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Effects of dilution standard diets with palm kernels on the growing parameters of local chickens in Kongo Central (Democratic Republic of Congo)

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ABSTRACT

Description of the subject. The productivity of poultry farming is closely linked to the ability to meet the animals' nutritional needs. This study constitutes a component of a research project that is focused on the enhancement of local poultry production in the Kongo Central region. In the course of this study, an exhaustive evaluation of the practice of raising local chickens in stalls was undertaken. The present analysis concentrated on the impact of diluting balanced feed on improving productivity and reducing feed costs.
Objective. The objective of this work is to study the effects of the dilution of a standard diet with palm kernels, on the growth performance of local chickens and on the feed cost, in order to evaluate the possibility of formalizing the use of this energy and protein source ingredient in the ration of local chickens.
Methods. The chicks intended for the study were reared in breeding batteries made of wood and trellis specially designed for this study. Parameters studied include chemical composition of ingredient and feeds, average feed consumption, average live weight, average weight gain, feed conversion rate and cost of rations.
Results. This study has indeed demonstrated that there could be a real interest in using crushed palm kernels for diluting expensive commercial local chicken rations, in order to reduce poultry breeding cost and better empowering local community small breeders, as an effective poverty reduction strategy and for a better protein nutrition status in rural communities. Palm kernel nutrition composition can be compared to the nutrition content of cereals, rich in energy (palm kernel 418 kcal/100 g; maize: around 390 kcal/100 g) and a content of around 10 % protein (palm kernel 11 % protein; maize: around % 8,1 protein).
Conclusion. This study has demonstrated that one can integrate crushed palm kernels and still achieve acceptable growth rates, at a reduced cost, a strategy that could contribute to increasing the number of locally produced poultry by local poultry breeders, rendering populations more autonomous and contributing to the national food security. Non-extracted palm kernels can be useful for poultry feed, due to their high availability and low market price.

Keywords: Local chicks, crushed oil palm kernel, standard diets, feed intake, performance.

RESUME

Effets de la dilution des régimes alimentaires standard par les amandes de palmistes sur les paramètres de croissance des poulets locaux du Kongo Central (République démocratique du Congo)
Description du sujet. La productivité de l'élevage avicole est étroitement liée à la capacité à satisfaire les besoins alimentaires des animaux. Cette étude s'inscrit dans le cadre d'un projet de recherche visant à améliorer la production avicole locale dans la région du Kongo Central. Dans le cadre de cette étude, une évaluation approfondie de la pratique de l'élevage de poules locales en stabulation a été conduite. Cette analyse s'est concentrée sur l'impact de la dilution de l'aliment équilibré sur l'amélioration de la productivité et la réduction du coût de l'alimentation.
Objectif. Dans le cadre de cette étude, il s'est agi d'analyser les effets de la dilution d'un régime alimentaire standard avec des noix de palmiste sur les performances de croissance des poulets locaux et sur le coût de l'alimentation. Cette analyse a permis d'évaluer la possibilité de formaliser l'utilisation de cet ingrédient, source d'énergie et de protéines, dans la ration des poulets locaux.
Méthodes. Les poussins destinés à l'étude ont été élevés dans des batteries d'élevage en bois et en treillis spécialement conçues pour cette étude. Les paramètres étudiés comprennent la composition chimique des

