



## EFFECTS OF SAMSORG-25 VARIETY OF SORGHUM (*Sorghum bicolor*) BASED DIETS ON CARCASS TRAITS AND HAEMATO-BIOCHEMICAL INDICES OF BROILER CHICKENS

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### ABSTRACT

This study was conducted to evaluate the effects of dietary samsorg-25 as a replacement for maize on the carcass characteristics and blood parameters of broiler chickens. Five diets were formulated, with samsorg-25 replacing white maize at 0, 25, 50, 75, and 100%. These diets were labeled as T1, T2, T3, T4, and T5, respectively. Three hundred (300) two-week-old broiler chickens, weighing between 187.00 and 194.75 grams, were randomly assigned to the five diets in four replicates of 15 birds each, following a Completely Randomized Design. Feed and water were provided *ad libitum*, and the feeding trial lasted for 42 days. The results of the carcass analysis revealed no significant effect ( $P>0.05$ ) of samsorg-25 on most carcass and organ characteristics. The carcass weight of the birds ranged from 1.75 kg (T1) to 1.87 kg (T4), and the dressing percentage varied from 74.88% to 77.68% for diets T2 and T4, respectively. The relative weight of the liver showed a significant ( $P<0.05$ ) dietary effect, with birds fed the control diet (T1) having a higher liver weight (1.73%) compared to those on T3 (1.53%). However, birds on both diets were comparable to those on other diets: T2 (1.66%), T4 (1.59%), and T5 (1.65%). Similarly, abdominal fat weight was higher on diet T1 (1.35%) than on T2 (1.17%), with birds on other diets showing comparable results to those on T1 and T2. The weight of the gizzard was also significantly ( $P<0.05$ ) affected, favoring diets T1 (3.37%) and T3 (3.31%), which were similar and comparable to T2 (3.13%) and T5 (3.02%). Birds fed diet T4 (2.89%) had the lowest average gizzard weight but did not differ significantly from those on T2 and T5. Except for platelet count, no haematological index was significantly ( $P<0.05$ ) affected. Platelet count was higher on T3 ( $2.69 \times 10^3/\mu\text{l}$ ) compared to T1 ( $1.70 \times 10^3/\mu\text{l}$ ) and T5 ( $1.60 \times 10^3/\mu\text{l}$ ), but comparable to T2 ( $2.13 \times 10^3/\mu\text{l}$ ) and T4 ( $1.88 \times 10^3/\mu\text{l}$ ). Serum biochemical assays indicated no significant dietary effect on all parameters except for urea. Urea concentration was higher ( $P<0.05$ ) in birds fed diet T2 (4.94 g/dl) compared to those on T1 (4.02 g/dl). However, birds in both groups did not differ significantly ( $P>0.05$ ) from those on other diets. It was concluded that *Samsorg-25* can completely replace white maize in broiler chicken diets without any negative effects on carcass yield and the health of broiler chickens.

**Keywords:** Broiler chicken, Samsorgh-25, Carcass, Haemato-biochemical indices, Maize

### INTRODUCTION

The impact of climate change and global warming on agriculture and food supply, especially in the tropics has been of great concern (Feng *et al.*, 2023). One specific area most affected by this predicament is the poultry industry which heavily relies on maize as conventional dietary energy source. Apart from its use in poultry diets, maize is also the staple food among many households around the globe. Consequently, a fierce competition for the available grains and its consistently increasing cost has put the poultry subsector at disadvantage. Against this background, a number of researches have been conducted with a



view to identifying alternative energy feed resources that are relatively drought resistant and low in competitive demand (Kawu *et al.*, 2019 and Doma, 2020). Among others, these alternative feed ingredients include, cereal by-products (Mutinda, 2023), cassava and different sorghum/millet varieties and cultivars, both local and improved (Farahat *et al.*, 2020; and Mnisi *et al.*, 2023). Different varieties of sorghum and millet have been reported to thrive well in areas of relatively low rainfall and soil fertility compared to maize. One of these varieties is *Samsorgh-25*, a sorghum variety commonly cultivated in Yobe and Borno States of Nigeria. It is an improved varieties of white sorghum which has not been adequately explored as alternative energy feed resource in poultry diets.

