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# Effects of Maize, Millet, and Sorghum as Energy Sources of Diet on Growth Performance of Guinea Fowl

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## ABSTRACT

Guinea fowls are more valuable in the market in Niger than chickens; however, their ability to meet consumer demands is limited by low productivity. Therefore, suitable nutrition is an important factor for this productivity. The current study aimed to evaluate the growth performance of guinea fowl using maize, millet, and sorghum as energy sources in the diet. A total of 108 one-day-old unsexed local keets, with an average live weight of 25.5 ± 0.83 g were randomly distributed among three dietary treatments with four replicates per treatment. The keets were reared on the ground with litter at CERRA Maradi, Niger, for an 8-week experimental period, involving 36 keets per treatment and 9 keets per replication. The parameters monitored were feed intake (FI), live weight (LW), average daily gain (ADG), and feed conversion ratio (FCR). After 8 weeks of experimentation, the results indicated that the cereal used in the diet had no statistically significant effect on the keets' FI. Those fed millet-based diets had higher LW, compared to those fed maize and sorghum diets, respectively, however, this difference was not statistically significant. Millet also facilitated a higher ADG, compared to maize and sorghum, although the differences were statistically insignificant. The keets fed sorghum-based had higher FCR, compared to the FCR of the guinea fowls fed maize and millet diet. based on the growth performance assessed in this study, the recommended order for cereals in guinea fowl feed to ensure better growth is millet, followed by maize, and then sorghum.

**Keywords:** Cereals, Energy source, Growth performance, Keets

## INTRODUCTION

Guinea fowl which is indigenous to Africa has been neglected and consigned to the rural areas where it is allowed to scavenge for feed (Amoah et al., 2018). These breeding and feeding conditions contribute to the poor productivity of the birds (Soara et al., 2020). Guinea fowl profitability is hampered by poor nutrition due to a lack of management and feeding guidelines (Tjetjoo et al., 2013). However, nutrition plays a determining role in the success and economic profitability of poultry products (Brah et al., 2015). There are a few formulated diets specifically for guinea fowl feeding. As a result, guinea fowl are fed with commercial broiler and layer diets (Moreki and Seabo, 2012). Cereals are the main source of energy used in poultry feed, with corn being the predominant cereal utilized for this purpose (Ravindran, 2013). However, the extensive use of corn in animal feed poses a challenge, as it contributes to food competition with humans (Teguia and Beynen, 2005). Corn metabolizable energy is used as a reference in the evaluation of other energy sources. Corn provides 3350 Kcal of metabolizable energy per kg of dry matter (NRC, 1994) and contains 11.5% crude protein (Houndonougbo et al., 2009). In Niger, the corn used in poultry feed is imported. However, millet and sorghum are alternatives to maize in poultry feed (Issa et al., 2015; 2016). Millet is a cereal from semi-arid tropical zones (Filardi et al., 2005). Millet provides 3360 Kcal of metabolizable energy per kg of dry matter (NRC, 1994) and contains 14.10% crude protein based on dry matter (Medugu et al., 2010). Sorghum is the cereal expected to replace corn in poultry feed (Etuk et al., 2012). Relative to dry matter, sorghum contains 11.7% crude protein (Issa et al., 2010) and provides 3212 Kcal of metabolizable energy (NRC, 1994). Therefore, this study aimed to evaluate the growth performance of keets under an intensive management system fed with diets containing maize, millet, and sorghum as energy sources.

## MATERIALS AND METHODS

### Ethical approval

The experiment was conducted in compliance with current standards for conducting experiments with animals of the National Institute for Agriculture Research of Niger. The guinea fowls were housed in groundnut hulls as beddings. The density was 5/m$^2$, and heating and lighting were adapted to their recommended living conditions. No injections even the vaccine were given. Human working to ensure hygiene, management, and data collection were equipped with suitable clothing.

### Keets and housing

A total of 108 one-day-old local unsexed keets, constituted the biological material of the study. They were obtained by artificial incubation of eggs collected from guinea fowl breeding at the CERRA animal production department in Maradi, Niger. These keets were raised in two phases. A starter phase from the first to the fourth weeks and a grower phase from the fifth to the eighth weeks. The experiment was conducted in an 11.9 m$^2$ (3.50 m × 3.40 m) poultry house. It was partitioned with small mesh wire into 12 boxes (6 on each side) measuring 0.56 m$^2$ each. In each box, a 60-watt bulb was positioned 50 cm above the ground to provide heat to the guinea fowl. Throughout the 8-week duration of the experiment, this setup aimed to maintain the temperature inside the poultry house within the range of 30 to 31°C. The humidity level was maintained at 46.6%.

