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National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email:japr@napri.gov.ng Url:journals.napri.gov.ng

RESPONSE OF LAYING HENS FED DIETS WITH IBURU (*DIGITARIA IBURUA*) OFFAL REPLACING MAIZE

[*1]Sudik, S. D., [2]Agbede, J. O., [2]Igbasan, F. A., [1]Maidala, A., [1]Bagudu, I. A., and [1]Lawan, A.
[1]Department of Animal Science, Federal University, Gashua, Yobe State, Nigeria
[2]Department of Animal Production and Health, Federal University of Technology, Akure, Ondo State, Nigeria
[*]Corresponding Author: davidsudik@yahoo.com +2348065633451

ABSTRACT

The continuous scarcity and high cost of livestock feed has necessitated the search for alternative ingredients. An experiment was conducted to determine the response of laying hens fed diets with iburu offal (IO) replacing maize. 162 laying hens were distributed to 6 diets with IO replacing maize at 0%, 5%, 7.5%, 10%, 12.5% and 15%. The 0% served as control. Each diet has 27 replicated 3 times and 9 hens per replicate in a completely randomized design. Feed was served twice a day but drinking water was provided ad libitum. The results showed that egg production rate (EPR), feed efficiency per dozen eggs (FE/dozen eggs) and feed efficiency per egg mass (FE/egg mass) were significantly (P<0.05) affected. Hens fed 12.5% IO had higher EPR, better FE/dozen eggs and FE/egg mass than those fed 0% IO while hens fed 5-10% and 15% IO had lower EPR, poor FE/dozen eggs and FE/egg mass comparable to those fed 0% IO. The other performance parameters were not significantly (P>0.05) affected. The entire egg quality parameters were also not significantly (P>0.05) affected except egg weight (EW) and egg yolk colour that were significantly (P<0.05) affected. Hens fed 12.5% IO also had higher EW and deep-yellow yolk than those fed 0% IO while hens fed 5-10% and 15% IO had lower EW and pale-yellow yolk similar to those fed 0% IO. Cost of feed per 100kg and 1kg decreased with increased IO in the diets. The diet with 0% IO had higher cost per 100kg and 1kg feed while diet with 15% IO had least. Cost of Feed per dozen eggs and cost of feed per egg mass fluctuate. In both parameters 0% IO had the higher cost while 12.5% IO had least. It was concluded that IO can replace maize at 12.5% in laying hens' diets without negative effect on egg production and egg quality. Also, a drastically reduction of cost of feed was recorded.

Keywords: Laying hens, Maize, Iburu offal, Performance, Egg quality, Cost implication

INTRODUCTION

The non-availability and increase in prices of conventional feed ingredients in developing countries including Nigeria have necessitated the search for alternative ingredients. Nwoche *et al*. (2009) observed that most farmers that cannot cope with rising prices of feeds have abundant livestock production particularly those dealing with non-ruminants. Unlike ruminant species that can thrive on forages, non-ruminants must be fed with grains which are sought by human (Agbede, 2000). The low participation of farmers in livestock production has adversely affected most developing countries in producing the needed animal protein (Nwoche *et al*., 2009). One of such alternative ingredients is iburu offal. Iburu offal (IO) is a by-product obtained when processing iburu grains into flour or any iburu-based foods. It is usually discarded as waste.

Iburu (black fonio) belongs to the family Poaceae and genus Digitaria. It is known (NRC, 1996) under many names as hungry rice, fundi, funde, su'uru podgi, apendi, mormor, atcha, tau, fini, foyo, nfoni etc known (NRC, 1996). It is a popular staple food grown across West Africa and in Nigeria it is grown in the central zone and dominantly in Plateau and Bauchi States (Gyang and Wuyep, 2005). Cruz *et al*. (2016) that iburu seed is rich in methionine and iron. The grain plays a major role in food security, preventing food shortages because it ripe faster than other cereals (NRC, 1996). It is not a demanding crop and

resistance to drought (Cruz *et al*., 2016). The 1000-grain weight is only about 0.5 g, making it the smallest cereal grain worldwide (NRC, 1996).

