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NUTRIENT DIGESTIBILITY AND ECONOMIC BENEFIT ANALYSIS OF JAPANESE QUAILS (*Coturnix coturnix japonica*) FED DIETS CONTAINING GRADED LEVELS OF GINGER (*Zingiber officinale*) WASTE MEAL

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ABSTRACT
A total of two hundred and eighty eight (288) two-weeks-old Japanese quails (Coturnix coturnix japonica) were used to evaluate their nutrient digestibility and economic benefit analysis when fed diets containing graded levels of ginger (Zingiber officinale) waste meal (GWM) as a replacement for maize. The birds were randomly allotted to four dietary treatments subdivided into four replicates containing 18 quail birds per replicate; and were fed formulated diets containing ginger waste meal at 0 (control), 10, 20 and 30 % respectively (designated as T1, T2, T3 and T4) for four weeks in a completely randomized design model. All data collected were subjected to analysis of variance (ANOVA). The results obtained revealed that there were no significant ($p>0.05$) differences observed in ether extract, total digestible nutrient, total feed intake and body weight gain (g). However, there were significant ($p<0.05$) differences in crude protein, crude fibre, ash, nitrogen free extract, dry matter digestibilities. Cost of feed, cost of total feed intake and cost/weight gain in ₦/kg were significantly different ($p<0.05$) between treatments. It was observed that all treatments had digestibility values above 50 % which implies that they all had high apparent nutrient digestibility and birds fed diets containing 30 % replacement of maize with GWM incurred the least in cost per weight gain in ₦/kg. It was therefore concluded that the replacing maize by up to 30 % with GWM in Japanese quail diets is more economically beneficial without any adverse effects on nutrient digestibility and it had a positive effect on the economic benefit analysis of growing Japanese quails.

Keywords: *Nutrient digestibility, economic benefit analysis, Japanese quail, ginger waste meal*

INTRODUCTION
Quails are small game birds that are suitable for meat and egg production on a commercial scale (Onyewuchi *et al.,* 2013). Abu *et al.* (2016) reported that there is a need to diversify and commercialize the production of other poultry birds such as quail, as chicken and ducks suffer losses due to diseases, chicken especially, they have lower disease resistance and have higher nutritional demand as compared to quails, which are more suitable species; easy to rear with little investment and provide more economic returns within a very short period of time. Utilization of antibiotics-based growth promoters have been confronted with severe criticisms and universal concern because of their alleged dangerous effects, which include microbial resistance and their potentially dangerous effects on the health of man (Rahmatnejad *et al.,* 2009). These problems have prompted the investigation of other alternative substances that can reduce these threats (Manesh, 2012). Ginger has been used over centuries for healing purposes in Asia, Middle East, Europe and India to treat diseases such as arthritis, menstrual irregularities, asthma, diabetes and stomach upset (Ali, 2008). Prasad *et al.,* (2014) reported that ginger serves as an anti-inflammatory agent, prevent respiratory tract infections, prevents cough and bronchitis, and even recommended it for leg joint problems. Ginger has constituents that have been found to help as antioxidants, with anti-inflammatory and antimutagenic properties. It also helps in the suppression of growths that induce varieties of cancer (Scrinivasan, 2008). Hence, the importance of this additive in the diets of poultry is not only nutritional or merely affecting the growth rate of the birds, but also has health and welfare implications (Kizilashlam, 2007). Japanese quail is one of the promising monogastric animals which can provide an excellent and cheap source of animal protein for the increasing Nigerian population considering its unique

characteristics of high production potential and short generation interval [Aygun and Sert, (2013)]. Also, conventional energy sources are costly due to high demand of these feed stuff by humans and other domestic animals, hence, the partial substitution of maize with ginger waste meal as energy source could go a long way to reduce the overall cost of production and could therefore be a cheap and locally available substitute for maize in livestock diet (Ali, 2008). Therefore, this research is aimed at investigating the apparent nutrient digestibility and to evaluate the cost implication of feeding ginger waste meal in partial replacement of maize in Japanese quails.