ingrédients et des aliments, la consommation moyenne d'aliments, le poids vif moyen, le gain de poids moyen, le taux de conversion alimentaire et le coût des rations.
Résultats. Cette étude a en effet démontré qu'il pourrait être très intéressant d'utiliser des noix de palme broyées pour diluer les rations commerciales coûteuses destinées aux poulets locaux. Cette pratique permettrait de réduire le coût de l'élevage de volailles et de mieux autonomiser les petits éleveurs des communautés locales. Cette approche s'inscrit dans le cadre d'une stratégie efficace de réduction de la pauvreté et pour améliorer l'apport en protéines dans les communautés rurales. La composition nutritionnelle des noix de palmiste présente des similitudes avec celle des céréales, qui sont reconnues pour leur forte teneur en énergie (418 kcal/100 g pour les noix de palme ; environ 390 kcal/100 g pour le maïs) et leur richesse en protéines (environ 10 % pour les noix de palme ; environ 8,1 % pour le maïs).
Conclusion. Cette étude a démontré qu'il est possible d'intégrer les amandes de noix de palmiste broyées tout en obtenant des taux de croissance acceptables, à moindre coût. Cette stratégie pourrait contribuer à augmenter le nombre de volailles produites localement par les éleveurs locaux, rendant les populations plus autonomes et contribuant à la sécurité alimentaire nationale. Les amandes de noix de palmiste non extraites peuvent s'avérer bénéfiques pour l'alimentation des volailles, en raison de leur grande disponibilité au Kongo Central et de leur faible coût sur le marché.

Mots-clés : Poules locales, noix de palmiste broyées, régimes alimentaires standard, consommation alimentaire et Performances.

1. INTRODUCTION

Modern poultry farming has emerged in recent years as an attractive solution to meet the growing demand for animal protein and a source of income for the African population (Ayssiwede *et al.*, 2009). Local poultry represents 74 % of the livestock of the main conventional livestock species in the DRC (INS-RDC, 2017). However, the high cost of feed limits the development of poultry farming. chickens feed accounts for 60-70 % of the total cost of production (Tandonkeng *et al.*, 2009). Performance is poor, and morbidity and mortality are high (Nkidiaka et Huart, 2013). Raising chickens as a social and economic activity for Congolese rural families requires accessible feed ingredient. Thus, it is essential to find alternative food resources capable of meeting the nutritional needs of chicken, especially local chickens (Yapi-Gnaore *et al.*, 2011). Local poultry products contribute significantly to the accessibility of populations to animal proteins (Tona Tona & Ndadi, 2013) and family food security.

Finding alternative methods of developing poultry farming could also have the effect of stopping the rural exodus and bringing the population back to rural areas, meeting the challenge of food self-sufficiency in animal products, reaching sustainable agricultural development in rural area, promoting economic integration and fighting against poverty. Poverty exposes people to food insecurity, malnutrition, disease and reduced intelligence quotient and productivity. To develop the country, it is therefore necessary to fight against poverty (Mbuya *et al.*, 2014). This fight will have to integrate current international concerns on sustainable development, respect for the environment, social equity and commercial success. One of the necessary aspects is the development of production techniques adapted to the economic environment of the country (Sinoya, 2017). The concern for sustainability and efficiency leads to favoring local resources and capacities as the basis for development. Indeed, sustainable development must not only achieve economic objectives and cover social responsibilities, but also preserve the environment. In addition, better feeding poultry will tend to reduce the high rate of morbidity and morbidity, the utilization of drugs (vaccines, antibiotics, etc.) and their harmful effects of the consumption of meat and eggs on human health.

According to Goromela *et al*. (2006) and Glatz (2012), among alternative methods, smallholders could adopt one of the following four feeding strategies depending on the feed resources available in the region: (a) formulation of a complete ration from local feed ingredients; (b) free choice of locally available food ingredients; (c) mixing a local or imported concentrate with local feed ingredients and (d) diluting a commercial complete ration with local feed ingredients. In the DRC, free choice of locally available food ingredients is widely applied by small farmers. Diluting a commercial feed appears to be a workable option in the context of expensive quality ingredients. The proposed model to be put in place in poultry feed, should making it possible to reduce the cost of feed with limited productivity but increased protein consumption in rural areas.

Among the possible solutions, the use of less expensive protein sources such as palm kernel cakes is being considered. However, the product marketed in Kinshasa under the term “palm kernel cake” is or is not defatted and contains more than 70% lignin-rich hard shells. The presence of these hulls reduces the digestibility and the efficiency of the use of this product by the monogastric and

constitutes the main constraint which limits its generalization among breeders in Kinshasa, as a source of protein. However, non-degreased palm kernels could be a cheap ingredient with good nutritional quality, due to their protein and high energy content. Thus, this study intends to innovate in the method of separation of palm kernels from the shells, to use crushed palm kernels separated from their shells for growth of local chicken starters and reduce food cost.

