Research Article

Effects of Pumpkin Oil Cake (*Cucurbita moschata)* in a Cafeteria Feeding System on Growth Performance of Common Guinea Fowl

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Abstract | The valorization of non-conventional phylogenetic resources such as pumpkin oilcake in improving animal production is a challenge for developing countries where crude protein sources are scarce and expensive.The aim of this study was to evaluate the effects of pumpkin oil cake in a cafeteria feeding system on growth performance of common guinea fowl A sample of 120 Guinea fowl, 8-week-old were randomly divided into two groups of 60 birds. Each group was then divided in three replicates of 20 birds during the finishing stage. The first group was fed with diet separated in two fractions, the energetic feedstuffs fraction and the crude protein and mineral feedstuff fraction. The crude protein and mineral feedstuffs fraction contained 14% of *C. moschata* oil cake. Each fraction (energy and crude proteins) was served separately in two feeders at the interval of 4 hours starting by feeder containg energetic feedstuffs. The second group as a control, was fed with conventional diet containg both energetic and crude protein fractions with 14% of *C.moschata* oil cake. All the birds had free acces to diet and clean water. Birds were weighted at week 8 and then weekly till the end of the experiment. The feed intake was measured daily, throughout the difference between the supply and the rejection feed and served to evaluate growth performance. Mortality rate was recorded daily. Feed conversion was calculated weekly. The most important finding was the treatment increased the daily voluntary consumption of *C. moschata* oil cake (20.75g/day/bird vs 27.4 g/day/bird). Overall, the treatment improved significantly the final body live weight (1302.38 g vs1579.23 g), the average daily weight gain (17.87 g/day vs 28.31 g/day) the daily feed intake the of the energetic feedstuff fraction, (58.20 g/day/bird vs 91.1g/day/bird) and the feed efficiency (9.39 vs 5.69) g). The hypothesis formulated had been successfully tested. Thererfore the valorization of the *C.moschata* oil cake at 14% in the crude protein fraction during the the finishing stage is a an opportunity in tropical poultry farming.

Keywords | Cucurbitaceae, Free-choice feeding, Growing, *Numida meleagris*, Congo- Brazzaville

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INTRODUCTION

Feeding is recognized as an important input as it accounts for 70-75% of the total cost involved in poultry production such as Guinea fowls (Adzona and Banga-Mboko, 2017). Solving the problem by reducing the cost of production could be done by incorporating local and non-conventional sources into the ration. Pumpkin waste is

reported to be high in crude protein content ranging from 65.3% to 68.9% (Klir *et al*., 2017) antioxidants, pigments, and polysaccharides content that could enhance quality of meat, milk, and egg, as well animal health (Klir *et al*., 2017; Valdez-Arjona and Ramírez-Mella, 2019; Hasan *et al*., 2020; Portillo-López, *et al*., 2021).

Pumpkin belongs in Cucurbitaceae family that is represented in Congo by 16 genera and 26 species, and includes numerous food plants (Bembe, 2005; Silou *et al*., 2008). Most of them, *Cucurbita moschata* called "*ntété, bibeté*" in the national language are produced naturally without chemical fertilization, for their seeds, fruits and leaves. Seeds are used to produce oils for dietary, medicinal (in traditional pharmacopoeia) and in women skin care purposes, resulting in solid residues. These residues called oil cake do not competitive with human foodstuffs, and therefore may be used for poultry feeding (Suleiman and Uko, 2010; Carvajal *et al*., 2017).

Most of studies reported that conventional feeding is not adapted to broiler in tropical areas since the birds had been selectected to be bred in moderate climate. In another way, it is known that high temperature from both tropical climate and equatorial climates have harmfull effect on viability rate and productivity in poultry farming (Chrysostome *et al*., 2010). So, many feeding strategies such as the separate feeding or cafeteria have been suggested in order to limit the effects of heat stress on the performances of poultry (Picard *et al*., 1993; Haskell *et al*., 2001; Chrysostome *et al*., 2010; Fanatico *et al*., 2016). Indeed, among the cafeteria method the separation of diets in two fractions: the energetic (1) and crude proteins and mineral (2) had been experimented in chicken (Aydilek *et al*., 2012; Fanatico *et al*., 2016; Adzona and Banga-Mboko, 2017). This method is based in the fact that birds have the ability to select naturally between various feed ingredients according to their nutritional needs and production in hot areas (Dana and Ogle, 2002; Pousga *et al*., 2005; Aydilek *et al*., 2012).