It contains 6.52% DM total ash, 12.49% DM crude protein, 4.15% DM ether extract, 10.54% DM crude fibre, 66.30% DM nitrogen free extract, 0. 05% calcium, 0.09% phosphorus, 3.25g/16gN lysine and 3.60g/16gN methionine (Sudik, 2016). The objective of this study was to determine the response of laying hens fed diets with iburu (*Digitaria iburua*) offal replacing maize.

MATERIALS AND METHODS

Location of study area

The experiment was conducted at the Teaching and Research Farms, Department of Animal Production and Health, Faculty of Agriculture, Federal University of Technology, Akure, Nigeria. Akure is on latitude 7^0 15' N and longitude 5^0 12' 0" E. The average annual rainfall was 1524 mm; temperature was from 28^0C to 31^0C and high relative humidity was 80% (Ajibefun, 2011).

The iburu offal was collected in iburu Milling Centres in Jos, Plateau State, Nigeria.

Experimental diets

A basal diet (0% IO) meeting the nutrient requirements of laying hens as recommended by NRC (1994) was formulated. Thereafter, five (5) other diets with IO replacing maize at 5%, 7.5%, 10%, 12.5% and 15% were formulated (Table 1).

Table 1: Gross composition (%) and analyzed composition (%) of diets with iburu offal replacing maize

Ingredients	Diet1 0% IO	Diet2 5% IO	Diet3 7.5% IO	Diet4 10% IO	Diet5 12.5% IO	Diet6 15% IO
Maize	59.00	56.05	54.57	53.10	51.62	50.15
D. iburua offal	0.00	2.95	4.43	5.90	7.38	8.85
Soybean meal	12.30	12.30	12.30	12.30	12.30	12.30
Groundnut cake	11.00	11.00	11.00	11.00	11.00	11.00
Soy oil	3.50	3.50	3.50	3.50	3.50	3.50
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00
Dicalcium phosphate	9.00	9.00	9.00	9.00	9.00	9.00
Oyster shell	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Premix*	2.50	2.50	2.50	2.50	2.50	2.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**`100.00**	**100.00**	**100.00**
Calculated						
Crude protein	16.26	16.33	16.36	16.39	16.43	16.46
ME (MJ/kg)	14.74	14.59	14.58	14.56	14.54	14.54
Calcium	4.13	4.13	4.14	4.14	4.14	4.14
Phosphorus	0.49	0.49	0.49	0.50	0.50	0.50
Lysine	0.93	0.98	1.01	1.04	1.07	1.09
Methionine	0.40	0.42	0.43	0.44	0.45	0.46
Fiber	2.57	2.65	2.69	2.74	2.78	2.82

ME = metabolizable energy, Optimix Layers * supplied the following per kg diet; Vit.A,100000iu; Vit.D3; 20000iu;Vit.E, 100iu; Vit.K, 20mg; ThiamineB1,15mg; RiboflavinB2, 40mg; PyridoxineB6, 15mg; Niacine, 150mg; Vit.B12, 0.01mg; Pantothenic acid, 50mg; Folic acid, 5mg;Biotin, 0.2mg; Choline chloride, 2mg; Anti-oxidant, 1.25g; Manganese, 0.8g; Zinc, 0.5g; Iron, 0.2g; Copper, 0.05g; Iodine, 0.12g; Selenium, 2mg; Cobalt, 2mg/kg.

Experimental design and birds' management

162 Harco black hens at 20 weeks old were purchased from Abivict Poultry Farms in Ilara Mokin, Ifedore Local Government of Ondo State, Nigeria and were used for this experiment that lasted for 84 days. The hens were kept in an open-sided house equipped with 3 tier California type colony cages (43×41cm). They were randomly distributed to the 6 diets by balancing their weights to ensure similar initial weights. Each diet has 27 hens in three replicates, and each replicate has three cell units and each cell unit has 3 hens, given 9 hens per replicate. The design used was a complete randomized design (CRD). The hens were served with their respective diets twice a day as adopted by Igbasan and Guenter (1999) while drinking water was supplied *ad libitum*. Prophylactic treatments were administered occasionally.

