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Effects of incorporating heat-treated voandzou (*Vigna subterranea*) seeds into diets on growth performance of chickens in improved traditional poultry farming

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Key words: Roasted voandzou seeds, Broilers, Growth performance.

<http://dx.doi.org/10.12692/ijb/21.3.75-84>

Article published on September 06, 2022

Abstract

This research was undertaken to contribute to the search for alternative ways to improve poultry nutrition in Burkina Faso. The objective of the study was to determine the effects of incorporating roasted voandzou (*Vigna subterranea*) seed meal into feed rations on the growth performance of broilers in traditional improved farming in Burkina Faso. The roasted soybean used as a control was partially substituted by voandzou seed meal. To this end, a trial was conducted on 120 3-week-old chicks obtained from a cross between an Isa Brown rooster and a local hen, divided into three (3) batches according to the rate of incorporation of the seeds in the rations (0%, 3%, 6%) for 56 days. A mortality rate of 2.02% was observed. Live weights decreased in proportion to the level of incorporation in the ration with the control Rt (0%) equal to (1300.93±85.92g), RE1 (3%) equal to (1394.33±79.41g) and RE2 (1234.46±91.56g). The average weight gain and feed intake were not significantly different from the control. The feed conversion ratio of RE2 (5.01) was significantly higher than RE1 (3.76) and the control (4.31). These results show that voandzou seeds incorporated in the ration at more than 3% significantly retard the growth performance of the chickens, probably due to the presence of anti-nutritional factors, and suggest that the effects of good prior detoxification should be evaluated.

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Introduction

In Burkina Faso, poultry farming occupies an important place in the economy. It plays a significant role as a source of income and animal protein. However, in order to meet the growing demand for poultry products, there are several constraints, one of which is access to feed (Ouédraogo, 2017).

Indeed, among the obstacles that hinder the development of poultry farming in Africa and particularly in our country, feed is one of the main constraints. The supplementation provided by farmers to poultry in traditional improved poultry farming does not optimise the productivity and profitability of poultry farms. The use of local legume seeds and other non-conventional feed resources, where availability or cost are not limiting factors, could be a solution. The price of soybean meal and maize, used as the main sources of vegetable protein and energy in poultry feed, has been rising steadily. The use of voandzou (*Vigna subterranea*) seeds in animal nutrition could reduce the cost of poultry farming, which is heavily dependent on conventional feeds such as soya.

The species *Vigna subterranea* (L.) (Verdc.) or groundnut has a fairly high genetic diversity in Burkina Faso, according to studies based on quantitative and molecular traits (Ouoba *et al.*, 2017). It is a traditional African legume, cultivated in all parts of Burkina Faso.

Several studies such as Fru Nji and co-workers (2003) as well as Amaefule and Osuagwu (2005) have evaluated the effect of incorporating voandzou seeds into broiler diets on the growth and physiological performance of chickens. Most of these studies showed that the inclusion of voandzou seeds in chicken diets had a positive effect on growth and productivity parameters at specific rates of incorporation.

These studies range from those that attempt to understand the effect of seed treatments prior to use to those that investigate the effect of different

incorporation rates on the growth and physiological performance of chickens (Nji FF *et al.*, 2003). But like many tropical legumes, its seeds contain anti-nutritional factors such as protease inhibitors, lectins, saponins, phytic acid, alkaloids and tannins. When present in large quantities, these compounds can reduce feed intake, digestion, or absorption of nutrients, which can reduce growth performance in livestock, hence the need for heat treatment before use.

The objective of the study was to determine the effects of incorporating heat-treated voandzou (*Vigna subterranea*) seed meal into feed rations on the growth performance of broilers in traditional improved poultry farming.

Material and methods

Study site and period

The trial was carried out at the Di station of the environmental and Agricultural Research (DRREA) of North West Burkina Faso. This station is located in the Sourou province, bordered to the north by the Yatenga province and the Republic of Mali; to the south by the Mouhoun and Sanguié provinces; to the east by the Yatenga, Passoré and Sanguié provinces; to the west by the Mouhoun and Kossi provinces. The experiment lasted 8 weeks.