The Guinea fowl (*Numida meleagris*) belongs to Numididae family, and in the order of GaIliformes. *Numidaea meleagris* is the unique domesticated bird native of Africa where wild species are still found in savannah. and bred in back yard in villages. Guinea fowls not very demanding in terms of diet and is highly prized for its meat and egg production. (Śmiecińska *et al*., 2022). However, studies on pumpkin seed meals in Guinea fowl are scarce (Carvajal *et al*., 2017).

Although many oil cakes have been successfully tested in cafeteria method (Adzona, 2019; Adzona *et al*., 2019), we are aware of only studies on the use of *C. moschata* oil cake in Guinea fowl in conventional system (Martinez *et al*., 2010; Chiroque *et al*., 2018). Therefore, the present work aimed to determine the effects of dietary inclusion of *C moschata* oil cake in the crude protein feedstuffs fraction . It was hypothesized that choice feeding may improve growth performance of Guinea fowl.

MATERIALS AND METHODS

Oil cake *C moschata* production

The oil cake meal used in this experiment was obtained by traditional manual pressure. The process is shown in Figure 1.

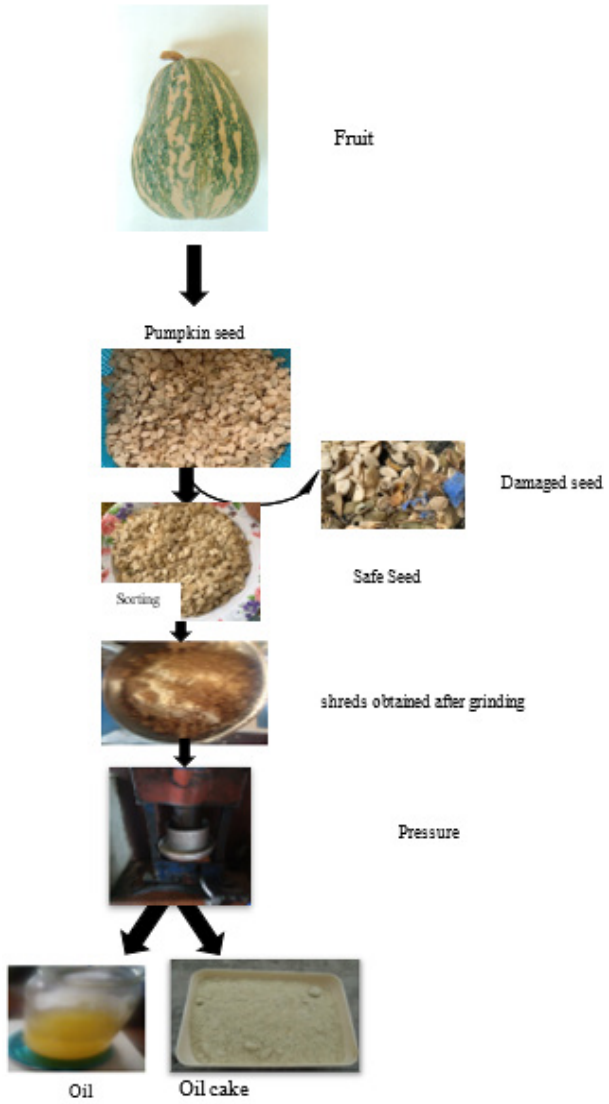

Figure 1: Traditional process of oil cake extraction.

Pre experimental study: Prior to the experiment 160 guinea fowl one-day old. They were bred in a single pen during the starter and the growing stages as previously described by Adzona and Banga-Mboko (2017) and recently by Saboukoulou *et al*. (2024). Birds were free access to feeders and drinkers. Temperature and hygrometry were daily set. At the end of the growing stage, a sample of 120 birds were selected and served for the experiment during the finishing stage.

