Performance of West African Dwarf goats fed maize offal diets supplemented with dry poultry excreta

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Keywords

Goat – Layer chicken – Excreta – Maize – Weight gain – Feed intake – Feed conversion efficiency – Economic value – Nigeria.

Summary

The nutritional quality of poultry excreta in replacement of maize offal was evaluated in 16 growing West African Dwarf (WAD) goats (eight females and eight males about eight months of age) with an average liveweight of 6.5 kg. The goats were allotted to four different diets containing 0% (T1, control treatment), 10% (T2), 20% (T3) and 30% (T4) poultry excreta in maize offal based diets. Each animal was fed its assigned diet *ad libitum* for 120 days. Feed intake, daily weight gain, feed conversion ratio and fat efficiency ratio were generally higher ($p < 0.05$) in diets including poultry excreta. The feed cost per kilogram, cost per kilogram of weight gain and cost of production were generally lower ($P<0.05$) with the inclusion of poultry excreta. The revenue, gross margin, return on investment and relative cost benefits were higher ($p < 0.05$) in diets that included poultry excreta and lowest in T1. The highest dress percentage was observed in T4 ($p > 0.05$). The leg, loin, rank, lean, shoulder, brisket cuts, fat and bone generally improved ($p < 0.05$) with the inclusion of poultry excreta in the diets. The bone:lean meat ratio increased similarly ($p > 0.05$) in all treatments, except in T3 where it was slightly higher. It is concluded that WAD goats could be sustained on poultry excreta as a component of formulated diets for increased performances in weight gain, feed conversion ratio, carcass yield, and increased economic benefits to farmers.

■ INTRODUCTION

In the southeast of Nigeria, many efforts have been made to improve the ruminant animal industry. However, the supply of major feeds, mainly roughages, has setback the enthusiastic growth of the industry both in the rural and the commercial production sectors, because of the lack of land availability to develop pasture (1, 9). The high demand for new feeds will have a major impact on the ruminant animal industry and production system. The problem is further aggravated by the fact that poultry excreta, industrial and farm wastes, which form the bulk of feed resources in the area, are poorly utilized and highly available all year round, thus causing pollution to the environment (2, 9). Therefore, the situation encourages the possibility of using these feed resources in order to improve the production efficiency of ruminant production systems (5, 13).

Farm animals fed with excreta (i.e. coprophagy) is not new in farm animal feeding systems. Feeding swine and poultry is mostly based on manure in a multi-husbandry system of farm animal production involving feeding beef cattle, followed by swine, then by poultry (15). We became interested in the utilization of poultry excreta as a component of balanced feed for the West African Dwarf (WAD) goats mostly because of the pollution it causes to the environment, as a result of the poor waste disposal system of farm animal operations in Nigeria. Apart from this problem, it has been recognized that large amounts of nutrient with high quantity of uric acid are wasted, and their reuse is another way of creating edible protein from waste material. Poultry excreta are often disposed of uneconomically without any benefit, or left to create nuisance in the field. The amount of excreta that can be produced in seven days by various farm animals is as follows: a 2-kg hen

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produces 0.8 kg, a 650-kg cow produces 150 kg, and an 80-kg swine produces 40 kg (17). It is generally admitted that poultry excreta can be used as substrate for both algae and yeasts for feedstuff, and in the production of maggots for poultry feed; however, the best option and the simplest way to use it is as a direct feed for farm animal nutrition, e.g. to feed goats, cattle and sheep, while avoiding polluting the environment.

Poultry excreta are a byproduct of the poultry industry. They are abundant in Nigeria, and could be used to reduce the gap between feed unavailability and nutrient requirements in ruminant animal production systems, if efforts are geared to explore the possibilities of its use as an alternative feed (5, 6). However, setbacks in the utilization of this waste in the farm animal feeding system include high levels in arsenic compounds, copper, salts, ashes, harmful microorganisms and drug residues which could be toxic and result in the poor productivity of farm stocks (11). It could also affect human health by poisoning if improperly used. The high levels of elements and other biochemical factors in poultry excreta could interact with proteins and minerals to form insoluble complexes. These interactions will depend on the relative properties of phenols, proteins, and poor processing, as well as minerals which could pose serious problems (3, 4).