Data collection

Performance

The hens were individually weighed at the start of the experiment to determine the initial weight and subsequently at 3 week intervals as adopted by Igbasan and Guenter (1999). The body weight change per diet was determined by dividing the cumulative weight by the number of hens. Feed consumption was also determined at the end of every 3 weeks as adopted by Igbasan and Guenter (1999). The leftover feed after 3 weeks was subtracted from the supplied to determine the quantity of feed consumed and was divided by number of hens and recorded per hen. Daily feed intake was determined by dividing the cumulative feed consumed by 84 days. Egg production rate, feed efficiency per dozen eggs and feed efficiency per egg mass were calculated using the formulae below:

$$\text{Egg Production Rate} = \frac{\text{Total number of eggs produced}}{\text{Number of birds alive}}\ x\ 100$$

$$\text{Feed Efficiecy per Dozen Eggs} = \frac{\text{Amount of Feed Consumed}}{\text{Dozens of eggs produced}}$$

$$\text{Feed Efficiency per Egg Mass} = \frac{\text{Amount of feed consumed}}{\text{Total egg mass produced}}$$

Egg quality determination

On the last 3 consecutive days of each 3 weeks, all the eggs produced per replicate were collected and a total of 1296 eggs were used for egg quality determination. Each egg was weighed on electronic weighing balance in grams. Egg length and width were measured in centimeters using a digital vernier caliper. Eggs were carefully broken using blunt edged knife to avoid damaging the content. Albumen and yolk weights were measured in grams using electronic weighing balance. Albumen height was measured in centimeters using digital vernier caliper and yolk colour was determined using the Roche Yolk Color Fan (RYCF). Shell weight was measured in grams using electronic weighing balance following the removal of egg membrane and sun dried for 2 days as adopted by Igbasan and Guenter (1999). Shell thickness was measured in millimeters using micrometer screw gauge. Egg shape index, Shell density and Haugh unit were calculated using the following formulae:

$$\text{Haugh Unit} = 100\log (H + 7.5 - 1.7W^{0.37}).$$

(Oluyemi and Roberts, 2000)

Where H= height of albumin, W = egg weight

$$\text{Egg Shape Index: ESI} = \frac{Width\ of\ egg}{Lenght\ of\ egg}\ x\ 100$$

(Jayasena *et al*., 2012)

$$\text{Egg Shell Density: ESD} = \frac{Shell\ weight}{4.68(egg\ weiht\ x\ \frac{2}{3})}\ x\ 100$$

(Riley *et al*., 2014)

Cost analysis

The cost of feed per 100kg per each diet was determined by adding the prevailing prices of feed ingredients as purchased. The cost per kg feed, cost of feed per dozen eggs and cost of feed per egg mas were calculated using the formulae below:

$$\text{Cost per kg feed} = \frac{Price\ of\ 100\ kg\ feed}{100}$$

Cost of feed per dozen eggs
= Feed consumed per dozen eggs multiply by cost per kg feed

Cost of feed per egg mass
= Feed consumed per egg mass multiply by cost per kg feed

Statistical analysis

Data generated were subjected to analysis of variance using SAS Statistical Package (SAS, 1999) and significant differences among treatment means were separated at 5% level of probability using Duncan Multiple Range Test of the same Package.

RESULTS

Table 2 shows the performance of hens fed diets with IO replacing maize. Egg production rate (EPR), feed efficiency per dozen eggs (FE/dozen eggs) and feed efficiency per egg mass (FE/egg mass) were significantly ($P<0.05$) affected. Hens fed 12.5% IO had higher EPR (77.49±1.68%) than hens fed 0% IO (69.71±1.45%), better FE/dozen eggs and FE/egg mass (4.55±0.28 and 4.34±4.11, respectively) than hens fed 0% IO (4.90±0.12 and 4.65±5.57, respectively) while hens fed 5-10% and 15% IO had lower EPR (70.19±2.15%, 70.27±1.45%, 70.83±2.37% and 70.89±2.56%, respectively), poor FE/dozen eggs (4.92±0.25, 4.92±0.33, 4.87±0.36, and 4.93±0.34, respectively) and poor FE/egg mass (4.67±6.26, 4.68±6.15, 4.63±5.48 and 4.69±3.46, respectively) similar to hens fed 0% IO. Final body weight, body weight change, total feed intake, daily feed intake, feed consumed/ dozen eggs and feed consumed/egg mass were not significantly ($P>0.05$) affected.