Successful poultry production is being challenged by a number of factors notably high cost of feed ingredients. In poultry production, feed cost alone, represents about 65 -70% of the total cost of production (Amaza *et al.*, 2020). The use of relatively low cost, readily available, unconventional feed ingredients could serve as panacea to this problem. However, their use is limited by cost, availability and level of ANFs among others. Scientific research is therefore required in determining the potentiality of these alternatives. According to Indorama (2023), Nigeria is the second largest producer of sorghum in the world. It requires a warm weather for good germination and growth which the study area is endowed with. Different varieties of sorghum, both local and improved are available in Nigeria. SAMSORG-25 is an improved variety which is high-yielding, striga-tolerant and does well on relatively poor soils (NSPI, 2023). Generally, sorghum contains a crude protein level which is higher than that of maize (11.0 versus 9.0%) and an amino acid profile that is comparable to maize (Ochieng *et al.*, 2020)). Although slightly lower than maize (85%) in metabolizable (ME) energy content (3270 kcal/kg) (Daramola *et al.*, 2021), sorghum can adequately provide the required ME in poultry rations. The aim of the study was to evaluate the potential of *Samsorgh-25* as alternative energy source in broiler chicken diets.

## **MATERIALS AND METHODS**

### **Experimental Site**

The experiment was conducted at the Poultry Unit, Teaching and Research Farm, Yobe State College of Agriculture, Damaturu Campus, Yobe State. Damaturu is within the GPS location of Latitude: 11° 44' 49.1856" N and Longitude: 11° 57' 58.2912" E. Situated in the semi-arid region of Nigeria, the area is characterized by a tropical continental climate with a short wet season (June – August) and a long dry season (October – May). The mean annual temperature varies from 14.4 to 43°C while the average annual rainfall is about 560mm. (Weather Spark, 2021).

The test ingredient, *SAMSORG-25*, was purchased at the Damaturu Sunday market, while other feed components were sourced from Damaturu and Potiskum towns in Yobe state. Three hundred (300) two-weeks-old broiler chickens were randomly allotted to five experimental diets in replicates of 4 containing 15 birds each in a completely randomized design. Feed and drinking water were served *ad libitum*. All recommended management practices, such as vaccination and sanitation, were strictly observed, and the study lasted for six weeks (42 days).

Five experimental starter and finisher diets were formulated with replacement levels of *Samsorgh-25* for white maize at 0, 25, 50, 75 and 100%, designated as T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, respectively (Tables 1 and 2).



**Table 1:** Ingredients and Composition of Experimental Diets Containing Dietary *Samsorg-25* as Replacement for White Maize Fed to Starter Broiler Chickens (3 – 5 weeks)

Ingredient (%)	Diets				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
White Maize	43.00	32.25	21.50	10.75	0.00
<i>Samsorg-25</i>	0.00	10.75	21.50	32.25	43.00
Full Fat Soya bean	37.50	37.50	37.50	37.50	37.50
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Fish Meal	5.00	5.00	5.00	5.00	5.00
Bone Meal	2.50	2.50	2.50	2.50	2.50
Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
<b>TOTAL</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Chemical Analysis (%)</b>					
ME (kcal/kg)	2900.80	2898.12	2896.33	2880.26	2873.66
Crude Protein	23.00	22.85	22.76	22.63	22.57
Crude Fibre	3.87	4.48	4.16	4.19	4.22
Ether Extract	12.35	12.11	11.94	11.24	10.88
Calcium	1.69	1.69	1.69	1.70	1.70
Phosphorous	0.82	0.84	0.87	0.89	0.92
Methionine	0.69	0.69	0.68	0.67	0.66
Lysine	1.52	1.53	1.54	1.55	1.57

**Table 2:** Ingredients and Composition (%) of Experimental Diets Containing Dietary *Samsorg-25* as Replacement for White Maize Fed Finisher Broiler Chickens (6-8 weeks)