Therefore, the use of poultry excreta in the ruminant production industry in the manufacturing of balanced diets for efficient production systems should be developed (6, 13). This may be appropriate for the biological conversion of poultry excreta into valuable feed, in order to make the enzymic hydrolysis more accessible in the ruminant farm animal feeding system. Therefore, an attempt has been made to show its effect on compounded complete diets for goat production in an intensive feeding system, through the replacement of maize offal with poultry excreta.

■ MATERIALS AND METHODS

This study was carried out at the Sheep and Goat Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike (MOUAU), Abia State, Nigeria. Poultry excreta were collected from 10-month-old layers raised in cages as part of the poultry farm project. They were sun dried for three days and turned three times daily to obtain 85% dry matter, before being milled with a hammer-milling machine on a 1-mm sieve, then bagged for the study. Poultry excreta and maize offal as major feeds were analyzed according to AOAC (10) (Table I).

Table I

Chemical composition of maize offal and poultry excreta

	Maize offal (%)	Poultry excreta (%)
Dry matter	89.72	84.70
Nitrogen	1.70	4.29
Crude fiber	12.65	13.00
Ether extract	4.20	2.20
Nitrogen	1.71	4.29
Ash	4.30	27.00
MER/MJ/kg*	13.68	11.20

* Metabolizable energy for ruminant, in megajoules/kilogram

Sixteen WAD goats of both sexes (eight females and eight males) of 6.50 kg average body weight and aged about eight months were purchased at Isiala-Ngwa, North Local Government Area, Abia State, Nigeria. Each goat was housed separately in 1.5 m x 2.0 m well-ventilated pen with cemented floor and wood shavings as bedding materials. The animals were quarantined for 30 days and a prophylactic broad-spectrum antibiotic (long acting terramycin) was administered intramuscularly on the third day. IVOMEC was administered as a prophylactic treatment against internal and external parasites on the seventh day. Tissue Culture Rinder Pest Vaccine was also administered intra-muscularly on the fifteenth day. During this period the experimental rations were fed to the goats before the actual study began. The study lasted for 120 days. The pens were thoroughly washed and disinfected before introducing the goats.

The 16 WAD goats of the study were distributed between four dietary treatment groups of four (two females and two males). Each dietary treatment was replicated four times with one goat per replicate. The diets were referred to as T1, T2, T3 and T4 and included 0, 10, 20 and 30% poultry excreta, respectively (Table II). Chemical compositions are detailed in Table III. The goats were fed their

Table II

Composition of the experimental diets (%)

	T1	T2	T3	T4
Poultry excreta	0.0	10.0	20.0	30.0
Maize offal	30.0	20.0	10.0	00.0
Brewer's dried grain	50.0	50.0	50.0	50.0
Palm kernel cake	13.0	13.0	13.0	13.0
Molasses	5.0	5.0	5.0	5.0
Oyster shell	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5
Vitamin premix*	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0

* HI-MIX® GROWER guaranteed added in 5 0 kg per ton. Description: Vitamin A, 8,000,000 IU; Vitamin D3, 2,000,000 IU; Vitamin E, 8,000 mg; Vitamin K3, 2,000 mg; Vitamin B1, 1,500 mg; Vitamin B2, 4,000 mg; Vitamin B6, 1,500 mg; Vitamin B12, 10 μg; Niacin, 15,000 mg; Pantothenic acid, 5,000 mg; Folic acid, 5,000 mg; Biotin, 20 μg; Cholinchloride, 100,000 mg; Manganese, 75,000 mg; Zinc, 45,000 mg; Iron, 20,000 mg; Copper, 4,000 mg; Iodine, 1,000 mg; Selenium, 200 mg; Cobalt, 500 mg; Antioxidant, 125,000 mg.