Table 3 shows egg quality of laying hens fed diets with IO replacing maize. The entire egg quality parameters (Egg length, egg width, yolk weight, albumen weight, albumen height, egg shape index, shell weight, shell thickness, egg shell density and Haugh unit) were not significantly ($P>0.05$) affected except egg weight (EW) and egg yolk colour that were significantly ($P<0.05$) affected. Hens fed 12.5% IO had higher EW (62.75±6.15g) than hens fed 0% IO (59.27±9.05g) and deep-yellow yolk than 0% IO (Plate 2) while hens fed 5-10% and 15% IO had lower EW (58.61±8.51g, 58.85±8.36g, 59.52±7.13g 59.09±8.24g, respectively) and pale-yellow yolk similar to hens fed 0% IO (Plate 1)

Table 2: Performance (g) of laying hens fed with iburu offal replacing maize

Parameters	**Diet1**	**Diet2**	**Diet3**	**Diet4**	**Diet5**	**Diet6**
	0% IO	**5% IO**	**7.5% IO**	**10% IO**	**12.5% IO**	**15% IO**
Initial body weight (kg)	1.67±2.71	1.66±3.54	1.66±1.15	1.66±2.63	1.67±2.11	1.67±1.16
Final body weight (kg)	1.81±1.63	1.80±1.15	1.80±2.08	1-81±1.67	1.82±2.14	1.81±2.12
Body weight change (kg)	0.14±1.33	0.14±1.01	0.14±1.36	0.14±1.02	0.14±1.46	0.14±1.55
Egg production rate (%)	69.71±1.45^{b}	70.19±2.15^{b}	70.27±1.45^{b}	70.83±2.37^{b}	77.49±1.68^{a}	70.89±2.56^{b}
Total feed intake (kg)	9.12±3.00	9.20±3.00	9.30±4.02	9.36±3.54	9.37±2.83	9.38±2.87
Daily feed intake (g)	108.61±0.63	109.55.1.14	110.68±1.37	111.40±1.16	111.81±1.07	113.89±1.17
Feed consumed/dozen eggs (kg)	1.87±0.63	1.87±0.92	1.89±0.08	1.89±0.34	1.73±1.48	1.93±0.89
Feed consumed/eggs mass (kg)	2.93±0.47	2.96±.85	2.99±0.36	3.01±0.80	3.02±0.87	3.08±0.03
Feed efficiency/dozen eggs	4.90±0.12^{b}	4.92±0.25^{b}	4.92±0.33^{b}	4.87±0.36^{b}	4.55±0.28^{a}	4.93±0.34^{b}
Feed efficiency per egg mass	4.65±5.57^{b}	4.67±6.26^{b}	4.68±6.15^{b}	4.63±5.48^{b}	4.34±4.11^{a}	4.69±3.46^{b}

Values are average of 27 hens.
Values with different superscripts within a row are significantly different ($p<0.05$).

Table 3: Egg quality laying hens fed diets with offal replacing maize

Parameters	Diet1	Diet2	Diet3	Diet4	Diet5	Diet6
	0% IO	5% IO	7.5% IO	10% IO	12.5% IO	15% IO
Egg weight (g)	59.27±9.05^{b}	58.61±8.51^{b}	58.85±8.36^{b}	59.52±7.13^{b}	62.75±6.15^{a}	59.09±8.24^{b}
Egg length (cm)	5.53±1.11	5.67±1.22	5.54±1.15	5.61±1.35	5.53±1.13	5.52±1.21
Egg width (cm)	4.01±0.35	3.92±0.14	4.33±0.23	4.34±0.40	4.45±0.24	4.00±0.31
Yolk Weight (g)	18.84±2.13	17.89±1.54	17.56±1.55	18.68±0.45	18.94±0.42	18.85±0.36
Yolk colour	6.00±.00^{b}	6.00±0.00^{b}	6.00±0.00^{b}	6.00±0.00^{b}	7.00±0.00^{a}	6.00±0.00^{b}
Albumen weight (g)	40.78±1.18	38.26±2.02	38.58±1.43	41.13±0.78	43.22±0.27	40.37±1.75
Albumen height (cm)	1.64±0.12	1.62±0.16	1.52±0.32	1.58±0.25	1.99±0.11	1.56±0.21
Egg shape index	72.51±2.13	69.14±2.45	78.16±4.45	77.36±3.21	80.47±3.56	72.46±4.47
Shell weight (g)	5.42±0.05	5.41±0.10	5.33±0.21	5.23±0.14	5.20±0.15	5.15±0.17
Shell thickness (mm)	0.33±0.00	0.33±0.00	0.33±0.00	0.33±0.00	0.33±0.00	0.33±0.00
Egg shell density(g/cm2)	2.92±0.14	2.97±0.33	2.90±0.23	2.80±0.16	2.70±0.36	2.77±0.41
Haugh Unit	85.00±1.23	83.00±1.22	83.34±1.13	85.00±1.13	86.00±125	85.00±1.33