<b>Diets</b>					
<b>Ingredient (%)</b>	<b>T<sub>1</sub></b>	<b>T<sub>2</sub></b>	<b>T<sub>3</sub></b>	<b>T<sub>4</sub></b>	<b>T<sub>5</sub></b>
White Maize	48.90	36.68	24.45	12.22	0.00
<i>Samsorg-25</i>	0.00	12.22	24.45	36.68	48.90
Soya bean meal	29.60	29.60	29.60	29.60	29.60
Palm oil	2.00	2.00	2.00	2.00	2.00
Wheat Offal	15.00	15.00	15.00	15.00	15.00
Bone Meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
<b>TOTAL</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Chemical Analysis (%)</b>					
ME (kcal/kg)	3086.65	3079.27	3047.32	3043.14	3037.99
Crude Protein	20.00	19.78	19.85	19.73	19.93
Crude Fibre	3.89	4.00	3.86	4.00	4.11
Ether Extract	14.42	14.28	14.33	14.21	14.11
Calcium	1.49	1.49	1.50	1.50	1.50
Phosphorous	0.64	0.67	0.70	0.73	0.75
Methionine	0.59	0.58	0.57	0.56	0.55
Lysine	1.17	1.18	1.19	1.20	1.22

### Data Collection

At the end of the experiment, two birds were randomly selected from each replicate for carcass analysis. The birds were labelled for proper identification, starved of feed overnight and slaughtered the following morning. Before slaughter, the weight of each bird was recorded. Similarly, after slaughter, the birds' plucked weight, eviscerated weight and dressed weights were measured. Dressing percentage was calculated using the relationship;

$$\text{Dressed (\%)} = \frac{\text{CW}}{\text{LW}} \times 100$$

Weight of major organs was also taken and presented as percent live weight of birds.

$$\text{Organs weight} = \frac{\text{Weight of organ}}{\text{Live weight}} \times 100$$

### Blood Parameters

Samples of blood were collected from randomly selected birds (2 per replicate) and analysed for haematological and serum biochemical parameters. Samples for haematology were collected in special bottles containing Ethylene Diamine Tetra Acetic acid (EDTA) while those for serum biochemistry were collected in plain samples collection tubes. The samples were screened for some haematological and biochemical indices based on methods described by Bush (1991) and Baker *et al.*, (1988).

### Data Analysis

All data obtained were analysed using one-way analysis of variance (ANOVA) of the statistical package SPSS version 23. Differences between treatment means were separated using the Duncan's Post Hoc method (Duncan, 1955).



## RESULTS AND DISCUSSION

### Carcass and Organ Characteristics

Results for carcass and organ traits are presented in Table 3. None of the carcass parameters showed a significant ( $P>0.05$ ) effect of diet. This implies that *Samsorg-25* is good as maize for dietary energy supply in broiler chicken rations. These findings are in line with Puntigam *et al.* (2020) who concluded that partial or total replacement of maize by ground or whole grain low-tannin sorghum in broiler diets did not influence the zootechnical or slaughter performance parameters. Live weight of birds ranged from 2.33kg (T1) to 2.41kg (T4), plucked weight from 2.21kg (T1) to 2.30kg (T3), eviscerated weight from 1.87 kg (T1 to 2.02kg (T4) and carcass weight between 1.75 and 1.87 kg on diets T1 and T4 respectively. Dressing percentage (DP) was between 74.88% on diet T2 and 77.68% on diet T4. Values for DP obtained in this study are higher than 65.70% reported by Salami *et al.*, (2004) for well-finished broiler chickens.

The Relative weight of organs except for liver, abdominal fat and gizzard, showed significant influence of diet. Birds fed the control diet (T1) had higher liver weights (1.73%) than those on T3 (1.53%). However, birds on both diets were comparable with those on other diets; T2 (1.66%), T4 (1.59%) and T5 (1.65%). Similarly, abdominal fat weight was higher on diet T1 (1.35%) than on T2 (1.17%). Birds on other diets did not differ ( $P>0.05$ ) from those on T1 and T2. These values are comparable with 1.60 – 1.81% reported by Farahat *et al.*, (2020) in a similar study. Weight of gizzard was also significantly ( $P<0.05$ ) affected in favour of diets T1 (3.37%) and T3 (3.31%) which were the same and comparable with T2 (3.13%) and T5 (3.02%). Birds fed diet T4 (2.89%) which recorded the lower average weight of gizzard, did not differ from those on T2 and T5.



