



EGG PRODUCTION USING SORGHUM VARIETY ICSV400 AS REPLACEMENT FOR MAIZE

Jama'a, N. A. and Balarabe, S.

Department of Animal Production, Abubakar Tafawa Balewa University Bauchi,
Bauchi State, Nigeria.

Corresponding Author's Email: najamaa@atbu.edu.ng, **GSM:** + 234 7061097766

ABSTRACT

The study was conducted during the months of August- November, 2025 at the Teaching and Research Farm of the Department of Animal Production, Abubakar Tafawa Balewa University, Yelwa Campus, Bauchi to evaluate the productive performance of layer chickens using sorghum variety ICSV400 as it replaces maize. Five diets were formulated in which sorghum variety ICSV400 replaced maize at 0, 25, 50, 75 and 100% in diets 1, 2, 3, 4 and 5 respectively. Two hundred (200) pullets (point of lay) were randomly allotted to the 5 diets in four replicates of 10 birds each in a completely randomised design. Fresh experimental feeds and fresh drinking water were supplied *ad-libitum* and the feeding trial lasted for 10 weeks. Daily feed intake (DFI) and total number of eggs produced (TEP) were recorded every day per replicate while 2 fresh eggs were randomly selected and marked on weekly basis from each replicate for external and internal egg quality parameters such as Egg Weight (EW), Egg Length (EL), Egg Diameter (ED), Shell Weight (SW), Shell Thickness (ST), Albumin Weight (AW), Albumin Height (AH), Albumin Diameter (AD), Yolk Weight (YW), Yolk Height (YH), Yolk Diameter (YD) assessment. From the relationships of daily feed intake, number of eggs laid and number of birds initially housed and at present, layer performance indicators like percent hen day production (%HDP) and percent hen house production (%HHP) as well as feed conversion ratio (FCR) were calculated. Other egg quality parameters (yolk index, albumin index, yolk/albumin index) were calculated using the relationships of the internal egg parameters. Data generated were processed and analysed using MINITAB 17 version statistical package. Means with significant differences were separated using Duncan Multiple Range Test (DMRT). The results indicated that DFI was significantly ($P<0.001$) affected by the dietary treatments with highest value (115.12g) on birds fed diets 5 (100% sorghum) and lowest (111.05g) on those fed diet 1 (100% maize). TEP was also significantly ($P<0.05$) influenced by the sorghum inclusion levels in the diets with highest value (181) on birds fed diet 1. %HDP and %HHP were significantly ($P<0.05$) affected by the dietary treatment. However, FCR was not influenced by the dietary levels of sorghum variety ICSV400 in the diets, with the best (1.51) FCR in birds fed diet 1 and lowest (1.63) in those fed diet 5. The remaining egg quality parameters were not affected by the dietary treatments except on EW and EL which were significantly influenced at $P<0.01$. It was concluded that using sorghum variety ICSV400 to completely replace maize in layer diets does not negatively affect their productive performance. It is therefore recommended that sorghum variety ICSV400 be used to replace maize up to 100% in layer chicken's Diets.

Keywords: Pullet, Egg, Diet, Performance

INTRODUCTION

The significance of layer farming (egg production) in bridging animal protein malnutrition in Nigeria and world at large cannot be under emphasized. Birds lay eggs for reproduction not for human consumption, yet eggs have been eaten by man since early times. Eggs are incredibly nutritious and are among the most nutritious foods on the planet earth. A whole egg contains all the nutrients required to turn a single cell into a baby chicken. Eggs are among the few foods classified as "super foods." They are loaded with nutrients, some of which are rare in the modern diet (Kris, 2017). A single large boiled egg contains 6, 5, 7, 9 and 15% of vitamin A, Folate, B5, B12 and B2 respectively in addition to 9% **phosphorus** and 22% **selenium**. Eggs contain decent amounts of vitamin D, vitamin E, vitamin K, vitamin B6, calcium, zinc and omega-3. This is coming with 77 calories, 6 grams of protein and 5 grams of healthy fats. It also contains various other trace nutrients that are important for health. Eggs are