Values are average of 216 eggs.
Values with different superscripts within a row are significantly different ($p<0.05$).

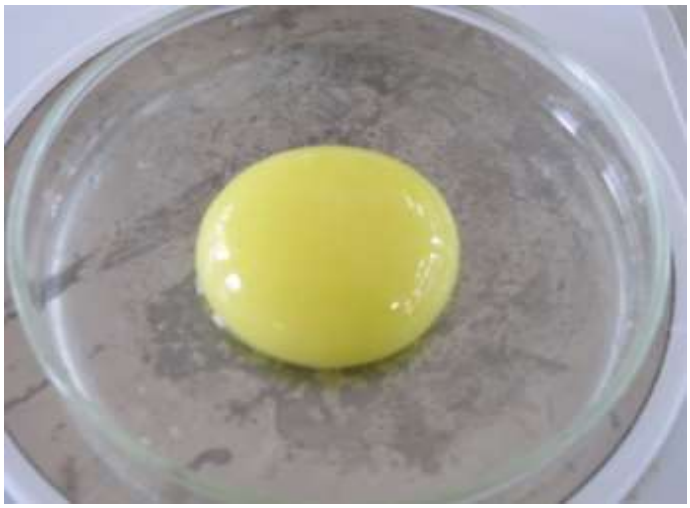


Plate 1: Pale-yellow yolk of laying hens fed with iburu offal replacing maize at 0%, 5%, 7.5%, 10% and 15%

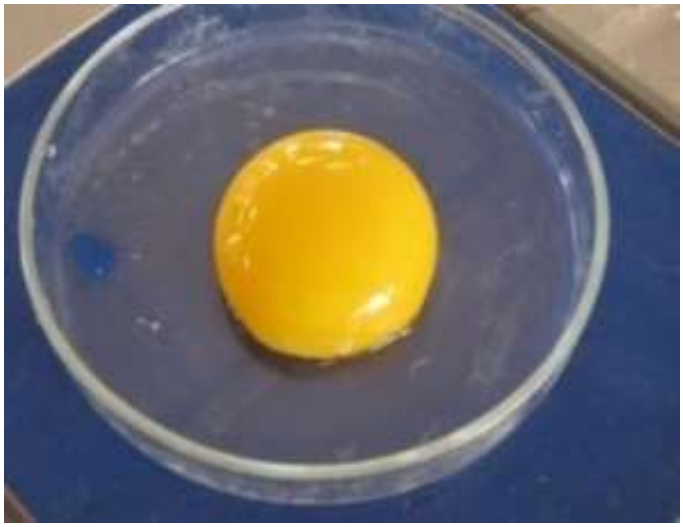


Plate 2: Deep-yellow yolk of laying hens fed with iburu offal replacing maize at 12.5%

Table 4 shows the cost implication of diets with IO replacing maize. Cost of feed at 100kg and 1kg decreased with increased inclusion of IO in the diets. The control diet (0% IO) had highest cost per 100kg feed and 1kg feed (₦10131.00 and ₦101.31, respectively) while 15% IO least (₦9555.00 and ₦95.55, respectively). Cost of feed /dozen eggs and cost of feed /egg mass showed fluctuate. 0% IO had highest cost of Feed /dozen eggs and cost of Feed/egg mass (₦189.41 and ₦297.09, respectively) while 12.5% IO had lowest (₦167.10 and ₦291.35, respectively).