Materials and Methods

Experimental site: This research study was carried at the Quail Unit of the Department of Animal Production Old Teaching and Research Farm, Federal University of Technology, Bosso Campus, Minna, Niger State. Minna is located between latitude 9^0 15′ and 9^0 45′ N and between longitude 6^0 15′ and 6^0 45′ E of the equator. The yearly range of rainfall is 1000-1300 mm with a temperature range of about 28-42^0C. Minna falls within the Southern Guinea Savannah vegetation of Nigeria (FUTMINNA, 2019).

Source and processing of ginger waste: Ginger waste was sourced from Kafanchan in Giwa Local Government Area of Kaduna State. The ginger waste was sun dried for many days until it was properly dried to a moisture content of about 10 %. It was then milled using an attrition mill and stored in plastic containers until it was needed for use. Ingredients such as maize, soya bean meal, maize offal, fish meal and salt were purchased at the Kure Ultra-Modern Market, Minna. Other micro ingredients such as vitamin premix, lysine, methionine, and bone meal were purchased from feed ingredient depots in UK Bello, Minna.

Experimental Animals and Diets:During the growth phase of quails, the experimental diets had crude protein (CP) level set at 23 %. Treatment 1 (T1) contained no ginger waste meal which served as the control diet; while Treatments 2, 3 and 4 (T2, T3 and T4) contained 10 %, 20 %, and 30 % replacement of maize respectively. Two hundred and eighty eight (288) two-week-old unsexed Japanese quails were used for the first phase (growth phase) of the experiment, and were allocated to four dietary treatments with four replicates of 18 birds per replicate in a Complete Randomised Design. Data collected from the experiment were subjected to a one-way analysis of variance (ANOVA) at 5% probability level. Significantly different means were separated using Duncan multiple range test. The Statistical Package for Social Sciences version 17 (SPSS, 2012) was used to analyze the data. The experimental birds were purchased from the National Veterinary Research Institute (NVRI) of Nigeria Vom, Plateau State, Nigeria.

Table 2. Ingredient Composition of the Experimental Diets for the Growth Phase of Quail Birds

Ingredient	T1	T2	T3	T4
Maize	43.29	38.83	34.54	30.14
Ginger waste meal	0.00	4.33	8.66	12.99
Soybean meal	40.01	40.13	40.12	40.25
Maize offal	10.00	10.00	10.00	10.00
Fish meal	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50
Limestone	1.50	1.50	1.50	1.50
*Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calculated analysis				
ME (Kcal/Kg)	2760	2658	2536	2323
Crude protein (%)	22.90	23.11	23.78	23.49
Crude fibre (%)	5.14	5.15	5.16	5.17

Lysine (%)	1.39	1.39	1.38	1.37
Methionine (%)	0.45	0.44	0.44	0.43
Calcium (%)	1.20	1.20	1.20	1.20
Phosphorus (%)	0.77	0.76	0.74	0.73

*Premix supplied per 2.5kg contains: Vitamin A (7,500 IU), vitamin D (500,000 IU), vitamin E (100 IU), vitamin B1 (325 mg), vitamin B2 (125 mg), vitamin B3 (500 mg), vitamin B6 (150 mg), vitamin B12 (2.5 mg), vitamin C (10 mg), vitamin K (15 mg), and folic acid (150 mg), Minerals: Ca (12.5 mg), Cu (8.0 mg), Fe (32 mg), I (0.8 mg), Se (100 mg), Mg (0.25 mg), Chlorine (250 mg), Panthotenic acid (14.4 mg)

ME: Metabolizable Energy

T1: ginger waste meal replacing 0 % of maize

T2: ginger waste meal replacing 10 % of maize

T3: ginger waste meal replacing 20 % of maize

T4: ginger waste meal replacing 30 % of maize

Table 1. Proximate Composition and Energy Value of Ginger Waste Meal (GWM)

Parameter	% Composition
Dry matter	87.50
Ash	5.50
Crude protein	12.95
Crude fibre	10.00
Ether extract	3.60
Nitrogen free extract	55.45
M.E. (Kcal/kg) of (GWM)	2742