The experiment design: In the finisher stage, a sample of 120

male Guinea fowl, 8 weeks-old was randomly distributed into two groups of 60 chickens (control and treatment group). Each group was then divided into two groups of 60 birds. Each group was then divided in three replicates of 20 birds. during the finishing stage. All replicate presented approximately the same average body weight.

Birds were housed in floor pens 3.1 m x 3.1 m wood dust at a depth of 15 cm. Each group was under controlled environmental conditions.

In the control group cage there was a single feeder and one drinker, whereas in the treatment group there were two feeders and one drinker (Figure 2). These guinea fowl were ringed on the left leg for identification during weight growth monitoring.

The animals were protected against infectious diseases with the anti-infective Oxyfuran4®. They also received preventive treatment against coccidiosis (*Amproluim*®) and were dewormed against internal parasites (*Levalap*®). Finally, during the experimental phase, the guinea fowl were given an anti-stress medication due to high temperature (*Amin total*®).

Diets: Birds in control group were fed with a complete diet onto all feedstuffs were mixed.

Meanwhile in treatment group, diet was separated in two fractions. The first feeder contained energetic mixture fraction (maize, cassava meal, palm oil) and the second feeder the crude proteins and mineral mixture fraction (oil cake, fish meal, Calcium, salt and vitamins). These two fractions (energy and crude proteins) were served separately to the animals at the interval of 4 hours' starting by the energetic fraction and lasting by the crude protein fraction containing g 14% of oil cake.

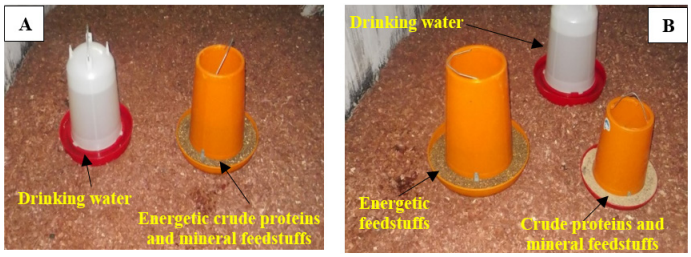

Figure 2: Diets distribution in cafeteria system. A: control group; B: treatment group.

In both group birds had access freely to feed and clean drinking water for 4 weeks. The composition and nutritional values of complete diet (Control group)), and the cafeteria feeding system (Treatment group) are given in Table 1.

Table 1: Diet formulations in control and treatment groups.

Ingredients	Complete diet	Free choice group	
	***C. curcurbita* oil cake is mixed in both energetic and crude protein feedstuffs (%)**	***C. cucurbita* oil cake is mixed only in the crude protein feedstuffs fraction (%)**	
		Energy feedstuff fraction (%)	
Maize	40	40	
Brewer's grains(1)	3	3	
Wheat bran	7	7	
Palm oil	1	1	
Cassava flour	15,4	15,4	
		Total Energy	66,4
Crude proteins and mineral feedstuffs fraction (%)			
Fish meal	5	5	
Cowpea flour(2)	10	10	
C.moschata oil cake	14	14	
Mixed mineral and vitamins	0,2	0,2	
Limestone	3,9	3,9	
Salt	0,5	0,5	
		Total CP	33,6
Total	100	100	
Nutritional value of foods			
EM (Kcal/kg)	2983,33	2983,33	
MAT (%)	17,62	17,62	
Ca (%)	1,83	1,83	
Ratio (EM/MAT)	169,31	169,31	

[1]Brewer's grain was collected in brewers and then dried in open an in the court of the farm. [2]Cowpea flour was purchased in the local market, crushed and warned at 50°C

The study lasted from 8 weeks and ended when the one group had reached the commercially live weight by 1500g. Finally, the study was carried out in accordance with the ethics of the ministry of scientific, Brazzaville, Congo.