Experimental animals

The experimental flock consisted of 198 Leghorn chicks. After hatching, the chicks were fed during the start-up phase (01 to 15 days) with commercial chick feed consisting of maize meal, Vitamin C, trace elements, bone meal from a feed mill in the study area. After this period, sexed animals were selected in batches of approximately equal weight and randomly allocated to the experimental diets for growth-finishing. The trial on these animals was conducted on the floor, on bedding in a building covering an area of 32 m² with a screened outdoor run of 64 m². Ventilation and lighting were provided by screened openings in the walls at a height of 1.5 m from the floor. During the first weeks, the chicks were given an anti-stress treatment, then vaccinated against

Newcastle disease and treated against coccidiosis and gastrointestinal parasitosis

Ingredients used

The ingredients used were roasted soybeans, roasted voandzou (pea) seeds (Fig. 1), maize, wheat bran, groundnuts and fish meal. These ingredients were purchased locally in the local market. The rest of the ration components such as groundnut cake and synthetic amino acids were also purchased from a feed mill in Bobo - Dioulasso. The voandzou seeds were cleaned before being roasted and ground using a multipurpose grinder.

Feed rations

Three rations (Rt, RE1 and RE2) were formulated and used for growth-finishing. The Rt ration served as a control and corresponds to 0% incorporation of roasted voandzou seeds. The other two rations are experimental RE1 and RE2. Roasted soybean was partially substituted by voandzou meal at 3% and 6% respectively. The other feed ingredients such as maize, roasted soybean, and fishmeal were purchased from the local market (Table 1).

Experimental setup

The 198 chicks were distributed among the three feed treatments at a rate of 66 birds per treatment and three (3) replicates of 22 birds each (Table 2). Batching was done in such a way that there was no significant difference between the mean weights of the chicks in the different batches. The birds in each batch were identified by plastic rings placed on the right wing. After batching, the chicks were subjected to a one-week feeding transition during which the commercial feed was progressively replaced by the experimental feed to allow the birds to gradually become accustomed to the experimental ration. Tap water was given to them ad libitum and renewed daily.

Medical prophylaxis

During the first weeks, the chicks were given an anti-stress treatment, then vaccinated against Newcastle disease and treated against coccidiosis and

gastrointestinal parasitosis. The first deworming took place just after the chicks were put into batches, i.e. at the 3rd week of age. It should be noted that deworming is done every month. From the time the chicks were obtained until the time of the experiment, deworming with albendazole and vitamin therapy (AMINTOTAL) was done systematically every four weeks. We also used anticoccidials for coccidial control every three weeks.

Data collection

The different parameters were calculated as follows:

Individual feed consumption

This is the ratio of the total amount consumed (difference between distributed and rejected feed) to the number of animals.

Average daily gain (ADG)

Average daily gain is the ratio of the average weight gain during a period to the length of the period in days. It is expressed in grams per day.

Consumption index (CI)

This was calculated as the ratio of the average amount of feed consumed during a period to the average weight gain during the period.

Mortality

The mortality rate is the ratio of the number of deaths recorded during the rearing period to the total number of birds at the start of the rearing period, expressed as a percentage (%).

Statistical analysis of the data

The results were entered using the Excel spreadsheet. 2010. Statistical analyses of the data were performed using R 3.5.1. The effects of food on food consumption, weight gain and consumption index were tested by analysis of variance (ANOVA) using the Tukey HSD model at a threshold of 0.05

Results discussions

Nutritive values of the voandzou seeds used

According to several authors, the seeds of voandzou

cultivars are an excellent source of nutrients, especially protein. Biochemical studies show that 100 g of material, contains 60% carbohydrates, 21% protein, 6% fat and 6% fibre (FAO, 2016). It also contains antioxidants and trace elements such as iron

(Fe), magnesium (Mg), phosphorus (P), potassium (K), zinc (Zn) and copper (Cu) (Nacoulma, 1996; FAO, 2016). Potato pea also contains vitamin E (3.18 ± 0.15 mg/100 g), vitamin C (1.17 ± 0.20 mg/100 g) and vitamin A (26.05 ± 0.14 mg/100 g).

Table 1. Composition (%) of experimental diets.

