving the absorption of fiber, and increasing the synthesis of essential amino acids, vitamins, and proteins. It also facilitates micronutrient availability while reducing anti-nutritional compound levels (1; 4).

There are two fermentation techniques: Solid state and submerged fermentation. Solid-state fermentation (SSF) is a process with a porous solid substrate or support for the growth of microorganisms with a continuous gas phase. It is arguably the most natural condition for the growth of microorganisms whose natural habitats are solid materials, such as plant and rock surfaces, soils and decomposing organic matter such as leaves, bark and wood. (15). To initiate solid state-fermentation (SSF), bacterial and fungal species that are generally recognized as safe (GRAS) organism are utilized (1). During fermentation, microorganisms break down fermentable carbohydrates into end products such as organic acid, carbon dioxide, and alcohol, as well as anti-microbial metabolites such as bacteriocins that increase food safety by killing or inhibiting food-borne pathogens (14).

In published works, there is paucity of results on the effect of fermented sugarcane tops inclusion in broiler chickens diet as carbohydrate source replacement for maize. As such, this work aimed to evaluate whether fermented sugarcane affects growth performance and lipid profile of broiler chickens.

The results obtained will be potentially useful in the poultry production sector, by provision of a cheaper and viable maize replacement in broiler feed formulation with a focus on its effects on growth performance, nutritional value, and economic viability.

2. material and methods

**2.1 SAMPLING AREA**

The study was carried out during 2024 in Katsina State, Nigeria. The State is located between latitude 12015’N and longitude of 7030’E in the North West Zone of Nigeria, with an area of 24,192km2 (9,341 sq meters). Katsina State has two distinct seasons: rainy and dry. The rainy season begins in April and ends in October, while the dry season starts in November and ends in March. The average annual rainfall, temperature, and relative humidity of Katsina State are 1,312 mm, 27.3ºC and 50.2%, respectively (16).

**Sample preparation**

The Sugarcane tops were purchased from the Katsina city central market. The sugar cane tops were cut into pieces and dried at room temperature to reduced moisture content. The dried sugarcane tops were then grinded into fine powder using a grinding machine. Alkaline treatment of the sample was done using 4 g of NaOH in 1litre of distilled water for 5 hours and then washed thoroughly, followed by spreading at room temperature for optimum drying of the substrate.

**Preparation of fermentation Medium**

Exactly 60 g, of the sample was measured and placed into a fermentation vessel. 140 mls of solution containing 28 g of peptone dissolved in 1000 mls of distilled water, 0.28 g of Disodium Hydrogen Phosphate, 1.4 g of Sodium Chloride, was measured and placed into the vessel, this mixture was shaken vigorously and was then autoclaved at 121⁰C for 30 minutes.

**Isolation of *lactobacillus* and inoculum preparation**

5.512 g of MRS agar was dissolved in 100 mls of distilled water, heated to dissolved and autoclaved at 1210C for 15 minute. After pouring the media (MRS) the sample was inoculated using sterile wire loop and autoclaved at 300C for 72 hours and colonies were observed and subcultured.

The treated sugarcane tops sample was fermented using the isolated *lactobacillus* at pH 7 and temperature of 30 degree Celsius for 7 days. The fermentation product was allowed to dry at room temperature.

**Experimental design for feed formulations and feeding trial**

Two hundred and fifty broiler chicks were purchased from certified sale outlets in Katsina state. The broilers were raised from a day old on a starter feed (premix and maize). The recommended medications and vaccines was administered to ensure good health status of the experimental birds. On the 14th day (2 weeks), the birds were weighed and divided into five groups in a completely randomized design. The broiler finisher feed was formulated with fermented sugarcane tops to replace maize in the premix /maize formulation; Diets A to E was produced using the following maize to fermented sugarcane tops as ratios: 4:0 (control), 3:1, 1:1, 1:3, and 0:4. Each diet was fed to each group for six weeks. Throughout the experiment, feed and water were provided *ad libitum*.