therefore pretty much the **perfect** food. Eating eggs regularly will supply the body with needed nutrients thereby reducing the problems of malnutrition. Normal egg comprises of 10% shell, 58% white and 32% yolk (Poultry site, 2017). Report by Rafed *et al.* (2024) also indicated that eggs are rich source of high-quality protein, essential vitamins and minerals, contain heart healthy unsaturated fats that make it crucial for human nutrition. It was illustrated that the corn flour-egg powder composite is a nutrient-dense, scientifically validated solution to addressing micronutrient deficiencies and protein-energy malnutrition in children (Joe, *et al.*, 2025). The balanced micronutrient profile of the composite is in line with WHO guidelines, contributing about 34.7% of daily needs (RDA) for children aged 5-12 years. Its high iron, zinc and magnesium contents, coupled with enhanced bioavailability from heme and non-heme iron synergy, makes it suitable for addressing anemia risk, which are common in resource-limited settings. For this reason, the demand for eggs has been on the increase due to many factors; some of which are raising population, urbanization and increasing income (FAO, 2020). Over the past two decades, Nigeria has experienced a dramatic population surge, which has significantly increased the demand for food (Moseri and Belonwu, 2023). However, the availability of high-quality food items such as meat, eggs, and milk has become scarce due to the economic challenges faced by many Nigerians. Food and Agricultural Organization (FAO, 1991) recommended that 35g of the required minimum of 65-72g of reference protein should be obtained from animal products and the average animal protein intake per capita per day in Nigeria ranged from 7.6 to 13.26g which is widely acknowledged to be inadequate. Egg production is a significant industry in Nigerian, with the country producing over 10 billion eggs annually. According to FAO (2022), the country has the capacity of over 1.5 million crates of eggs per day. The demand for poultry added chain was over N500bn with 165 million birds, 650,000 metric tons of eggs and 290,000 metric tons of meat demanded annually. Local production only meets 30% of the demand which suggest plenty of room for growth in the industry. Nigeria is the largest producer of eggs in Africa, with 10.3 billion eggs produced annually. Global egg production has been steadily increasing over the years, with an average yearly growth rate of 2.2% from 2009 to 2018. In 2020, the world produced 1.6 trillion shell eggs, with China being the largest producer, accounting for more than a third of global shell egg production. The global egg market is expected to continue growing, driven by increasing demand for protein-rich foods, particularly in developing countries like Nigeria. Despite all these, Nigerians suffer protein malnutrition due poor standard of living. On the other hand, cost of production makes the product costly and unaffordable to majority of Nigerians. Cost of feeding is always on the increase due to continuous competition on the limited and scarce feed ingredients by humans and beverage industries. The pressure on maize as a conventional energy source is of great concern. Using other unconventional energy sources with less demand and lower prices to replace maize in layer chicken diets will definitely reduce cost of production which in turn will reduce cost of the product (eggs). Many feed ingredients have been used by researchers to substitute maize in layer chicken diets with very good end results. In that vein, Jama'a *et al.*, (2021) evaluated egg quality characteristics of layers fed graded levels of Kaura sorghum (*sorghum bicolor*) replacing maize with full fat soya bean. Similarly, studies were conducted by Jamilu *et al.*, (2020) and Jama'a *et al.*, (2020) to examine the productive performance of layer chickens fed kaura sorghum replacing maize with full-fat soya bean diets. Jama'a *et al.*, (2022) also fed ICSV400 based diets to layer chickens to evaluate layer performance and egg quality characteristics and reported improved performance and egg quality traits.

MATERIALS AND METHOD

Study Location

The research was conducted at the Teaching and Research Farm of the Department of Animal Production, Abubakar Tafawa Balewa University Bauchi, Bauchi State, Nigeria, between the months of August and November, 2025. The State occupies a land area of about 66,000 square kilometres. Bauchi town is located within Southern Guinea Savannah on latitude 13° 30' N and longitude 11° 50' E at an altitude of 690.20 meters above sea level. The climate is characterized by a well-defined rainy season (June-October) and dry season (November-May). The total mean annual rainfall in the State is 700-900 mm for the Northern zone, 690-1031 mm for Central zone and 900-1300 mm for the Western



zone (BSADP, 2023). The mean temperature ranges between 19.15 °C and 38.50 °C. The highest temperature is observed in the months of March, April and May, while the lowest is in the months of January and December every year. Highest relative humidity of 99% is observed in August and the lowest of 57% in February (Anonymous, 1999).