**Table 3:** Carcass and Organs Traits of Broiler Chickens Fed Diets Containing *Samsorg-25* as Replacement for White Maize (3 -8 weeks)

	Diets					
Parameter	T1	T2	T3	T4	T5	SEM
Carcass characteristics						
Live weight (g)	2.33	2.39	2.40	2.41	2.35	0.07 <sup>NS</sup>
Plucked weight (g)	2.21	2.26	2.30	2.29	2.24	0.07 <sup>NS</sup>
Eviscerated weight (g)	1.87	1.98	1.98	2.02	1.92	0.06 <sup>NS</sup>
Carcass weight (g)	1.75	1.79	1.80	1.87	1.78	0.06 <sup>NS</sup>
Dressing percentage (%)	75.33	74.88	75.07	77.68	75.68	1.39 <sup>NS</sup>
Organ characteristics expressed as percentage of live weight						
Head	1.93	2.08	1.89	1.95	2.15	0.09 <sup>NS</sup>
Legs	3.17	3.24	3.23	3.11	3.27	0.06 <sup>NS</sup>
Lungs	0.51	0.51	0.48	0.45	0.46	0.02 <sup>NS</sup>
Small intestine	3.99	3.49	3.50	3.52	3.80	0.31 <sup>NS</sup>
Kidney	0.11	0.10	0.13	0.11	0.11	0.01 <sup>NS</sup>
Liver	1.73 <sup>a</sup>	1.66 <sup>ab</sup>	1.53 <sup>b</sup>	1.59 <sup>ab</sup>	1.64 <sup>ab</sup>	0.06 <sup>*</sup>
Abdominal fat	1.35 <sup>a</sup>	1.17 <sup>b</sup>	1.26 <sup>ab</sup>	1.21 <sup>ab</sup>	1.25 <sup>ab</sup>	0.05 <sup>*</sup>
Heart	0.50	0.48	0.51	0.47	0.48	0.02 <sup>NS</sup>
Gizzard	3.37 <sup>a</sup>	3.13 <sup>ab</sup>	3.31 <sup>a</sup>	2.89 <sup>b</sup>	3.02 <sup>ab</sup>	0.12 <sup>*</sup>
Caeca	1.10	1.12	1.09	1.08	1.12	0.04 <sup>NS</sup>
Large intestine	0.62	0.61	0.64	0.59	0.68	0.03 <sup>NS</sup>
Pancreas	0.23	0.22	0.21	0.21	0.19	0.02 <sup>NS</sup>
Spleen	0.10	0.09	0.11	0.10	0.12	0.01 <sup>NS</sup>

<sup>a, b</sup> = Means bearing different superscripts within the same row differ, \* = (P<0.05), NS = Not Significant, SEM = Standard Error of Means

### Haemato-Biochemical Indices

Results for blood indices of broiler chickens fed *Samsorg-25*-based diets are presented in Table 5. Except for platelet count, no haematological index was significantly (P<0.05) affected. Furthermore, all the values obtained for each index are within the normal range for healthy broiler chickens as reported by Jain (Wikivet, 2012). Platelet count was higher on T3 ( $2.69 \times 10^3/\mu\text{l}$ ) than on T1 ( $1.70 \times 10^3/\mu\text{l}$ ) and T5 ( $1.60 \times 10^3/\mu\text{l}$ ) but comparable with T2 ( $2.13 \times 10^3/\mu\text{l}$ ) and T4 ( $1.88 \times 10^3/\mu\text{l}$ ). Serum biochemical assay indicated a non-significant effect of diet on all parameters except for urea. Urea concentration was higher (P<0.05) in birds fed diet T2 (4.94 g/dl) than those on T1 (4.02g/dl). However, birds in both groups did not differ from those on other diets.