Ingredients	Expérimental diets		
	Control Rt (0%)	RE1 (3%)	RE2 (6%)
Maize	51	51	51
Wheat bran	18	18	18
Roasted soybeans	16	13	10
Roasted voandzou seeds	00	3	6
Groundnut cake	7	7	7
Fish meal	5	5	5
C M V	2,5	2,5	2,5
salt	0,5	0,5	0,5
Total	100	100	100

The seeds of the voandzou cultivars had mean protein contents ranging from 14, 61 to 20.74g/100g DM protein. Statistical analysis revealed a significant difference ($p < 0.05$) between the protein contents of the seeds of the different voandzou cultivars. The values are approximately equal to the values reported by Amarteifio *et al.* (2010). These authors obtained 15.1 - 22.1; 17.5 - 21.2 grams of protein per 100 grams of dry matter respectively. This difference would be due to the genotypes and the environmental conditions under which these seeds were grown (Aremu *et al.*, 2005).

For ash content, the cultivars studied are statistically identical regardless of cultivar. Nevertheless, the contents are lower than those reported by Mazahid *et al.*, (2013) who obtained average content of 3.25% with voandzou seeds originating from Sudan. The

same is true for Amarteifio *et al.* (2010) and Abiodun *et al.* (2011) who reported contents between 3.57 g/100 g and 4.85 g/100 g dry matter for seeds from Namibia, Swaziland and Nigeria. According to Amarteifio *et al.*, (2006), this difference in ash content could be explained by the texture and composition of the soils which would have an effect on the mineral absorption of the plants and the varietal differences.

The crude fibre content of the seeds varied from 2.57 to 4.01% dry matter but significant differences ($P < 0.05$) existed between seeds of different cultivars.

Mazahid *et al.* (2013) found higher values than in our study. According to Amarteifio *et al.* (2010) and Himeda (2012), differences in nutrient contents in food plants are largely due to soil type, post-harvest treatment, environmental conditions and degree of ripening.

Table 2. Experimental set up.

Repeat A			Repeat B			Repeat C		
Sub-lot 1	Sub-lot 2	Sub-lot 3	Sub-lot 4	Sub-lot 5	Sub-lot 6	Sub-lot 7	Sub-lot 8	Sub-lot 9
Ration Rt	Ration RE1	Ration RE2	Ration Rt	Ration RE1	Ration RE2	Ration Rt	Ration RE1	Ration RE2
22 chicks	22 chicks	22 chicks	22 chicks	22 chicks	22 chicks	22 chicks	22 chicks	22 chicks

The lipid contents of the different voandzou cultivars ranged from 7.72 to 8.55%. Statistical analysis did not reveal any significant difference ($p > 0.05$). The results obtained are similar to the values obtained by Boateng *et al.* (2013). These authors showed that legume seeds, with the exception of soybean and peanut, generally contain little lipid. However, the contents obtained are higher than those reported by Abiodun and Adepēju (2011).

The lipid content of voandzou cultivar seeds is relatively low compared to soybean (40%) and groundnut (56%) (Kaya *et al.*, 2009). Given the low lipid content of these voandzou cultivar seeds, they can be recommended for a low-fat diet.

The seeds of the voandzou cultivars studied are, on the whole, more than 50% carbohydrates.

These contents are in agreement with those reported by Mazahib, (2013). The contents reported by these authors are between 54.51 and 65% DM. However, our results are lower than those reported by Aremu *et al.*, (2006). These authors reported average content of 73.50%. These differences in results can be attributed to varietal properties, and environmental conditions of their cultivation (Aremu *et al.*, 2006; Boateng *et al.*; 2013). The high carbohydrate content of voandzou seeds makes this legume an excellent source of energy like other legumes such as cowpea and pigeonpea (Ofuya *et al.*, 2005).

Table 3. Feed consumption of animals.

period	Rt	RE1	RE2	Pr(>F)	Meaning
S1-S2	70,31±2,95a	60,83±2,06b	61,79±1,54b	0,009	S
S3-S4	85,05±5,44a	66,25±1,64b	78,92±3,58ab	0,005	S
S5-S6	68,91±1,72a	80,57±2,27b	67,95±2,26a	0,000	S
S7-S8	75,02±1,18a	83,47±1,642b	82,98±1,54b	0,000	S
S1-S8	74,82±3,48	72,78±3,36	72,91±3,64	0,901	NS

The values in the same row, marked with different letters, are significantly different at the 5% level ($p < 0.05$).