Table III

Analysis of the experimental diets (%)

	T1	T2	T3	T4
Poultry excreta	0.0	10.0	20.0	30.0
Dry matter	91.9	90.9	89.9	88.9
Nitrogen	2.6	2.8	3.1	3.4
Crude fiber	14.3	14.5	14.7	14.9
Ash	1.0	1.4	2.3	2.9
Ether extract	5.4	5.2	5.0	4.8
MER/MJ/kg*	8.9	8.8	8.8	8.8

* Metabolizable energy for ruminant, in megajoules/kilogram

respective diets for 120 days. Water mixed with vitamin-mix was provided *ad libitum*. Diets were fed at 3.5% of the body weight of the goats during the 30-day quarantine, after which they were fed at 5% of their body weight throughout the rest of the study, firstly at 9.00 am, then at 3.00 pm daily. Diet intake was measured by differences in body weight each time before the next feeding. The initial body weight of the experimental animals was measured at the beginning of the experiment and subsequently at weekly intervals. All the data obtained were recorded. The diets offered were adjusted weekly depending on the body weight without altering their quality, and the feed conversion ratio, feed intake and weight gain were determined (3). Economic benefits were based on the Nigerian Naira (NGN) and were calculated according to Anigbogu and Ezekwem (5). The fat efficiency ratio was calculated based on the formula:

$$\frac{\text{Gain in body weight}}{\text{Fat intake}}$$

The metabolizable energy for ruminant (in MJ/kg) was calculated as:

$$\frac{\begin{array}{c}\text{Energy in}\\ \text{feed ingredient}\end{array} \times \begin{array}{c}\text{Quantity of feed}\\ \text{ingredient to be included}\end{array}}{\text{Total weight of diet to formulate}}$$

The complete randomized design was used for the study and the data collected was subjected to the analysis of variance as described by Gomez and Gomez (18). When differences between treatment means were found significant, they were subjected to Duncan's new multiple range test as described by Gomez and Gomez (18).

■ RESULTS AND DISCUSSION

The results of the chemical analysis of poultry excreta and maize offal (Table I) showed that the nitrogen content improved by about 60.15% in favor of poultry excreta. This is similar to the result obtained by Bakshi and Fontenot (12), and Anigbogu and Ibe (8). Whereas crude fiber was higher in poultry excreta and lower in maize offal, energy was generally lower in poultry excreta than in maize offal.

Table IV shows performance characteristics of WAD goats depending on various parameters. The daily weight gain of goats was high ($p < 0.05$) in T4 (30% poultry excreta), followed by T3 (20% poultry excreta), then by T2 (10% poultry excreta) compared to that of goats in T1 (no poultry excreta but 30% maize offal). These results were similar to those of Kayouli et al. (20), and Fajesimin et al. (14). The highest daily feed intake was observed in T2 ($p < 0.05$), followed by T4, then by T3, and these intakes were much higher than that in T1 (16). The highest daily poultry excreta intake was observed in T4, followed by T3, then by T2, then by T1, revealing significant differences ($p < 0.01$) between treatments (19, 22).

The best feed conversion ratio ($p < 0.05$) (Table IV) was noted in goats fed the diets containing poultry excreta, as observed by other authors (19). The litter condition of the goats was better ($p > 0.05$) in T2, followed by T4, then by T3, then by T1, which compared favorably with results from other studies (23). The fat efficiency ratio noted in our study was generally high ($p < 0.05$) in goats fed the T2 diet, followed by T1, then by T3, then by T4 (23).

Based on the economic benefits studied, the feed cost per kilogram was lower for diets containing poultry excreta ($p < 0.05$) than for the diet with no poultry excreta (Table IV) (24). Also, the cost per kilogram of weight gain was generally lower for diets containing poultry excreta ($p < 0.05$) than for the diet with no poultry excreta. The cost of production was lower for T4, followed by T3 ($p < 0.05$) than for T1 and T2, respectively (27). The revenue and gross margin were generally higher ($p < 0.05$) for diets containing poultry excreta than for that with no poultry excreta. The cost differential and relative cost benefit were generally better ($p < 0.05$) for poultry excreta based diets. The return on investment was higher ($p < 0.05$) for diets containing poultry excreta than for that with no poultry excreta (16, 21).