Data collection: Death**,** if present, was recorded daily. All the birds were weighed at the beginning of the trial and then weekly till the age of 12 weeks. The feed intake in grams/bird/d was recorded each day.in order to evaluate growth performance Feed conversion was calculated weekly.

Voluntary consumption of *C moschata* oil cake in a complete diet (VC) was the product of whole voluntary food intake multiplied by the incorporation rate (14%).

$$VC = \frac{VFI \times 14}{100}$$

Voluntary consumption of *C. moschata* oil cake in the treatment group separate feeding was the product of the voluntary feed consumption of the crude protein fraction with the incorporation rate of the *C. moschata* oil cake, divided by 33.6% as the total percentage of the feed formulation of the crude protein fraction.

$$VS = \frac{VFI \times 14}{33,6}$$

Statistical analysis

The various data collected were recorded in Microsoft Excel spreadsheets. SAS software (Statistical Analysis System, 2013) was used for data analysis. An analysis of variance. with one classification criterion mainly the mode of giving the oil cake was performed using the PROC GLM procedure in SAS. The group of birds and their duplicates were the only sources of variation in the ANOVA model. Calculated means were compared in pairs using the student t-test was used to compare two means. Significance implies $P < 0.05$.

RESULTS AND DISCUSSION

The study recorded no deaths in both dietary treatment and control. Suggesting a perfect preventive sanitary environment also the fact the study started with birds aged 4 week-old. Data collected during the experiment are presented in Table 2.

Effect of cafeteria method on body live weight (BLW): As shown in Table 2, the treatment improved significantly the final body weight. This is related to the incorporation of 14 % of oil cake *C. moschata*. in crude protein fraction. This result is consistent with the work of Adzona and Banga-Mboko (2017) based on Guinea fowl fed with diet containing oil cake soya. However, Martìnez *et al*., (2010) found any difference when the oil cake seed was incorporated at 10% in conventional feeding.

Table 2: Effect of cafeteria method on growth performance and feed intake.

Parameters	Age (week)	Control group	Free- choice group (FCG)	Statistical significance
Body live weight (g)				
Initial	8	861.57^{a} ± 216.06	877.17^{a} ± 194.57	NS
Final	12	1321.36^{b}±379.16	1579.23^{a}±335.22	.
Average daily gain (g)				
Initial	8	8.75^{b} ± 7.48	8.20^{a} ± 14.90	NS
Final	12	17.87^{b} ± 8.21	28.31^{a} ± 16.50	*
Feed intake (g)				
Energetic fraction				
Initial	8	40.65^{a} ± 7.57	46.51^{a} ± 2.41	NS
Final	12	58.20^{b} ± 11.42	91.09^{a} ± 12.61	*
Crude protein fraction				
Initial	8	25.43^{b} ± 3.85	34.37^{a} ± 4.24	*
Final	12	30.70^{b} ± 12.02	57.17^{a} ± 8.29	*
Total feed consumption				
Initial	8	66.09^{b} ± 4.36	80.88^{a} ± 6.01	*
Final	12	88.90^{b} ± 23.44	148.26^{a} ± 17.94	*
Consumption of oil cake *C. moschata*				
Initial	8	11.32 ± 0	13.81 ± 0	*
Final	12	20.75 ± 2.38	27.4 ± 4.5	*
Feed efficiency				
Initial	8	7.71^{a} ± 0.60	4.53^{b} ± 0.49	***
Final	12	9.39^{a} ± 2.31	5.69^{b} ± 0.73	***

*: $p<0.05$; ***: $p<0.001$; NS: Not significant.

Effect of cafeteria method on average daily weight gain (ADWG): The ADWG increased continuously from week 8 to week 12 about 58% by approximately. Such results are consistent with previous studies (Suleiman and Uko, 2010; Adzona and Banga-Mboko, 2017; Kliur *et al*., 2017; Chiroque *et al*., 2018). By contrast Fanatico *et al* (2016) reported low data in broiler chicken fed with conventional diets containing 10% oil pumpkin.