**Growth performance and survival of experimental broilers**

Each broiler was weighed daily and weight was recorded. The broiler samples were assessed after six weeks for growth performance analysis using the formulae recommended by Kari *et al.* (17):

Survival rate (%) = (Total number of survived broilers / Total number of experimental broilers at the beginning of the experiment) × 100%

Weight gain (%) = (Final weight − initial weight) × 100% / initial weight

Specific growth rate (%) = (log Final weight − log initial weight) × 100% / Experiment duration

Feed conversion rate (FCR) = Total feed consumption / broiler weight gain

**Blood sampling and biochemical analysis**

At the end of the feeding session, venous blood was taken with a sterile syringe and needle from pronounced veins in the experimental broilers' wings and transferred to a test tube. After allowing the blood to coagulate for a while, it was dislodged and centrifuged at 2000 g for 10 minutes to get the serum as supernatant. The supernatants were utilized for lipid profile investigations. Serum TC concentration was measured by the end point colorimetric method (18). Friedewald *et al.* (19) method was used to evaluated the serum HDL-Cholesterol. Serum LDL-Cholesterol concentration was measured using the method of Wiecland and Siedel (20). Tietz (21) method was used to evaluate the serum Triglyceride concentration.

**Statistical analysis**

The statistical analysis of this research was performed using the Statistical Package for the Social Sciences (SPSS) version 26.0. The results were presented as mean ± SD in normally distributed data, median and interquartile range for data that is not normally distributed. The Broiler growth performances, lipid profile and liver enzymes were evaluated using a one-way analysis of variance (ANOVA) and Kruskal Wallis test. A p- value < 0.05 was considered statistically significant.

3. results and discussion

**Growth Performance of Different Chickens Groups**

The current study evaluated the effects of fermented sugarcane tops at different inclusion levels on broiler chicken growth performance and lipid profile. The mean/median weight, average daily weight gain and average weight gain of the studied broiler chicken were higher in group A and least in group E, likewise the gain to feed ratio was higher in group A and least in group E. The growth rate was higher in group A followed by group C then B, D and E. The feed conversion ratio was higher in group E and least in group A. Mortality was higher in group E and D and least in groups B and C as shown in Table 1.

**Table 1: Growth Performance of Experimental Broilers**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Group** | **W (g)**  | **ADWG (g)** | **ABWG (g)** | **FCR** | **GR** | **GFR** | **MR (%)** |
| A | 930(624-1044)\* | 21.54 | 603 | 0.97 | 2.40 | 1.03 | 40 |
| B | 803 ± 80SD | 18.96 | 531 | 1.06 | 1.95 | 0.95 | 0 |
| C | 807 ± 66SD | 14.21 | 398 | 1.23 | 2.25 | 0.81 | 0 |
| D | 519(124-562)\* | 5.39 | 151 | 1.25 | 0.50 | 0.80 | 60 |
| E | 235(145-510)\* | 2.36 | 66 | 1.39 | 0.14 | 0.72 | 60 |

**Key: \*= Median (Interquartile range), SD = Standard deviation % = Percent, W=Weight; ADWG =Average daily weight gain; ABWG =Average body weight gain; FCR =Feed conversion ratio; GR =Growth rate; GFR =Gain to feed ratio; MR =Mortality rate**

Comparison of Growth Performance Among Groups

The mean weight, average daily weight gain, growth rate and gain to feed ratio were statistically higher in group A compared to other groups. Feed conversion ratio was statistically lower in group A compared to other groups. Mortality rate was not statistically different among different groups as shown in table 2.

**Table 2: Comparison of Growth Performance of Experimental Broilers After Feeding Trial Among Groups**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Test statistics (H)** | **P=value** |
| Mean Weight | 119.18  | 0.001\* |
| Average daily weight gain | 0.003 | 0.014\* |
| Average body weight gain | 0.001 | 0.012\* |
| Growth rate | 4.00 | 0.041\* |
| Feed conversion ratio | 0.005 | 0.011\* |
| Gain to feed ratio | 10.00 | 0.014\* |
| Mortality rate | 6.50 | 0.448 |

**Key: H= Kruskall- Wallis test, \*= statistically significant**

The serum levels of LDL and total cholesterol was statistically higher in group A compared to other groups as shown in table 3.