The objective of this work is to study the effects of the dilution of commercial feed by palm kernels on the growth performance of local chickens and on the feed cost, in order to consider the possibility of formalizing the use of this energy and protein ingredient in the ration of local chickens.

2. MATERIAL AND METHODS

2.1. Study site

The study was conducted from March to September 2024 at the UNIKIN Residents' Plateau, Cogelos district in Mont-Ngafula township, one of the 24 townships that make up the city of Kinshasa. This district is located at an altitude of 279 m, 4°15', latitude south and 15°14', longitude east. The climate is tropical with temperatures ranging between 20 and 28°C. Rainfall is 1400 to 1500 mm per year; November and April are the wettest months.

2.2. Material

The chicks intended for the study were reared in breeding batteries made of wood and trellis specially designed for this study. Each cage measured (L x W) 1.2 x 0.8 m and was 0.5 m high. It was equipped with a 2-liter trough and a 3-liter feeder, a 75-watt bulb and wood shavings bedding. The temperature and humidity in the cages were 28 °C and 75 % respectively. The temperature and humidity in the cages were 28 °C and 75 % respectively.

The study involved 180 unsexed chicks of indigenous chicken's strain. The chicks were vaccinated against diseases of Newcastle and given in their drinking water the pseudo-avian plague vaccine and anticoccidial and antiparasitic drugs.

2.3. Technological processing of palm kernels

The palm nuts were collected from an agropastoral farm located in the Gombe - Lutendele district in the Commune of Mont-Ngafula, in the suburbs of Kinshasa. The nuts were then crushed using an electric motor crusher, then soaked in water in order to separate from water, using a sieve, the lighter density and supernatant palm kernels. The crushed palm kernel was exposed to the sun on a surface covered with tarpaulin until completely dry.

2.4. Preparation of experimental diets

The crushed palm kernels were mixed with a commercial feed at different incorporation rates. Three diets were prepared according to incorporation rates of 0 %, 10% and 20 % palm kernel kernels and 100 %, 90 % and 80 % commercial food, respectively for T0, T1 and T2.

2.5. Conduct of animal experimentation

The experimental apparatus used was a plan completely randomized with three treatments in three replicates (Figure 1). On their arrival, the day-old chicks were weighed individually then divided into three batches of 60 chicks corresponding to three food treatments: a commercial feed (T0), a feed with 10% palm kernels (T1) and a feed with 20% palm kernels (T2). Each treatment consisted of three replicates of 20 chicks each. Batching by treatment was done in such a way as to respect an identical average weight.

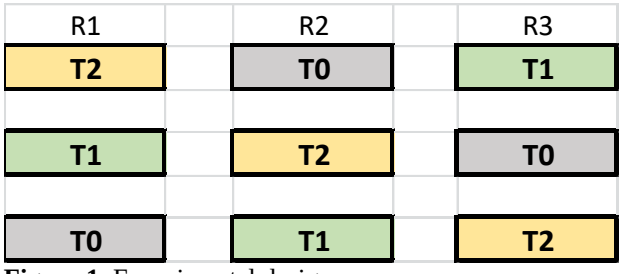

Figure 1. Experimental design

The different sub-batches were evenly distributed in the cages so as to reduce variations due to the environment. From this moment, the subjects submitted to the various dietary treatments were fed *ad libitum* three times a day from the 1st to the 3rd week of age. Parameters studied include (1) chemical composition of ingredient and feed, (2) average feed consumption, (3) average live weight, (4) average weight gain, (5) feed conversion rate and (6) the cost of rations.