Food consumption

Table 3 shows the average consumption of the subjects as a function of time.

Over the duration of the experiment (1st to 8th week of age) the incorporation of voandzou (*Vigna subterranea*) seed meal decreased feed intake with the rate of incorporation from one treatment to another compared to the control (Table 3). This decrease was not significant. Thus, the respective feed intakes (72.78±3.36 g/d and 72.91±3.64 g/day) of treatments RE1, RE2 were different and lower than those of treatment Rt (74.82±3.48 g/day).

Throughout the trial (S1-S8), feed intake as a function of voandzou (*Vigna subterranea*) seed rate did not vary significantly ($p = 0.901$). Our results corroborate those of F Fru Nji *et al.* (2003) who found that the rate of incorporation of seeds in the diets did not significantly influence food intake. The incorporation of voandzou seeds had no significant effect on the palatability of the diets and did not contain any anti-nutritional factors that could influence food intake. In the same vein, Ologhobo (1992) in a study reported that the feed intake of broilers fed 12.5% voandzou seed was not significantly different, while at 25% it was significantly lower than that of the control lot.

Table 4. Effect of feed treatments on feed conversion ratio

Period	Rt (0%)	RE1 (3%)	RE2 (6%)	Pr(>F)	Meaning
S1-S2	3,56±0,66	2,83±0,45	3,36±0,56	0,677	NS
S3-S4	4,24±0,40	3,3±0,07	4,58±0,01	0,630	NS
S5-S6	4,03±0,33	4,24±0,50	6,14±1,03	0,203	NS
S7-S8	5,41±1,22	4,66±0,92	5,96±1,66	0,792	NS
S1-S8	4,31±0,38	3,76±0,35	5,01±0,57	1,620	NS

The same trends were observed with another *Vigna* species. Gupta *et al.* (1991) incorporated up to 40% *Vigna umbellata* in broiler rations without a significant reduction in feed intake. Lon Wo *et al.* (1998) cited by Fru Nji *et al.* (2003) reported 35%

incorporation of *Vigna unguiculata* in broiler diets without significant effect on feed intake. Akanji,(2015) also observed that chicks without voandzou seeds in their diet had higher feed intake than those containing voandzou seeds.

Table 5. Mortalities recorded.

Parameters	Lots			Total
	Rt (0%)	RE1 (3%)	RE2 (6%)	
Starting number	66	66	66	
[S1-S2]	1	0	0	1
[S3-S4]	0	0	0	0
[S5-S6]	0	0	0	0
[S7-S8]	0	0	2	2
[S1-S8]	0	1	0	1
TM/total number (%)				2,02

MM/total number: mortality rate calculated in relation to the total number of animals.

Weight evolution

The effect of the incorporation of voandzou seeds on the evolution of the live weights of the animals is shown in (Fig. 2).

The weight evolution of chicks according to the rate of incorporation of voandzou seeds in the diets shows

non-significant differences until the end of the 7th week. However, over the entire duration of the trial (So-S8), i.e. 56 days of age, the chicks of each batch weighed on average 1300.93 ± 85.92 g for the controls (Rt), 1394.33 ± 79.41 for the 3% incorporation rate (RE1) and 1234.46 ± 91.56 for RE2 with a 6% incorporation rate.