### Sanitary and feeding conduct

At the beginning of the experiment, one-day-old keets were introduced to a sugar solution in water (5g/L) for the initial 2 days. Amin'Total, produced by LAPROVET/France (1g/5L), was provided in the drinking water for stress control during the first 5 days. Tetracolivit from LAPROVET/France was administered as an antibiotic in the keet's drinking water at a concentration of 0.5g/L, following the manufacturer's guidelines for 5 days. One day before and the day of weighing keet (4 and 8 weeks old), Amin'Total for stress control was administered at 1g/5L) in keet's drinking water. Corn, millet, sorghum without tannin (IRAT 204), wheat bran, broiler concentrate, peanut meal, bone meal, and peanut oil were used to formulate the experimental diet according to NRC (1994) reference. They were formulated by maintaining the same level (59% at stater and 63% at grower phase) of cereal in the feed and providing at least 2900 kcal of metabolizable energy per kg of dry matter throughout the experiment and 22% and 20% of crude protein in the feed in the start-up and growth phases respectively (Table 1).

**Table 1.** Ingredient and nutrient composition of 8 weeks experimental local keets' diets

| Ingredients (% Dry matter) | Starter phase (1-4 weeks) | | | Grower phase (5-8 weeks) | | |
|---|---|---|---|---|---|---|
| | Maize | Millet | Sorghum | Maize | Millet | Sorghum |
| Millet | 0 | 59 | 0 | 0 | 63 | 0 |
| Maize | 59 | 0 | 0 | 63 | 0 | 0 |
| Sorghum IRAT 204 | 0 | 0 | 59 | 0 | 0 | 63 |
| Wheat bran | 3 | 3 | 3 | 5 | 5 | 5 |
| Broiler concentrate | 16 | 18 | 17 | 14 | 14,5 | 14,25 |
| Peanut meal | 19 | 17 | 17,5 | 14,5 | 14 | 14 |
| Bone meal | 2 | 2 | 2 | 2,75 | 3 | 2,75 |
| Peanut oil | 1 | 1 | 1,5 | 0,75 | 0,5 | 1 |
| TOTAL | 100 | 100 | 100 | 100 | 100 | 100 |
| **Calculated nutritional composition** | | | | | | |
| ME* (Kcal/KgDM) | 2906.98 | 2931.79 | 2924.26 | 2902.59 | 2911.43 | 2905.71 |
| Crude Protein (%) | 22.3407 | 22.2053 | 22.4297 | 20,. | 20.1737 | 20.463 |
| Crude fiber (%) | 3.797 | 3.724 | 3.9833 | 3.739 | 3.62425 | 3.933725 |
| Lysine (%) | 0.9571 | 1.1407 | 0.93475 | 0.84475 | 1.0161 | 0.81305 |
| Methionine (%) | 0.3944 | 0.9052 | 0.38185 | 0.35835 | 0.89135 | 0.340125 |
| Calcium (%) | 1.13 | 1.2037 | 1.1688 | 1.2881 | 1.3955 | 1.3072 |
| NPP** (%) | 0.5392 | 0.5748 | 0.496 | 0.60215 | 0.6616 | 0.55225 |

*ME: Metabolizable Energy in Kilo calorie per kilogram of dry matter, **NPP: Non Phytate Phosphorus

**Experimental design and data recording**

The keets were raised on the ground on peanut hull litter during the 8 weeks of the experiment, starting from 1 day old. They were randomly allocated among the 12 boxes, with 9 keets per box. Water and feed were distributed *ad bilitum*. The three dietary treatments (maize, millet, sorghum) were randomly distributed in the boxes with four repetitions per treatment. The experiment parameters monitored included feed intake, live weight, average daily gain, and feed conversion ratio.

Feed intake was evaluated by calculating the difference between the quantities distributed and refusal every day. Within each box, the average feed intake per guinea fowl, expressed in grams (g) per day (d), was determined by dividing the total amount consumed by the number of guinea fowl on that particular day.

At the start of the experiment, the initial keet weight was recorded. At the end of the starter period (4 weeks) and the experiment (8 weeks), all keets from each batch were weighed individually. The average live weight of keet in grams (g) at different phases (start, 4 weeks, and 8 weeks old) was determined by the ratio of the total weight in g and the total number of keet in the same batch. Using weight measurements per period, the average daily gain (ADG) of guinea fowl at 4 and 8 weeks was calculated by taking the ratio of the average gain during a period to the duration in days.

The feed conversion ratio (FCR) was calculated by the ratio between the average amount of feed consumed by the keet over a given period and the average weight gain of this keet corresponding to this period (Gatien et al., 2020).