**Table 3: Comparison of Lipid Profile Among Groups of Experimental Broilers**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group** | **TC (mg/dl)** | **TG (mg/dl)** | **HDL-C (mg/dl)** | **LDL-C(mg/dl)** |
| A | 3.20 ± 0.36 | 1.40 (1.08-1.40)\* | 1.10 ± 0.10 | 1.78 (1.45-2.03)\* |
| B | 3.10 ± 0.28 | 1.20 (2.25-1.50)\* | 1.20 (1.10-1.20)\* | 1.60 ± 0.15 |
| C | 2.90 ± 0.01 | 1.50 ± 0.53 | 1.18 ± 0.15 | 1.50 (1.10-1.68)\* |
| D | 2.40 ± 0.14 | 1.35 ± 0.07 | 1.15 ± 0.07 | 1.05 ± 0.07 |
| E | 2.05 ± 0.09 | 1.10 ± 0.05 | 1.05 ± 0.05 | 0.85 ± 0.07 |

**Values are in mean ± Standard deviation/median and interquartile range, Key: \*= Median (Interquartile range), LDL-C =Low density lipoprotein cholesterol, HDL-C = High density lipoprotein cholesterol, TC= Total cholesterol, TG= Triglyceride**

**Table 4: Comparison of Lipid Profile Among Groups of Experimental Broilers**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Test statistic (F/H)** | **Pvalue** |
| TG | 0.47b | 0.990 |
| HDL-C | 0.596a | 0.675 |
| LDL-C | 4.45 a | 0.016\* |
| TC | 5.55 a | 0.016\* |

**Key: F= Analysis of variance (a), H= Kruskal- wallis test (b), \*- Statistically significant, LDL-C =Low density lipoprotein cholesterol, HDL-C = High density lipoprotein cholesterol, TC= Total cholesterol, TG= Triglyceride**

The findings of the study has revealed that the mean weight, average daily weight gain, average body weight gain, growth rate were statistically higher in group A compared to other groups. These findings could be because the quantity of maize in group a is higher (100%) compared to other groups (75%, 50% 25% and 0% respectively). Findings of daily weight gain were lower compared to that of Rajput *et al*. (22), this could be due to the differences of amount of sugarcane tops used in the study. The findings of feed conversion ratio were also similar to the findings of another study Rajput *et al.* (22). This also corroborate with the optimal range of 1.2 to 1.5. a low feed conversion ratio denotes better nutrient absorption and utilization, improved digestive health and enhanced metabolic efficiency. Gain to feed ratio was lower in group E compared to other groups. This could be because the amount of sugarcane tops increases from group B to E and sugarcane tops contain lower nutritional contents compared to maize. Mortality was higher in group E and D and surprisingly least in groups B and C. The higher mortality rates could be due to deficient optimal nutritional requirements in their formulation.

The serum level of LDL and total cholesterol were statistically higher in group A compared to other groups. this may be due to the higher quantity of maize in group A (100%) compared to other groups (75, 50, 25 and 0% in group B, C, D and E respectively). The crude fat content of maize is higher than that of the sugarcane tops 4-5% compared to 1.2- 4.3% (23). All these differences are not statistically significant. These differences may be due to the differences in the percentages of sugarcane tops used.

4. Conclusion

The current study has demonstrated that fermented sugarcane top is a promising maize alternative that could improve the growth performance and lipid profile of broiler chickens. At 25% inclusion in the broiler formulated feed, fermented sugarcane top enhanced the broiler growth performance and lipid profile. The study findings also revealed a decline in growth performance when the fermented sugarcane top level exceeded 25%. In addition, this study will provide the baseline information for researchers to discover the full potential of fermented millet stalk as a possible maize replacement in broiler chicken feed formulation.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models and text-to-image generators have been used during the writing or editing of this manuscript.

TYPE OF ARTICLE

Original research article

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