2.6. Determination of chemical composition of palm kernels and foods

The chemical analysis was carried out according to the official methods of the AOAC (1990) (Association of Official Analytical Chemist, Washington DC) at OCC laboratory (Office Congolais de Contrôle). They carried out the determination of moisture, protein, fiber, fat and energy content of the crushed palm kernels, the commercial feed, and of the experimental feed at 10 % and 20 % crushed palm kernels incorporated.

2.7. Calculation of zootechnical indices

The biological parameters of physiological responses monitored are:

(i) Average feed intake $FIa = \frac{Quantity\ of\ feed\ ingested\ per\ batch\ per\ period}{Number\ of\ chicks}$

(ii) Average live weight: $PVm = \frac{Total\ Batch\ Weight}{Number\ of\ chicks}$

(iii) Weight gain: $GPm = \frac{Final\ weight - initial\ weight}{Number\ of\ chicks}$

(iv) Feed conversion rate $TCA\ ou\ IC = \frac{Qty\ of\ food\ ingested}{Weight\ gain}$

(vi) The cost of the rations (1 kg chicken): $Production\ cost = final\ weight * (Consumption\ index\ IC * price\ 1\ kg\ feed)$

The cost of the palm kernels was taken from the cost of the bag of crushed kernels (30 kg, 9.14 $US) of which palm kernels constituted according to our assessment 13.5 % (4.05 kg of palm kernels in the bag). It follows that the kilo of palm kernels cost 2.26 $US.

2.8. Statistical analysis

Descriptive statistics and analysis of variance of the univariate general linear model (ANOVA) were performed for the analysis of feed consumption, weight gain and feed conversion. The general linear model was used to test the effects of the factors on the variables; the differences were considered significant at the 5% error threshold.

3. RESULTS

3.1. Chemical composition of feeds

The nutritional composition of walnut kernels and diets is outlined in Table 1. A proportional reduction in concentration is observed in diluted rations, with the exception of energy, which increases.

Table 1. Chemical composition of the ingredient and diluted rations

Component	CPK	T0	T1	T2
Moisture (% of product)	13.16	11.54	11.70	11.86
Crude protein (%MS)	11.00	23.50	22.25	21.00
Fat (% DM)	17.80	3.30	4.75	6.20
Fibers (% DM)	0.50	0.00	0.05	0.10
Raw ash (% DM)	2.50	6.30	5.92	5.54
Hydrates of C (% DM)	68.20	66.80	66.94	67.08
Energy (Kcal / 100g)	417.85	350.91	357.60	364.30

Legend*:* CPK (Crushed Palm Kernels); TO (0 % kernel); T10 (10 % kernel), T2 (20 % kernel)

The laboratory analysis has highlighted the high crushed palm kernel energy content, contributed by its high fat content. Table 1 also shows that crude protein, fat, fiber and energy were affected by dilution in the T1 and T2 rations. But it was not possible to conduct any ANOVA for lack of adequate data.

3.2. Feed intake

The feed intake of the experimental chickens is shown in Table 2. It was evident that, in general, there was an increase in consumption over time until the conclusion of the experiment for all feeds.

Table 2. Daily feed intake in g/chick

Treatment	Average Feed Intake g/chick/day			
	1st week	2nd week	3rd week	Total
T0	174.06	380.43	617.85	1172.34
T1	195.12	414.99	647.28	1257.39
T2	190.98	387.00	675.90	1253.88

Legend: T0 (0 % kernel); T1 (10 % kernel), T2 (20 % kernel)

The ANOVA showed no significant difference in daily food consumption per day, especially during the two first weeks (See Table 2).

3.3. Evolution of average weekly live weight

Table 3 shows data on the weight of chicks at different stages of development, in weeks, and variations in this physical parameter.