**Statistical analysis**

The data collected were entered into Excel 2016. The R software 4.2.1. (2022) was used to carry out the analysis of the variance of biological performances followed by the comparison of the arithmetic means using the Student-Newman-Keuls test to detect the effects of treatments. The means were compared to the 5%, that is for probability values (p value) lower than 0.05, the difference between treatments is considered as significant. Data expressed as mean ± SD.

## RESULTS AND DISCUSSION

**Feed intake**

In the starter millet-based feed and at the grower phases, the sorghum-based feed was better consumed by the keets (Table 2). The group fed by corn had the lowest amount ingested by the keets. However, the difference was not statistically significant ($p > 0.05$). Considering the 8 weeks of the experiment, the keets in sorghum treatment had the greatest feed intake and exceeded the ingestions of feed in maize by 1.96 g/d and millet treatments by 0.17 g/d, without statistically significant difference ($p > 0.05$). The cereal used did not significantly influence the keet feed intake. These feeds have theoretically similar energy concentrations and crude protein (CP) levels. Variations in feed intake of guinea fowl have been reported with feeds varying in their composition, especially in energy and crude protein. An increase in energy density varying from 3050 to 3150 kcal/kg of feed reduced the guinea fowl feed ingestion (Nahashon et al, 2005). Tjetjoo et al. (2013) found that the control feed containing 20% CP in the starter and 18% during the grower phase was significantly less consumed by guinea fowl than feeds based on maize, millet, and sorghum which had 24% CP in the starter and 20% in the grower phase. The amount of feed ingested per keet in this study was greater than the amount reported by Ebegbulem and Asuquo (2018) in rural areas. This could be linked to the CP content because an increase in the ingestion of guinea fowl with the increase in the CP rate from 21 to 25% was reported by Nahashon et al. (2005).

**Table 2.** Local keet feed intake (g/d) depending on the cereal used for 8 weeks of the experiment

| Parameters | Maize | Millet | Sorghum | P-value |
|---|---|---|---|---|
| Starter (1-4 weeks) | 9.73 ± 1.14 | 10.94 ± 0.5 | 10.37 ± 0.84 | 0.25 |
| Grower (5-8 weeks) | 19.65 ± 1.36 | 22.02 ± 2.64 | 22.94 ± 2.49 | 0.29 |
| All phases (1-8 weeks) | 14.69 ± 5.52 | 16.48 ± 6.20 | 16.65 ± 6.93 | 0.26 |

**Table 3.** Local keet live weight (g) depending on the cereal used in 8 weeks of the experiment

| Parameters | Maize | Millet | Sorghum | P-value |
|---|---|---|---|---|
| Initial live weight (1 day) | 25.74 ± 1.007 | 25.03 ± 1.13 | 25.74 ± 0.38 | 0.46 |
| Starter phase ( 4 weeks) | 109.95 ± 6.22[b] | 135.75 ± 12.57[a] | 128.10 ± 14.42[ab] | 0.03 |
| Grower phase (8 weeks) | 274.88 ± 16.26 | 336.83 ± 47.49 | 329.60 ± 44.05 | 0.09 |

[a, b] indicate that the values with the same letters on the same row are not statistically different (P > 0.05).

**Table 4.** Local keet average daily gain (g/d) depending on the cereal used in 8 weeks of the experiment

| Parameters | Maize | Millet | Sorghum | P-value |
|---|---|---|---|---|
| Starter (1-4 weeks) | 3.007 ± 0.24[b] | 3.95 ± 0.42[a] | 3.65 ± 0.52[ab] | 0.02 |
| Grower (5-8 weeks) | 5.89 ± 0.50 | 7.18 ± 1.49 | 7.19 ± 1.09 | 0.21 |
| All phases (1-8 weeks) | 4.44 ± 0.28 | 5.56 ± 0.85 | 5.42 ± 0.78 | 0.09 |

[a, b] indicate that the values with the same letters on the same row are not statistically different (p > 0.05).