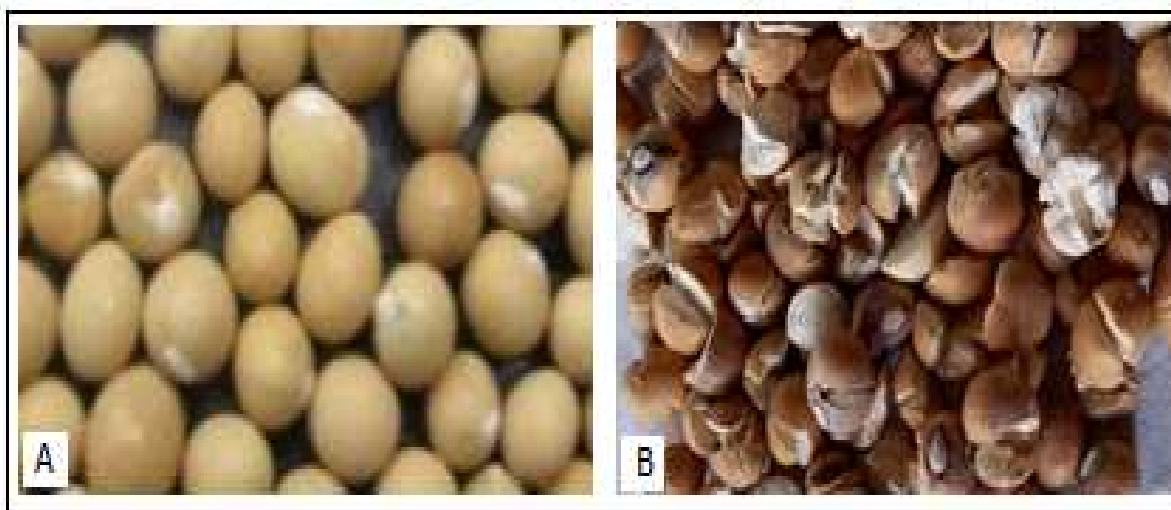


Fig. 1. Uniform Beige voandzou seeds (A) and roasted seeds (B) Source: authors' study.

The incorporation of voandzou seed meal influenced the weight of the subjects for treatments RE1 (3%) and RE2 (6%) in relation to the live weight of the control subjects. In fact, a regular downward trend

was observed with the increase in the rate of incorporation of voandzou seeds in the diets. This is in agreement with the work of Fru Nji *et al.* (2003) who showed that raw or autoclaved voandzou did not

alter the feed intake of chickens but decreased performance in proportion to the level of incorporation in the diet, especially the raw seeds. Similar results were obtained by Amaefule and Osuagwu (2005) with chicks. In the same vein, Ologhobo (1992) tested seed incorporation levels of 12.5 and 25% voandzou seeds in the rations of growing broilers and concluded that at 25%, performance was significantly reduced. However, a study by Nwaigwe *et al.* (2010) showed that voandzou (*Vigna subterranea*) seeds could partially replace soybean meal in broiler diets, and that the 25% crude seed incorporation rate did not provide a sufficient amount of anti-nutritional factors to cause growth retardation or observable toxic effects in the experimental diets. Our work is also contrary to that of Ironkwe and Esonu (2012) who found that raw and roasted voandzou seed meal can be incorporated into

the diet of growing broilers - up to 30% finitition without significant negative effects on growth. In our study, we heat-treated voandzou seeds and found that at 3% voandzou seed meal incorporation growth was improved compared to the control. A similar result was obtained by Obih and Ekenyemi (2010) who also found that the incorporation of voandzou seed meal at 5% of the broiler diet had no negative effect on growth. This result is also in agreement with that of Oyeagu *et al.*(2016) who observed that autoclaved voandzou seeds were better than raw voandzou seeds.

These authors noted that heat treatment of legume seeds was used to reduce the levels of anti-nutritional factors such as tannins. As such, the better performance of autoclaved voandzou seeds in our study can be attributed to the reduced levels of anti-nutritional factors in the grains.