Table 3. Average weekly live weight (in g/chick)

Treatment	Live Weight/Week (g)			
	Initial weight	End of 1st week	End of 2nd week	End of 3rd week
T0	30.6	71.69	190.42a	340.24a
T1	29.4	67.85	171.25ab	326.30ab
T2	29.8	63.32	153.19b	298.80b

Legend: T0 (0 % kernel); T1 (10 % kernel), T2 (20 % kernel)

The ANOVA showed already a significant difference in live weight after the second week and this difference could also be seen after the third week, between the chicks fed the commercial feed (T0) and those fed T2 (20 %). The commercial feed proved to be more efficient (Table 3). But there was no significant difference after one week.

3.4. Evolution of body weight gain

As demonstrated in Table 4, the weight gain of the chicks was meticulously monitored on a weekly basis, contingent on their dietary regimens.

Table 4. Weekly body weight gains (in g/chick)

Treatment	Body weight gain/Week		
	End of 1st week	End of 2nd week	End of 3rd week
T0	41.09	118.72	149.83
T1	38.45	103.40	155.05
T2	33.52	89.87	145.61
Standard breed	135.00	282.00	432.00

Legend: T0 (0 % kernel); T1 (10 % kernel), T2 (20 % kernel)

The ANOVA showed there was no difference yet during the first week between the three treatments in weekly body weight gain. However, at the end of the second week, body weight gain was higher for the commercial feed compared to T2 (20 %).

3.5. Evolution of the feed consumption coefficient

As part of the experiment, data on food consumption was collected and recorded during the observation period. This information, which was analysed in meticulous detail, is presented in the attached table (see Table 5).

Table 5. Weekly feed consumption coefficient

Treatment	(Intake/gain)/Week			
	Week 1	Week 2	Week 3	Means
T0	4.24	3.20	4.12	3.85
T1	5.07	4.01	4.17	4.42
T2	5.70	4.31	4.64	4.88

Legend: T0 (0 % kernel); T1 (10 % kernel), T2 (20 % kernel)
The ANOVA showed there was no significant difference in the efficiency of feed utilization.

3.6. Feed cost

The cost price, calculated on the basis of the quantity of feed required to obtain the live weight of different groups of experimental chickens, is shown in Table 6. In this economic analysis, particular emphasis was placed on the financial burden associated with feed. It was hypothesised that other items of expenditure, including but not limited to transport and living costs, would be constant and uniform for all the treatments considered.

Table 6. Feed cost of producing a 3-week-old chick using T0, T1 and T2

Factors	**T0**	**T1**	**T2**
Quantity of commercial feed/kg intake (%)	100.00	90.00	80.00
Estimated cost of one bag of feed intake ($US)	20.80	19.605	18.46
Quantity feed intake (kg per chick during 3 weeks)	1.17	1.26	1.25
Cost per kg feed chick intake during 3 weeks. US $)	0.83	0.78	0.73
Price of a 25 kg bag of the commercial feed = 20.80 or 0.832 US $/kg			
Price of a 30 kg bag of oil byproduct = 9.14 or 0.31 US $/kg			
Total cost of feed consumed in three weeks (US $)	0.98	0.98	0.91

Legend: T0 (0 % kernel); T1 (10 % kernel), T2 (20 % kernel)

This table shows that our three-week experiment used 1.17 kg, 1.26 kg and 1.25 kg of feed per chick from 65 g, to 528 g, 504 g, and 459 g after 3 weeks of age, respectively on T0, T10, and T20. The total cost of feed after three weeks of feeding was $0.98, $0.98 and $0.91 respectively for T0, T10, and T20. These results show that the commercial feed was more efficient but more expensive.

4. DISCUSSION

We conducted an experiment to find out if the product sold in Kinshasa under the name of palm kernel meal could, after sorting and recovery of the palm kernels, be used to reduce the cost of the industrial feed for poultry, while maintaining acceptable performance. Our results showed a reduction in the cost of feeding the chicks during the first three weeks, but also a reduction in the daily growth rate.