The dress percentage was generally higher ($p < 0.05$) in goats fed with poultry excreta than in those fed without poultry excreta, a result which agrees with those of other authors (7, 12). The highest ($p < 0.05$) leg cut value (3.80 kg) was observed with T4, followed by T3, then by T2, and they were much higher than that obtained with T1. A higher ($p < 0.05$) loin cut value was also obtained in goats fed poultry excreta than in those fed without poultry excreta

Table IV

Performance characteristics of West African Dwarf goats

Parameters	Treatment diets			
	T1	T2	T3	T4
Initial weight gain (kg)	6.3	6.8	6.7	6.4
Final weight gain (kg)	10.7^{b}	12.3^{a}	12.4^{a}	12.5^{a}
Daily feed intake (g)	583.0^{b}	629.0^{a}	616.0^{a}	622.0^{a}
Poultry excreta intake (g)	0.0^{d}	62.0^{c}	123.0^{b}	187.0^{a}
Daily weight gain (g)	36.0^{b}	46.0^{a}	48.0^{a}	51.0^{a}
Feed conversion ratio	16.2^{b}	13.7^{a}	12.8^{a}	12.2^{a}
Fat efficiency ratio	3.2	3.3	3.1	3.0
Litter condition	3.6	3.6	3.4	3.6
Cost benefit analysis (Nigerian Naira*)				
Feed cost/kg	23^{c}	22^{c}	20^{b}	19^{a}
Cost/kg weight gain	153^{d}	132^{c}	119^{b}	111^{a}
Cost of production	3228^{c}	3238^{c}	3085^{b}	2981^{a}
Revenue	3950^{b}	4533^{a}	4588^{a}	4616^{a}
Gross margin	721^{d}	1294^{c}	1504^{b}	1635^{a}
Cost differential	0^{d}	22^{c}	33^{b}	42^{a}
Relative cost benefit (%)	0.0^{d}	13.7^{c}	21.4^{b}	27.3^{a}
Return on investment (%)	22.3^{d}	40.0^{c}	48.8^{b}	54.8^{a}
Carcass yield and characteristics				
Dress percentage (%)	42.0	42.1	43.2	44.4
Leg cut (kg)	3.1^{b}	3.7^{a}	3.8^{a}	3.8^{a}
Loin cut (kg)	1.3^{b}	1.7^{a}	1.7^{a}	1.7^{a}
Rank cut (kg)	1.8^{c}	2.1^{b}	2.2^{a}	2.3^{a}
Shoulder cut (kg)	2.5^{b}	2.8^{a}	2.9^{a}	3.1^{a}
Brisket cut (kg)	1.5^{b}	1.8^{a}	1.8^{a}	1.8^{a}
Lean cut (kg)	6.9^{a}	8.0^{b}	8.1^{b}	8.1^{b}
Bone (kg)	2.7^{b}	3.1^{a}	3.1^{a}	3.1^{a}
Fat (kg)	0.9^{b}	1.0^{a}	1.0^{a}	1.0^{a}
Bone:meat ratio	1:2.60	1:2.60	1:2.63	1:2.60

Means within the same row with different letters are significantly different ($p < 0.05$)

* 1 € ≈ N210

(19, 21). The lean cut values were higher ($p < 0.05$) in diets containing poultry excreta than in that with no poultry excreta, and they were similar to those reported by Lal et al. (21). The rank, shoulder and brisket cut values generally improved ($p < 0.05$) with the inclusion of poultry excreta in the diets in relation to the diet without excreta (19). The fat and bone values were greatly improved ($p < 0.05$) with the incorporation of poultry excreta in the diets in relation to the diet without excreta (16). The bone:lean meat ratio was generally better ($p > 0.05$) in goats fed poultry excreta than in goats fed without excreta (25, 26).

With the intensification of poultry husbandry in Nigeria, not many poultry farmers have land where poultry waste-management can be intensified or where manure can be spread. The results of our experiments indicated further that poultry excreta if properly processed could be successfully included as a component to balance the ration of goats. In our study, we noted that fresh poultry excreta if properly processed contained about 4.29% nitrogen on dry matter basis, about half of which is derived from uric acid. This supports the argument that in ruminants such as goats digestibility of the nitrogen in poultry excreta is close to 80%, with an organic matter composition of about 65% (17, 27). It was further observed that poultry excreta are generally rich in minerals and nutrients which make some supplements unnecessary. As observed in our study, fresh poultry excreta ferment very quickly. They must be dried without delay if they are meant to be used in farm animal nutrition in order to improve productivity of goat husbandry. The drying temperature of poultry excreta should not exceed 90°C to prevent damage to the proteins and should not be below 70°C to sterilize excreta nutrients, which are then ground to facilitate removal of feathers.