Key: GWM= Ginger waste meal

RESULT AND DISCUSSION

Results on nutrient digestibilityreveal that quails fed diets containing 30 and 40 % ginger waste meal had significantly higher crude protein (74.53 and 76.16) and crude fibre (86.39 and 88.31) digestibilities compared to birds fed diets containing 10 and 0 % (control) GWM.Results of research agrees with the findings of Abd El-Galil and Henda (2015) who recorded significant ($p<0.05$) differences in crude fibre, nitrogen free extract and total digestible nutrient in laying Japanese quails when ginger root meal was included in their diet. The result of ash revealed that T3 had better ($p<0.05$) result in ash (88.16) as compared to all other treatments and the control. The nitrogen free extract result revealed that treatments T4 (95.74 %) had better ($p<0.05$) result as compared to all treatments and the control. The results of economic benefits analysis of growing Japanese quails fed ginger waste meal revealed that T1 were significantly ($p<0.05$) better than all treatment in cost of total feed intake in naira (₦) per kg with (696.44) value. T1 and T2 (8.07 and 7.52) were not significantly ($p>0.05$) different but were significantly better than T3 and T4 with the values (6.34 and 5.80). This agrees with Kafi *et al,* (2017) who reported that the use of ginger and turmeric in the research work done yielded positive results throughout all levels of inclusion from (0.50 and 0.75 %) ginger and (0.50 and 0.75 %) turmeric.

Table 3. Apparent Nutrient Digestibility of Growing Japanese Quails Fed Diets Containing Ginger Waste Meal

Parameter	T1 (0 %)	T2 (10 %)	T3 (20 %)	T4 (30 %)	SEM	LS	p-value
Crude protein	70.97^{b}	65.47^{c}	74.53^{a}	76.16^{a}	1.17	*	0.05
Ether extract	82.07	82.89	84.18	86.34	0.55	NS	0.14
Crude fibre	81.66^{b}	74.05^{c}	86.39^{a}	88.31^{a}	1.47	*	0.05
Ash	79.33^{c}	73.92^{d}	88.16a	84.55^{b}	1.42	*	0.05
NFE	89.92^{b}	80.64^{c}	86.57^{b}	95.74^{a}	1.50	*	0.05
Dry matter	85.37^{a}	76.27^{b}	84.63^{a}	85.36^{a}	1.11	*	0.05

TDN	61.80	71.38	79.48	81.63	4.44	NS	0.41

[abcd]Means on the same row with different superscripts are significantly ($p<0.05$) different.
* = Significant ($P<0.05$) difference NS = Not significant SEM = Standard error of the means, LS = Level of significance ,NFE = Nitrogen free extract, TDN = Total Digestible Nutrient,

Table 4. Economic Benefit Analysis of Growing Japanese Quails Fed Ginger Waste Meal as Partial Replacement for Maize

	T1	T2	T3	T4	SEM	P-value	LS
Total feed intake (kg)	5.38	5.47	5.41	5.53	0.03	0.24	NS
Cost of feed in ₦ per kg	129.45[a]	114.64[b]	102.11[c]	91.60[d]	3.65	0.01	*
Cost of total feed intake in ₦/kg	696.44[a]	626.81[b]	552.55[c]	506.36[d]	18.83	0.01	*
Body weight gain /g	86.47	84.08	87.26	87.27	1.19	0.78	NS
Cost/weight gain in ₦/kg	8.07[a]	7.52[a]	6.34[b]	5.80[b]	0.26	0.01	*

Key
[abcd]Means on the same row with different superscripts are significantly ($p<0.05$) different.
SEM = Standard error of the means
NS = Not significant

CONCLUSION AND RECOMMENDATIONS

Apparent nutrients digestibility of growing Japanese quails fed partial replacement of ginger waste meal in the diets compared favourably with the control for all parameters measured except crude fibre and nitrogen free extract. Based on the results of this research study, up to 30 % partial replacement of maize with ginger waste meal is recommended for optimum nutrient digestibility and economic benefits analysis Japanese quails. It is also recommended that further research studies on the replacement value of ginger waste meal for maize should be carried out on other species of poultry.

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