Table 4: Cost implication of laying hens' diets with iburu offal replacing maize

Parameters	Diet1 0% IO	Diet2 5% IO	Diet3 7.5% IO	Diet4 10% IO	Diet5 12.5% IO	Diet6 15% IO
Cost of Feed @ (N/ 100kg)	10131.00	9939.00	9843.00	9747.00	9651.00	9555.00
Cost of Feed @ (N/kg)	101.31	99.39	98.43	97.47	96.51	95.55
Cost of Feed @ (N/dozen of egg)	189.41	186.15	186.04	183.96	167.10	184.21
Cost of Feed @ (N/egg mass)	297.09	293.98	294.14	293.17	291.35	293.82

DISCUSSION

In this experiment the performance of laying hens fed diets with 5-10% and 15% IO in most cases compared favourably with hens fed control. Only hens fed diet with 12.5% IO had egg production rate, feed efficiency per dozen eggs and efficiency per egg mass that surpassed hens fed control. The higher performance of hens fed 12.5% IO over the control diet may probably due to the higher crude protein (12.49% DM) and methionine (3.60g/16gN) in IO (Sudik, 2016) in IO than 9.4% DM crude protein and 2.1g/16gN methionine in maize (Heuze *et al*., 2017). According to Rostagno (2005) the performance of laying hens depend on the constituent of amino acid in the diet and on the physiological utilization of specific amino acids after digestion, absorption and minimum obligatory rates of oxidation. The decline in performance at 15% IO may be due to decrease in quality because as IO increased in the diets crude fibre content increased (Table 1). Igbasan *et al.* (1997) explained that high fibre feeds are indigestible and also interfere with the digestion of other nutrients. This thus suggests that the optimum replacement of maize with IO in laying hens could be 12.5% beyond which decline in performance may be noted.

The higher egg weight observed in the hens fed 12.5% IO further confirmed that certain nutrients were present in the diet and at a level that favoured higher egg weight. Also, the deep-yellow yolk observed in the eggs of hens fed 12.5% IO means that the diet may contained more pigments that promote yolk colour. Thus suggesting that the egg produced using the 12.5% diets would command high price in the market. This is in consonance with the reports of Aro *et al.* (2009) that high preference and premium is attached to the eggs with deep yellow to orange yolk colour. According to Lokaewmanee *et al*. (2011) and Beardsworth and Hernandez (2004) that egg yolk color is a result of egg pigmentation influenced by the carotenoids from diets. The insignificant in egg length, egg width, yolk weight, albumen weight, albumen height, egg shape index, shell weight, shell thickness, egg shell density, Haugh between the control and IO based diets implied that IO has the potential in promoting good egg quality.

The values for shell thickness across the diets were within 0.34-0.43 mm reported by Oluyemi and Roberts (2000). This could mean that the present experimental diets contained the required calcium: phosphorus ratio. The

significance of having normal shell thickness is eggs can move through normal market handlings without breaking (Stadelman, 1997). The values for Haugh unit in this experiment were above 70 indicating a normal egg (Stadelman, 2002). Stadelman (2002) reported that higher Haugh unit indicates better albumen quality. According to Jayasena *et al*. (2012) eggs having Haugh unit value of 70 and above are considered as good quality eggs.

The steady reduction in the cost of feed as IO increased in the diets was due to the prevailing lower cost of IO in comparison to the same quantity of maize as at the time of the experiment. The lower cost of feed per dozen eggs and cost per egg mass in 12.5% IO was due to the higher egg production rate in the hens fed this diet in relation to the quantity of feed consumed. This confirmed the report of Olajide and Akinsoyinu (2015) that less costly feed ingredients reduce high cost of livestock feeds.

CONCLUSION

The study with commercial laying hens showed that iburu offal can replaced maize at 12.5% with credible egg production performance and egg quality. Also, a drastically reduction of cost was recorded in the use of iburu offal in laying hens diets than the control. Therefore, iburu offal can be included in commercial laying hen diet at 12.5% without adverse effect on egg production and egg quality.

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