Experimental Diets

Five diet were formulated in which ICSV400 sorghum variety replaced maize at 0, 25, 50, 75 and 100% in diets 1, 2, 3, 4 and 5 respectively. Industrial groundnut cake was used as plant protein source. (Table 1).

Table 1: Ingredients and Percentage Compositions of Experimental Diets

Ingredients%	Diets				
	1(0%)	2(25%)	3(50%)	4(75%)	5(100%)
Maize	47.83	35.87	23.92	11.96	0.00
ICSV400	0.00	11.96	23.92	35.87	47.83
IGNC	19.37	19.37	19.37	19.37	19.37
Wheat offal	20.00	20.00	20.00	20.00	20.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Lime stone	7.00	7.00	7.00	7.00	7.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25	0.25
*Layer Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10
Total	100.0	100.0	100.0	100.0	100.0
Calculated analysis					
Crude Protein (%)	16.93	17.05	17.17	17.29	17.41
ME (kcal/kg)	2712	2686	2681	2665	2649
Crude Fiber (%)	3.75	3.75	3.75	3.75	3.75
Ether Extract (%)	6.19	6.07	5.95	5.83	5.72
Calcium (%)	3.70	3.70	3.70	3.71	3.71
Phosphorus (%)	0.61	0.64	0.66	0.69	0.72
Methionine (%)	0.48	0.47	0.46	0.45	0.44
Lysine (%)	0.96	0.97	0.98	1.00	1.01

IGNC= Industrial Groundnut. *Vitamin-mineral Premix contains the following per 2.5 kg: Vitamin A 10,000 IU, Vit. D3 2,000,000IU, Vit E 12,000mg, Vit K3 2,000mg, Vit B1 1,500mg, Vit B2 4,000mg, Vit B6 1,500mg, Niacin 15,000mg, Vit B12 10mcg, Pantothenic acid 5,000mg, Folic acid 500mg, Biotin 20mcg, Cholinechloride 100,000mg, Manganese 75,000mg, Zinc 50,000mg, Iron 20,000mg, Copper 5,000mg, Iodine 1,000mg, Selenium 200mg, Cobalt 5000mg, Antioxidant 125,000mg.

Experimental Birds and their Management

Two hundred (200) pullets (point of lay) were randomly allotted to the 5 experimental diets in four replicates of 10 birds each in a completely randomised design. Experimental feeds and fresh drinking water were supplied *ad-libitum* and the feeding trial lasted for 10 weeks.

Data Collection

Records of Feed Intake (FI) and number of Eggs Laid (EL) were taken every day and on weekly basis, 2 eggs were randomly selected from each replicate for external and internal egg quality parameters assessment. Layer performance parameters that include Feed Conversion Ratio (FCR), Percent Hen day Production (%HDP) and Percent Henhouse Production (%HHP) were calculated from relationships of FI and EL (eqn. 1, 2 and 3). Yolk index, albumin index and yolk albumin index were calculated from the internal egg parameters obtained (eqn. 4, 5 and 6).

$$i - \%HDP = \frac{\text{total eggs produced}}{\text{number of live birds}} \times 100 \text{ ----- (1)}$$



$$\text{ii - \%HHP} = \frac{\text{total eggs produced}}{\text{initial number of birds housed}} \times 100 \text{ ----- (2)}$$

$$\text{iii - FCR layers} = \frac{\text{feed intake (kg)}}{\text{dozens of eggs produced}} \times 100 \text{ ----- (3)}$$

$$\text{iv - YI} = \frac{\text{yolk height}}{\text{yolk diameter}} \times 100 \text{ ----- (4)}$$

$$\text{v - AI} = \frac{\text{albumen height}}{\text{albumen diameter}} \times 100 \text{ ----- (5)}$$

$$\text{vi - YAR} = \frac{\text{yolk weight}}{\text{albumen weight}} \times 100 \text{ ----- (6)}$$

Data Analysis

Data generated were processed and analysed using MINITAB 17 version statistical package. Where significant differences exist, Duncan Multiple Range Test were used to separate the means.