**Table 4:** Haematological Parameters of Broiler Chickens Fed Diets Containing Samsorg-25 as Replacement for White Maize (3 -8 wks.)

Parameter	Diets					SEM
	T1	T2	T3	T4	T5	
Packed cell volume (%)	32.52	30.13	26.66	29.25	29.92	2.39 <sup>NS</sup>
Red blood cells (x 10 <sup>6</sup> /μl)	2.76	2.38	2.21	3	2.87	0.39 <sup>NS</sup>
Haemoglobin (g/dl)	11.63	10.65	9.55	11.17	11.33	0.95 <sup>NS</sup>
Mean corpuscular volume (fl)	118.6	131.93	118.22	119.98	123.13	7.21 <sup>NS</sup>
Mean corpuscular haemoglobin (pg)	42.35	46.08	41.72	43.23	44.05	1.85 <sup>NS</sup>
MCHC (g/dl)	35.75	35.33	38.15	36.03	35.78	1.23 <sup>NS</sup>
White blood cells (x 10 <sup>3</sup> /μl)	23.35	23.38	21.97	24.03	23.7	0.71 <sup>NS</sup>
Platelets (x 10 <sup>3</sup> /μl)	1.70 <sup>b</sup>	2.13 <sup>ab</sup>	2.69 <sup>a</sup>	1.88 <sup>ab</sup>	1.60 <sup>b</sup>	0.29 <sup>*</sup>

a, b = Means bearing different superscripts within the same row differ. \* = (P<0.05), NS = Not Significant, SEM = Standard Error of Means.

**Table 5:** Serum Biochemical Indices of Broiler Chickens Fed Diets Containing Samsorg-25 as Replacement for White Maize (3 -8 wks.)

Parameter	Diets					SEM
	T1	T2	T3	T4	T5	
Total protein (g/dl)	3.48	4.3	3.56	3.09	3.45	0.44 <sup>NS</sup>
Total cholesterol(g/dl)	30.28	33.25	30.5	40.5	34	3.51 <sup>NS</sup>
Albumin (g/dl)	1.92	2.37	1.96	1.71	1.9	0.24 <sup>NS</sup>
Glucose (g/dl)	54.25	50	53.75	56.5	57.5	4.33 <sup>NS</sup>
Globulin (g/dl)	1.32	1.64	1.35	1.17	1.31	0.17 <sup>NS</sup>
Urea(g/dl)	4.02 <sup>b</sup>	4.94 <sup>a</sup>	4.64 <sup>ab</sup>	4.14 <sup>ab</sup>	4.52 <sup>ab</sup>	0.26 <sup>*</sup>
Total Cholesterol (mg/dl)	30.28	30.23	30.5	40.5	34	3.51 <sup>NS</sup>

a, b = Means bearing different superscripts within the same row differ. \* = (P<0.05), NS = Not Significant, SEM = Standard Error of Means

## CONCLUSION AND RECOMMENDATION

Based on the findings of this study, it was concluded that *Samsorg- 25* can completely replace white maize in broiler chicken diets without reduction in carcass yield or impairment of broiler chickens' health. Therefore, samsorg-25 variety of sorghum is recommended as replacement for maize in the diets of broiler chickens.

## REFERENCES

- Amaza, I. B., Oboh, S. O., Isidahome, C. E., Duwa, H., Njidda, A. A. and Maidala, A. (2020). Effect of feeding raw and differently processed *Cassia obtusifolia* seed meal on performance, serum biochemical indices and haematological values of finisher broiler chickens. *Nigerian Journal of Animal Science*, **22**(2): 240 – 247.
- Baker, F.J., Silvertown, R.E. and Palliater, C.J. (1998). **Introduction to Medical Laboratory Technology**. 7<sup>th</sup> edition. Butterworth-Heinemann. Linaore House Jordan Hill Oxford OX280P.
- Bush, B.M. (1991). **Interpretation of Laboratory Results for Small Animal Clinician**. Blackwell Scientific Publication. U.K. 32-67.
- Daramola, S.T., Sekoni, A.A., Oimage, J.J., Duru, S. and Odegbile, O.E. (2021). Effects of feeding four varieties of Sorghum supplemented with Maxigrain® enzyme on haematology and carcass characteristics of broiler finishers. *Nigerian Journal of Animal Science*, **23**(1): 35-45