With regard to the uric acid found in poultry excreta, the general performance noted in this study showed that it was properly utilized by the goats because of the beneficial microbes that reside in the reticulo-rumen (15). However, the uric acid is not easily dissolved in the rumen fluid since the ammonia is only slowly released during metabolism. It is therefore more efficiently utilized than other non-protein nitrogen feed resources. The rumen microflora takes about three weeks to adapt to the uric acid. As observed in the present study, for the WAD goats, dried poultry excreta could be used like any other protein concentrate present in feed (15, 17). Furthermore, when dried poultry excreta are included in the compounded feeding system and the ration is maintained at a normal energy level, the weight gains and other performances of the goats are satisfactory (17). Poultry excreta low energy value may have contributed to its low palatability as noted in our study; another factor could be the non-pelleting of the diets for easy acceptability by the goats, when poultry excreta were fed at higher levels as noted in Table IV. Various steps could be taken to improve palatability and general acceptability of poultry excreta as part of the formulated diets, i.e. addition of fats, sugar, molasses, and other sweeteners (6, 15). In our observation, feeding goats with poultry excreta as part of a feeding system does not affect the flavor of goat meat.

The study also revealed the general acceptability of poultry excreta by goats. Performance increased when including 10% excreta, then was stable at excreta levels up to 30%. The nitrogen level was lower in 0% (but with 30% maize offal) poultry excreta diet, which was why there was a reduction in the performance of goats fed this control diet as also reported by Ososanya (25). Results of the present work showed that, based on the composition of the diets, the feed efficiency, carcass composition, economic costs and other parameters studied were greatly improved when replacing maize offals with dry poultry excreta as feed for WAD goats. It is important to include poultry excreta (layer excreta) as part of the goat ration in totality without forage addition (3, 5) because urbanization and industrialization drastically shrank land availability for production of pasture for ruminants and other herbivores. Poultry excreta should be processed and included as part of the complete ration not only for higher animal productivity, but also to increase economic benefits and mitigate environmental impacts, as long as they are properly used (19). However, in such intensive husbandry conditions, the use of poultry excreta needs to be studied further for enhanced productivity (3, 20).

■ CONCLUSION

Replacing maize offals with dry poultry excreta in the ration greatly improved the performance of WAD goats (19). It is therefore recommended that, when poultry excreta are cheap, they should be included at 10 to 30% levels in the formulated concentrate diets of WAD goats. The poultry excreta used in this study were obtained from layer hens raised in cages. Their nutritive value is different from that of a broiler litter, which is mixed with either straw, wood shavings, rice hulls or other wastes that are high in ligno-carbohydrate components. These wastes mixed with broiler excreta have a poor nutritive value compared to layer excreta from cages (3, 20). Therefore, studies should be conducted on broiler litter as feed for farm animals, if it is to be used as a component of a mixed diet. In this study, layer excreta were used as part of a complete mixed diet. In practice, if they are well managed, farmers could use poultry excreta of layer origin and housed in cage as total replacement to forage where there is scarcity of land to produce pasture, and where waste is abundant. However, excreta contain toxic substances, if they are not well processed or processed with poor compounds, they may affect goat production (16, 25).

Based on our observation, fresh poultry excreta if properly processed and used will contain no toxic products. Some parasites and pathogens can be disseminated in the manure, but there will be no risk if the manure is pretreated by heating; disease transmission from poultry to goat is unlikely. Similarly, there seems to be no serious problem of drug residues in poultry excreta if properly processed. Ruminants, especially sheep, are sensitive to copper. Manure from animals receiving high levels of copper in their diets should be fed with care.