RESULTS AND DISCUSSION

Results obtained showed that, daily feed intake and total feed intake were significantly ($P < 0.001$ and $P < 0.01$ respectively) influenced by the dietary treatment. Similarly, total eggs produced, percent hen day production and percent hen house production were significantly ($P < 0.05$) affected by the dietary levels of sorghum (ICSV400 variety) in the diets. These findings were similar to that of Jama'a *et al.* (2022) where feed intake was found to range between 111.00 – 123.00g. On the other hand, feed conversion ratio was not statistically ($P > 0.05$) influenced by the dietary formulations. However, the best feed conversion ratio (1.51) was obtained on birds fed diet 1 (0% sorghum) while the lowest (1.68) was found on birds fed diet 5 (100% sorghum). This is in agreement with the report of Jama'a *et al.* (2022) where he obtained better (1.17) FCR on birds fed control diets (100% maize) and lower (1.80) on birds fed diet with 100% sorghum variety ICSV400. However, these findings did not agree with the report of Jamilu, *et al.* (2020) who substituted maize with kaura sorghum in layer chicken diets. He reported that birds fed diet 4 (75% kaura sorghum) had the highest feed consumption value of 113.33g while the lowest intake was obtained on diet 1(control) with a value of 91.39g. The highest hen-day egg and hen house egg production (72.59% and 70.00%, $P < 0.001$) was obtained on diet 5 (100% kaura sorghum). The best feed conversion ratio (1.42) was found on diet 2 while the poorest was obtained on the maize control diet (1.68), even though the value did not differ statistically. This result did not agree with the reports of Salissou (2009) of nonsignificant differences in average egg weight and feed conversion ratio among birds fed corn and sorghum-based diets and that of Narkhede *et al.* (1981); Thakur *et al.* (1985); and Ramo Rao *et al.* (1995) of nonsignificant effect in FCR by including sorghum in the diets of laying chickens. The result for egg quality parameters indicated that substituting maize with sorghum variety ICSV400 had significant ($P < 0.01$) effects on egg weights (60.71- 65.62g), egg length (55.18-58.11cm) and yolk albumin index (0.39-0.45cm). This result did not agree with the finding of Jama'a *et al.* (2022) who reported nonsignificant difference on egg weight when fed layers' sorghum variety ICSV400 based diets. The results also disagreed with the reports of Issa *et al.* (2007) and that of Freitas *et al.* (2014) that egg production and egg weights were not influenced by red or white sorghum-based diets. Similarly, the dietary treatments had significant effects ($P < 0.05$) on egg diameter and $P < 0.001$ on albumin weight. All other egg quality parameters were not statistically influenced ($P > 0.05$) by the dietary variations. However, values on albumin heights ranged from 10.19 in birds fed diet 1 (0% ICSV400 sorghum) to 11.26 on those fed diet 2 (25% ICSV400 sorghum/75% maize). The highest albumin diameter was obtained in birds fed diet 5, containing 100% ICSV400 sorghum/0% maize and the lowest on those on diet 4, made of 25% ICSV400/75% maize. Values of yolk weight ranged between 15.95 in diet 5 (100% sorghum/0% maize) and 16.37 in diet 4 (25% ICSV400/75% maize). Reading obtained on yolk heights ranged from 17.52 on birds fed diet 2 (25% ICSV400 sorghum/75% maize) to 18.55 for birds fed diet 1 (0% ICSV400 sorghum/100% maize). Birds fed diet 4 had the highest (40.47) yolk diameter and the lowest (39.02) was obtained in those on diet 1. The lowest (7.44) shell weight, shell thickness (0.37) and yolk index (42.45) were found in birds fed diet 4 and the highest (8.05) shell weight was on birds fed diet 3 while

birds fed diet 1 gave the highest (0.45) shell thickness and yolk index (47.55). Albumin index had the lowest (14.91) value on birds fed diet 5 and highest (17.26) in those on diet 3.