- Doma, U. D. (2020). Growth performance, carcass characteristics and financial benefit of broiler chickens fed dietary levels of maize milling waste as replacement for maize. *Nigerian Journal of Animal Science and Technology*, **3**(2): 1 -10.
- Duncan, D.B. (1955). Multiple Range and Multiple F. Test. *Biometrics*.**11**: 1-42.
- Farahat, M., Badawi, M., Hussein, A. and Attia, G. (2020). Effect of Replacing Dietary Corn by Sorghum on The Growth Performance, Shank Skin Pigmentation, Carcass Traits, Caecal Microflora and Nutrient Digestibility of Broiler Chickens. *International Journal of Poultry Science*, **19**: 424-431.
- Feng, X., Tian, H., Cong, J. and Zhao, C. (2023). A Review of the climate change impact on crop yield. *Frontiers in Forests and Global Change*, 6:1198186.
- Indorama (2023). Crop management practices: Sorghum. Retrived 23<sup>rd</sup> November, 2024 from <https://www.indoramafertilizers.com/image/crop-practice-sorghum.pdf>
- Kawu, Y. U., Doma, U. D., Abubakar, M., Bello, K. M. and Muhammad, A. I. (2019). Performance and Economics of Broiler Chickens Fed Dietary Levels of *Gayamba* Pearl millet (*Pennisetum glaucum* L.) as Replacement for Red Sorghum (*Sorghum bicolor*). *Nigerian Journal of Animal Science and Technology*, **2**(2): 72 – 84.
- Mnisi. C. M., Oyeagu, C. E., Akuru, E. A., Rudvidzo, O. and Lewu, F. B. (2023). Sorghum, millet and cassava as alternative dietary energy sources for sustainable quail production: A review. *Frontiers in Animal Science*, **4**:106-108.
- Mutinda, V. M. (2023). Cereal by-products as alternative energy sources in poultry: A review. *International Journal of Veterinary Sciences and Animal Husbandry*, **8**(6): 1-6.
- NSPI (2024). **Nigeria Seed Portal Initiative**. Samsorg-25 (SSV-11 (L.3800)). Retrieved 23<sup>rd</sup> November, 2024 from <https://www.seedportal.org.ng/variety.php?keyword=&category=&varid=418&cropid=12&task=view>
- Ochieng, B. A., Owino, W. O., Kinyuru, J. N., Mburu, J. N. and Gicheha, M. G. (2020). Effect of low-tannin sorghum based feeds on broiler meat nutritional quality. *Journal of Agriculture & Food Research*, **2**: 100-108.
- Puntigam, R., Brugger, D., Slama, J., Inhurber, V., Boden, B., Krammer, V., Schedle, K. *et al.* (2020). The effect of partial or total replacement of ground corn with ground and whole grain low-tannin sorghum (*Sorghum bicolor* L. Moench) on zootechnical parameters, carcass traits and apparent ileal amino acid digestibility of broiler chicken. *Livestock Science*, **24**(1): 104-108.
- Salami, R. T. Longe, O. G. and Oluyemi, J. A. (2004). Effect of dietary protein on the performance and carcass characteristics of cockerel finishers. *Nigerian Journal of Animal Science*. **31**: 27-31.
- SPSS (2017). Statistical Package for Social Sciences. IBM corporation released August, 2017. IBM SPSS, statistics for windows, version 25.0. Armonk, New York.
- Weatherspark (2021). Retrieved 12<sup>th</sup> August 2024 from <https://weatherspark.com/y/68827/Average-Weather-in-Damaturu-Nigeria-Year-Round>.
- WikiVet, (2012). Chicken Haematology and Biochemistry. Retrieved November 21, 2024 from [http://en.wikivet.net?chicken\\_Biochemistry](http://en.wikivet.net?chicken_Biochemistry).