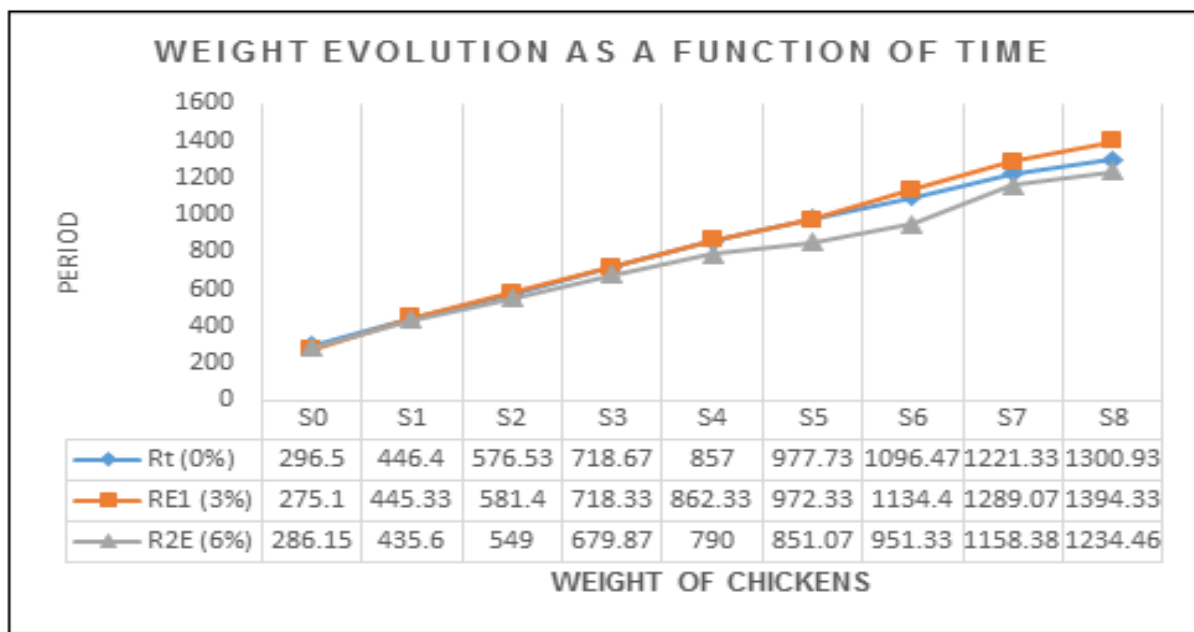


Fig. 2. Evolution of live weights of chickens in different batches.

Consumption index

Table 4 presents the results of the effect of the different feed treatments on the feed conversion ratio of the chickens.

The food consumption indices obtained per treatment throughout the duration of our experiment are Rt (4.31±0.38); RE1 (3.76±0.35) and RE2 (5.01±0.57). It was found that the incorporation of roasted voandzou

seeds into the ration did not have any significant effect (Table 4) on food consumption indices (FCIs) in the subjects of the different treatments compared to the control. This is in agreement with the results obtained by Nwaigwe *et al.* (2010). Similarly, Onyimonyi AE, Ugwu SOC (2007) found no negative effects of incorporating 5% roasted voandzou seed meal in broiler diets on growth and feed conversion efficiency. The same observations were made by Obih

and Ekenyemi (2010) who also found that the incorporation of voandzou seed meal at 5% of the broiler diet had no negative effect on growth and feed conversion efficiency. Overall, there was a slight deterioration in feed conversion with rations containing 6% roasted voandzou seed compared to the control and RE1. However, we note that the feed conversion ratio of subjects fed rations containing voandzou seeds is better for RE1 than for control (Rt) and RE2 rations, even though statistical analyses showed that these results obtained do not present any significant difference between treatments at the 5% threshold. In contrast to these authors Emiola *et al.* (2007) in studying the effect of dry-heated, water-heated and dehulled voandzou seeds on broilers, showed that feed conversion efficiency was significantly reduced when broilers were fed diets containing voandzou seeds.

Mortality

Our study showed that the incorporation of roasted voandzou seeds did not have a negative effect on the health status of the chickens. We recorded low mortality rates during our study (Table 5). In total, four (4) cases of mortality were recorded, representing 2.02% of the experimental population. No mortality was recorded in the control lot (Rt). These losses are minimal and do not affect the relevance of the statistical analyses. No organic diseases or lesions were found at necropsy.

Conclusion

The study showed that roasted voandzou seeds could be incorporated into chicken diets for up to 3% without significant negative effects on growth. However, incorporation at the rate of 6% in chicken diets significantly reduces the growth of chickens.

The results of our study suggest that roasted voandzou seeds can partially replace roasted soybean meal in broiler diets. The use of roasted voandzou seeds in poultry feeds could be an alternative for reducing the cost of poultry farming which is highly dependent on imported ingredients such as soybean. However, there are grey areas in the knowledge of the

nutritional characteristics of voandzou seeds. Our work suggests the need to better characterise them by testing the digestibility of their nutrients in order to verify the effects of anti-nutritional factors and to determine their tolerance thresholds, the effect on growth and the physiological performance of broilers and even laying hens. This will contribute to its incorporation not only in poultry rations but also in those of other livestock.

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