**Table 5.** Local keet feed conversion ratio (kg/kg) depending on the cereal used in 8 weeks of the experiment

| Parameters | Maize | Millet | Sorghum | P-value |
|---|---|---|---|---|
| Starter (1-4 weeks) | 3.67 ± 0.46 | 3.17 ± 0.23 | 3.47 ± 0.54 | 0.31 |
| Grower (5-8 weeks) | 3.40 ± 0.91 | 3.60 ± 0.81 | 3.98 ± 0.34 | 0.54 |
| All phases (1-8 weeks) | 3.53 ± 0.46 | 3.38 ± 0.48 | 3.73 ± 0.40 | 0.58 |

**Live weight**

At the start of the experiment, the initial keet weight was similar for all dietary treatments (Table 3). At the end of the starter period, the keets fed the millet-based feed had the highest live weight and exceeded those from the maize by 25.80 g and those from sorghum treatments by 7.65 g. This difference was statistically significant ($p < 0.05$, Table 3). At the end of the experiment (8 weeks old), the keet from the millet treatment also had the highest live weight, compared to the guinea fowl from the maize and sorghum treatments. This difference could be attributed to the level of lysine and methionine in diet which was higher than the levels contained in corn and sorghum-based feeds. Guinea fowl have a better live weight with a lysine content varying from 0.8 to 1.04 in their feed (Portillo Salgado et al., 2022), and feed containing a higher level of methionine improves poultry growth performance (Bunchasak, 2009). The live weights of the guinea fowl obtained were higher than those observed by Ouattara et al. (2016) at 54 days with feeds containing 17.5 to 20% crude protein. It can be due to the protein level in the diet.

**Average daily gain**

The average daily gain (ADG) of keet was statistically significant at the starter phase between the dietary treatments ($p < 0.05$; Table 4). The millet-based feed induced the greatest ADG at this phase. During the growth phase, the keet ingesting the millet and sorghum-based feeds had similar ADGs (Table 4) and exceeded the guinea fowl in the maize treatment. Considering the experiment period, the keet ingesting the millet-based feed had a higher average ADG and this ADG was higher without significant difference than the average ADG of those consuming the maize-based feed by 1.12 g/d and the sorghum-based feed by 0.14 g/d ($p > 0.05$). This insignificant difference might be due to similarity in crude protein levels that satisfy the nutritional needs regardless of the cereal used in the guinea fowl's diet. The reduction in protein content from 21.48 to 19.11% led to a decrease in weight gain of 5.8% in week 4 (Lombo et al., 2018). However, the increase in protein content of 24 to 25% with the same energy level did not significantly increase the weight gain of guinea fowl (Amoah et al., 2018).

These results of ADG are similar to those found by Sanfo et al. (2015) in a controlled environment, but lower than those reported by Tjetjoo et al. (2013).

### Feed conversion ratio

Keets fed with millet-based feed had the lowest FCR followed by those fed with sorghum-based feed in the starter phase. Keets ingested in the maize-based feed had a higher FCR in the starter phase (Table 5). During the growing period, keet that fed maize had the lowest FCR and those fed sorghum had higher FCR. However, this difference was not statistically significant ($p > 0.05$). On average, during the 8 weeks of the experiment, the sorghum-based feed caused a higher FCR of 0.2 from the maize group and 0.35 with those fed millet-based feed. However, this difference was not statistically significant ($p > 0.05$). Tjetjoo et al. (2013) did not report any difference between the FCR induced by the different cereals. However, the control feed containing less crude protein content induced higher FCR than the feeds containing cereals. In addition, Seabo et al. (2011) reported that an increase in FCR was associated with a decrease in the crude protein content in the diet. The FCR obtained in the present study were lower than those reported by Ouattara et al. (2016) in the starter and grower phase of guinea fowl, also lower to those obtained by Tjetjoo et al. (2013) at 16 weeks by using corn, millet and sorghum in keet diet.

## CONCLUSION

During the 8 weeks of experimentation, the maize, millet, or sorghum used in feed did not have a statistical effect on keet growth performance. However, the millet-based feed had a greater influence on live weight, and average daily gain and presented the lowest feed conversion ratio than the other feeds. The keet average daily gain induced by the sorghum-based feed was higher than that induced by the maize-based feed during the experimentation period, but the feed conversion ratio obtained with the maize-based feed was better than that recorded with the sorghum-based feed. For a choice of cereal in the diet of guinea fowl, millet would be best indicated for growth performance, followed by maize and sorghum. Further research should be carried out on the effect of cereals on guinea fowl egg production.

## DECLARATION

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This research received no external funding.

### Availability of data and materials

The original contributions presented in the study are included in the article/supplementary material. For inquiries, please contact the corresponding author/s.

### Ethical Consideration

All authors have reviewed ethical concerns, such as data fabrication, double publication and submission, redundancy, plagiarism, consent to publish, and misconduct before being published in this journal.

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### Authors' contributions

Nouri Brah, Issa Chaibou, and Ousseini Moussa Hassan contributed to the conceptualization, investigation, data curation, and writing manuscript. Abdoul Rachidou Sodo Daka is involved in data collection and analysis. All authors approved and read the final version of the manuscript

### Conflicts of interests

The authors declare no conflict of interest for this article.

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