Effect of cafeteria method on the voluntary feed intake of the energetic and crude protein fractions: The treatment, improved significantly the feed intake of the energetic feedstuff fraction, (+56%) and the crude protein feedstuff fraction (+67%) in both group (control and treatment group), In the same time, the feed intake of the energetic feedstuffs was higher than in the crude protein feedstuff group. The explanation is that birds during the growing

stage, perfected to build the muscular tissue and used more energetic feedstuff during the finishing stage to satisfy the fat tissue (Dana and Ogle, 2002; Hasan *et al*., 2020).

Effect of cafeteria method on the voluntary consumption of the *C. moschata* Oil cake

The most important finding was the consumption of *C. moschata* oil cake that was significantly higher in cafeteria method.

Our results demonstrated that by using a conventional feeding, birds eat to satisfy firstly energetic needs. Whereas, in cafeteria method with 2 fractions, bird intakes are controlled independently (Dana and Ogle, 2002; Pousga *et al*., 2005).

Another explanation is that it may have an increasing palatability when the crude protein and energetic fractions of the feed are not mixed. The feeding method, which consist in separating food fractions according to their nutritional characteristics or form, is strategy that offer the animal the possibility of adjusting its intake according to intrinsic and extrinsic factors. These intrinsic and extrinsic factors include taste, appearance, odor, texture and flavor pleasantness (Haskell *et al*., 2001; Dana and Ogle, 2002; Adzona and Banga-Mboko, 2017; Hasan *et al*., 2020).

Effect of cafeteria method on feed efficiency: The cafeteria method improved significantly feed conversion ratio by 60%. This finding is in accordance with previous studies carried out after the starting stage (Suleiman and Uko, 2010; Adzona and Banga-Mboko, 2017; Kliur *et al*., 2017; Chiroque *et al*., 2018).

The superiority of the cafeteria method vs conventional system is likely was due to the ability of birds to choice feedstuffs according their needs (Dana and Ogle, 2002; Pousga *et al*., 2005).

CONCLUSION

The present study was carried out in order to evaluate the response of Guinea fowl broiler in cafeteria method including *C. moschata* oil cake waste in the crude protein fraction. The collected and analyzed data showed clearly that the incorporation of 14% *C. moschata* in crude protein fraction improved significantly the body live weight, the feed consumption intakes and feed efficiency. Thus, the formulated hypothesis in the beginning of this study has been verified and the objective is reached.

So, the use of *C. moschata* in cafeteria method is an interesting tool in the valorization of pumpkin cultivation and waste production for poultry farming in hot climate where crude protein sources are scarce.

Nevertheless, investigation carried out in a large sample size is needed to confirm this preliminary study Also, data related on carcass quality and economic factors are to be studied.

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NOVELTY STATEMENT

The novelty of our work entitled "Effects of Pumpkin Oil Cake (Cucurbita moschata) in a Cafeteria Feeding System on Growth Performance of Common Guinea Fowl" can be summarized as the inclusion of 14% C. moschata oil cake in the crude protein fraction improved body weight, feed efficiency, and voluntary feed intake. The study suggests C. moschata oil cake as a promising local protein source for guinea fowl production under tropical climates.

AUTHOR'S CONTRIBUTION

This study is the result of a joint effort by all authors. Dr. Pitchou Prudence Adzona designed and conducted the experiment, performed data analysis, and wrote the first draft of the manuscript. Dr. Alain Juste Saboukoulou assisted in the experimental setup, statistical analysis, and contributed to manuscript editing. Ir. Aimé Emmanuel Kikabou participated in animal care, feed preparation, and contributed to manuscript editing. Prof. Henri Banga-Mboko supervised the entire research process, provided critical revisions, and validated the final version of the manuscript. Dr. Issaka Youssao Abdou Karim contributed to methodology validation, interpretation of results, and improvement of the manuscript content

Data availability

All data are included in the article content.

Financing statement

The experiment was funded by the national Institute for agronomic research in Congo.

Generative AI or AI-assisted Technology Statement

The author(s) declare that no Genrative AI was used in the creation of this manuscript.

Conflict of interest

The authors declare that they had no conflict of interest during the submission of the article.

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