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Accepté le 02.12.2013

Résumé

Anigbogu N.M., Nwagbara N.N.N. Performance des chèvres Naines d'Afrique de l'Ouest alimentées à partir de résidus de maïs améliorés avec des fientes de volaille séchées

La qualité nutritionnelle des fientes de volaille en remplacement de résidus de maïs a été évaluée chez 16 chèvres Naines d'Afrique de l'Ouest (WAD) en croissance (huit femelles et huit mâles âgés environ de huit mois) avec un poids vif moyen de 6,5 kg. Les chèvres ont été réparties dans quatre lots contenant respectivement 0 p. 100 (L1, lot témoin), 10 p. 100 (L2), 20 p. 100 (L3) et 30 p. 100 (L4) de fientes de volaille dans des régimes à base de résidus de maïs. Chaque animal a été alimenté *ad libitum* pendant 120 jours selon le régime assigné. La prise alimentaire, le gain de poids quotidien, le taux de conversion alimentaire et l'efficacité lipidique ont été dans l'ensemble plus élevés ($p < 0,05$) dans les régimes comportant des fientes de volaille que dans L1. Le coût par kilogramme d'aliment, le coût par kilogramme de gain de poids et le coût de production ont été en général moins élevés ($p < 0,05$) avec l'incorporation de fientes de volaille dans l'alimentation. Les gains, la marge brute, le retour sur investissement et les avantages relatifs de coûts ont été plus élevés ($p < 0,05$) dans les régimes comportant les fientes de volaille. Le rendement carcasse le plus élevé a été observé dans L4 ($p > 0,05$) et le plus faible dans L1. La cuisse, le dos, le flanc, le maigre, l'épaule, l'entrecôte, la graisse et les os ont été généralement améliorés ($p < 0,05$) par l'inclusion de fientes de volaille dans l'alimentation. Le ratio os / viande maigre a augmenté de façon similaire ($p > 0,05$) dans tous les lots, sauf dans L3 où il a été légèrement plus élevé. En conclusion, les chèvres WAD peuvent être alimentées à partir de régimes comportant des fientes de volaille afin d'accroître, d'une part, les performances comme le gain de poids, le taux de conversion alimentaire, le rendement de la carcasse et, d'autre part, les avantages économiques des agriculteurs.

Mots-clés : Caprin – Poule pondeuse – Excrément – Maïs – Gain de poids – Prise alimentaire – Efficacité conversion alimentaire – Valeur économique – Nigeria.

Resumen

Anigbogu N.M., Nwagbara N.N.N. Rendimiento de las cabras Enanas de África del Oeste alimentadas a base de dietas de residuos de maíz complementadas con excremento de pollo seco

Se evaluó la calidad nutricional del excremento de pollo como reemplazo de residuos de maíz en 16 cabras Enanas de África (WAD) del Oeste en crecimiento (ocho hembras y ocho machos, de alrededor ocho meses de edad), con un peso vivo promedio de 6.5 kg. Las cabras fueron asignadas cuatro dietas diferentes conteniendo 0% (T1, tratamiento control), 10% (T2), 20% (T3) y 30% (T4) de excremento de pollo en dietas a base de residuos de maíz. Cada animal se alimentó su dieta asignada *ad libitum* durante 120 días. El consumo de alimento, la ganancia de peso diario, la tasa de conversión alimenticia y la tasa de eficiencia de grasas fueron generalmente más elevadas ($p<0,05$) en dietas incluyendo el excremento de pollo. El costo del alimento por kilo, costo por kilo de la ganancia de peso y el costo de producción fueron generalmente menores ($P<0,05$) con la inclusión de excremento de pollo en las dietas de las cabras. El ingreso, margen bruto, retorno de inversión y costo beneficio relativo fueron más elevados ($P<0,05$) en dietas que incluían excremento de pollo y menores en T1. El porcentaje mayor de ropaje se observó en T4 ($p<0,05$). La pata, lomo, rango, tejido magro, hombro, corte de falda, grasa y hueso generalmente mejoraron ($p<0,05$) con la inclusión de excremento de pollo en las dietas. La tasa hueso:tejido magro aumentó de manera similar ($p<0,05$) en todos los tratamientos, excepto en T3, en donde fue ligeramente más elevada. Se concluye que las cabras WAD podrían ser mantenidas con excremento de pollo como componente de dietas compuestas, para aumentar los rendimientos en ganancia de peso, tasa de conversión alimenticia, rendimiento de carcasa y beneficios económicos más elevados para los finqueros.

Palabras clave: Caprino – Gallina ponedora – Excreta – Maíz – Ganancia de peso – Ingestión de piensos – Efficiencia de conversión del pienso – Valor ecónomica – Nigería.