This finding was predictable, but nevertheless this solution cannot be irretrievably ruled out. A longer experiment, in particular lasting 5 to 7 weeks, is needed to decide whether this alternative could be recommended and promoted to local communities. Indeed, it might not be necessary to obtain the maximum growth rate to contribute to better nutrition for the population in this country's current situation, especially because the alternative of using palm kernels appear to be more economical. This strategy could contribute to increasing the number of poultry produced locally and make the Congolese populations more autonomous and in better food security. This strategy would be all the more appropriate since the oil palm (*Elaeis guineensis*), from which the kernels in question come, originate from tropical Africa, of which the most exploited varieties in the world originate from Yangambi in the Democratic Republic of the Congo (DRC).

In all provinces of the DRC, there are natural populations of oil palm trees that have been exploited by local communities for centuries. This exploitation is essentially based on the extraction and use of palm oil to be used in cooking. This exploitation also provides quantities of palm butter frequently known as mwambe, which is made from the pericarp of palm nuts. The seeds with the kernels are discarded or used as fuel mostly by households or as fuel by oil mill industries. In the DRC, palm kernel is very little exploited for oil extraction, hence the scarcity of palm kernel meal on the livestock feed market. Boateng *et al*. (2008) inform that the limits in terms of amino acids (lysine, methionine/cystine) palm kernel meal must be taken into account when formulating a ration for

local chickens. This should also be applied for non-extracted palm kernels.

Leclerck *et al*. (2017) reports that growth performance is not significantly reduced by incorporating palm kernel meal at the rates of 20 to 30 % in a formulated ration. Our current experiment showed no significant difference at three weeks of age when diluting a standard diet with non-extracted crushed palm kernel at the rate of 10 %.
Jentsch *et al*. (2003) found that the intake of rations containing palm kernel meal is generally higher than for the reference diet, resulting in a less efficient feed conversion rate. Our chicks, fed the diet with the crushed non extracted palm kernel, also achieved lower weight than those fed the reference commercial diet. This could be due to the deficit of the protein content, that could have pushed the animal to ingest a larger amount of food (23.5 % in the commercial feed, versus 22.25 % and 21 % respectively in the 10 % dilution and the 20 % dilution). This could also be due to an increased appetence.

Carvalho *et al*. (2005) reported that an increase of feed consumption may compensate for low energy or protein content, but also for a reduced feed palatability, in poultry fed palm kernel meal. Higher levels of incorporation in ration formulation (more than 20 %) have also been tested, but incorporation rates of 40 or 50% proved to be detrimental to performance in several trials.

5. CONCLUSION

A study was conducted using a commercial poultry feed and diluted commercial poultry feeds during the start-up and growth phase (the first three weeks). The objective of this study was, to study the effects of the dilution of commercial feed with palm kernels, on the growth performance of local chickens and on feed cost, in order to consider the possibility of formalizing the use of this energy and protein ingredient in the ration of local chickens.

This study has indeed demonstrated that there could be a real interest in using crushed palm kernels for diluting expensive commercial local chicken rations, in order to reduce poultry breeding cost and better empowering local community small breeders, as an effective poverty reduction strategy and for a better protein nutrition status in rural communities.

Palm kernels can be compared to nutrition content of cereals, rich in energy and lower in protein (around 10 % protein). So, our study has demonstrated that one can integrate crushed palm kernels and still achieve acceptable growth rates, at a reduced cost, a strategy that could contribute to increasing the number of poultry locally produced by poultry breeders, rendering populations more autonomous and contribute to the national food security. These results highlighted the interest of using palm kernels in the dilution of local chicken rations in start-up and growth phases (the first three weeks).

Non-extracted palm kernels can be useful for poultry feed, due to their high availability and low price in the market. The incorporation of 20% palm kernels into a local chicken starter ration is safe when the ration is properly formulated because the feeds induced greater growth than that recommended by the poultry feeding.
It would be interesting to complete this work by studying the growth performance and the quality of carcass and meat of chicken, at the end of the rearing cycle (5 or 7 weeks). Also, more studies with increased rates of incorporation of palm kernels (up to 40 %) would allow testing feed efficiency and performance of animals in situations where palm kernels are available and at low cost.

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