Table 2: Productive Performance of Layer Chickens Fed Dietary Levels of Sorghum Variety ICSV400 as Replacement for Maize

Parameters	DIETS					SEM	LSD
	1(0%)	2(25%)	3(50%)	4(75%)	5(100%)		
DFI(g)	111.05 ^d	111.93 ^c	112.17 ^c	113.16 ^b	115.12 ^a	0.18	***
TFI (kg)	22.75 ^d	22.95 ^d	23.01 ^c	23.25 ^b	23.50 ^a	0.04	**
TEP	181.00 ^a	178.50 ^c	178.50 ^c	180.50 ^a	179.50 ^b	0.32	*
% HDP	88.29 ^a	87.13 ^d	87.08 ^d	88.05 ^b	87.57 ^c	0.16	*
% HHP	88.29 ^a	87.13 ^d	87.08 ^d	88.05 ^c	87.57 ^c	0.14	*
FCR	1.51	1.55	1.55	1.55	1.63	0.02	NS
Mortality	0	0	0	0	0	-	-

NB: DFI= daily feed intake, TFI= total feed intake, TEP= total eggs produced, %HDP, percentage hen day production, %HHP=percentage hen house production, FCR=feed conversion ratio.

Table 3: Egg Quality Parameters of Layer Chickens Fed Dietary Levels of Sorghum Variety ICSV400 as Replacement for Maize

Parameters	DIETS					SEM	LSD
	1(0%)	2(25%)	3(50%)	4(75%)	5(100%)		
EW	64.67 ^b	61.64 ^c	65.62 ^a	60.71 ^c	63.52 ^b	1.80	**
EL	57.01 ^b	55.18 ^c	58.11 ^a	55.53 ^c	57.00 ^b	1.00	**
ED	45.06 ^c	44.21 ^c	45.93 ^a	43.99 ^c	44.36 ^c	0.80	*
AW	40.28 ^b	37.03 ^c	40.87 ^a	36.58 ^c	39.46 ^b	1.36	***
AH	10.19	10.94	10.87	10.66	11.26	0.90	NS
AD	69.00	69.89	70.21	68.95	70.50	2.48	NS
YW	16.17	16.34	16.04	16.37	15.95	0.65	NS
YH	18.55	17.52	18.05	17.63	18.20	1.21	NS
YD	39.02	40.02	39.44	40.47	39.73	1.01	NS
SW	7.68	7.51	8.05	7.44	7.70	0.45	NS
ST	0.45	0.43	0.42	0.37	0.41	0.05	NS
YI	47.55	45.64	45.88	42.45	46.78	0.09	NS
AI	15.81	15.68	17.26	15.55	14.91	0.41	NS
YAI	0.41 ^b	0.44 ^a	0.39 ^c	0.45 ^a	0.41 ^b	0.01	**

NB: EW=egg weight, EL=egg length, ED=egg diameter, AW=albumin weight, AH=albumin height, AD=albumin diameter, YW=yolk weight, YH=yolk height, YD=yolk diameter, SW=shell weight, ST=shell thickness, YI=yolk index, AI=albumin index, YAR=yolk/albumin index.

CONCLUSION AND RECOMMENDATION

Based on the results obtained in this research, it was concluded that using Sorghum Variety ICSV400 to replace maize does not negatively affect the general layer performance as well as external and internal egg quality parameters even at 100% level of replacement. It was recommended that Sorghum Variety ICSV400 can be a substitute to maize in layer chicken diet for up to 100%.

REFERENCES

- Anonymous, (1999). Weather records of meteorological station, Bauchi Airport Bauchi State.
 BSADP (2023) Bauchi State Agricultural Development Programme Annual Report.



- Food and Agriculture Organization (1991) Protein Quality Evaluation: Report of the joint FAO/WHO Expert Consultation, FAO Food and Nutrition paper 51. Rome: FAO.
- Food and Agriculture Organization (FAO) (2020). Gateway to Poultry Production and Products: Products and Processing. Retrieved April 8, 2023 from <https://www.fao.org/poultry-production-products/products->
- Freitas, E. R., Raquel, D. L., Nascimento, A. J. N., Watanabe, P. H. and Lapes, I. R. V. (2014). Complex replacement of corn by white or red sorghum in Japanese quails feed. *Avic.*, **16**(3): 123-126
- Issa, S. J., Hankock, D., Tuinstra, M. R., Kapran, I. and Kaka, S. (2007). Effects of sorghum variety on growth and carcass characteristics in broiler chicks reared in West Africa. *Journal of Poultry Science*, **86** (1): 69-75.
- Jama'a, N. A., Abubakar, M., Bello, K. M. and Doma. U. D. (2020). Productive performance of layer chickens fed dietary levels of sorghum ICSV400 variety. *Journal of Agripreneurship and sustainable development* **3**(3): 247-251. <http://www.jasd.dae.atbu.edu.ng>
- Jama'a, N. A., H. Jamilu, U. D. Doma, M. L. Egbo, M. Abubakar, D. Zahraddeen. (2021). Egg quality characteristics of layers fed graded levels of kaura sorghum (*sorghum bicolor*) replacing maize with full fat soya bean. *Proceeding of the 46th Annual Conference of Nigeria Society for Animal Production*, Dutsin-ma, Pp 354-357
- Jama'a, N. A., Jamilu, H., Doma, U. D., Abubakar, M., Bello, K. M. and Balarabe, S. (2022). Productive performance and egg quality of layer chickens fed graded levels of sorghum variety ICSV400 as replacement for maize. *Journal of applied agricultural research*, **10**(2): 264-273.
- Jamilu, H., U. D. Doma, M. L. Egbo, M. Abubakar, D. Zahraddeen, N. A. Jama'a and H. S. Buhari. (2020). Productive performance of layers fed kaura sorghum replacing maize with full-fat soya bean diets. *Proceeding of the 45th Annual Conference of Nigeria Society for Animal Production*, Bauchi Pp 1564
- Joe, D. N., Felix, M. R., Isaac, A., Charles, A. and Christopher, E. (2025). Nutritional Composition and Acceptability of Egg Powder-Fortified Tom Brown Among School-Aged Children. *Journal of Food Nutrition*, **7**: 13-14.
- Kris, G. (2017). Top 10 Health Benefits of Eating Eggs. htm. *Authority Nutrition*. **An evidence-based approach**
- Moseri, H. and Belonwu, E.N. (2023). Proximate composition, carcass characteristic and relative organs weight of finisher broiler fed cassava peels palm kernel cake meal. *Journal of Agriculture and Social Development*, **2**: 41-49.
- Narkhede, P. N., Kaduskar, M. R. and Thatte, V. R. (1981). Replacement of maize by sorghum (Jawar grain) in layer rations. *Indian Journal of Poultry Science*. **16**:403-405.
- Poultry Site, (2017). How poultry perform globally in 2016 and what to expect in 2017, *5m publishing*.
- Rafed, R., Abedi, M. H. and Etmadi, M. H. (2024). Nutritional value of eggs in human diets. *Journal of Research in Applied Science and Biotechnology*, **1**: 172-176.
- Rama Rao, S. V., Praharaj, N. K., Raju, M. V. L. N., Mohapatra, S. C., Chawak, M. M. and Salissou, I. (2009). Nutritional value of sorghum for poultry feed in west Africa. PhD thesis, Department of Animal Science and Industry, Collage of Agriculture, Kansas State University, Manhattan, Kansas.
- Thakur, R. S., Gupta, P. C., Sagar, V., Prasad, D. and Lodhi, G. P. (1985). Different sorghum grain varieties as an alternative to maize in layer rations. *Journal of Poultry Science*, **20**: 85-88.