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Performance of broilers finisher hens as affected by fermentation duration of Bambara groundnut (*Vigna subterranean* (L.) *Verdc*.) meal

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Abstract

The effect of fermentation duration of raw Bambara groundnut (*Voandzeia subterranean* (L) on the growth performance, carcass quality and feed cost of finisher broilers were investigated. Two hundred 21 day old female Arbor acre broiler chicks were randomly divided into five treatment groups of forty birds each. The experimental design was a Completely Randomized Design with each treatment replicated five times with eight birds per replicated. Five test diets were formulated to contain no Bambara groundnut (C0) control or 15% of Bambara groundnut (BGN) either socked in water for 12 hours (F0) or socked and fermented for 12 hours, (F12), 24 hours (F24) and 36 hours (F36). Results showed that total feed consumption was significantly ($P<0.05$) higher with birds fed diet F0 compared with birds fed diet F12. The final body weight and total body weight gain were significantly ($P<0.05$) higher for the control diet (C0) compared to the rest of the treatments. Birds fed the control diet (C0) had improved fed conversion ratio ($P<0.05$) compared with the other treatments. Bigger liver and heart ($P<0.05$) were obtained with birds fed diet containing BGN (F0, F24 and F36) compared with the control (C0) and F12 group. The cost per kg weight gain ($1 USA = CFA 480 Francs) was significantly ($P<0.05$) lower with birds fed diet F0 compared with birds fed diet F12, F24 and F36 but comparable with the control (Co) diet. The result of the present study showed that fermentation duration had no significant effect on body live weight, weight gain and feed consumption ratio.

Keywords

Bambara Groundnut [*Vigna Subterraenea* (L.) *Verdc*], Fermentation Duration, Performance, Carcass Quality, Broiler

1. Introduction

The animal protein intake of most people living in developing countries has declined in recent years, especially for those in Cameroon and other African countries south of the Sahara, where the animal protein deficit involve more than 70% of the population [1]. The deficit in animal protein in Cameroon has been accentuated by an increasing urbanization and galloping demography [2], with a human population that grows at the rate of 3% per year [1]. The demand for animal protein cannot be satisfied by the present level of livestock in Cameroon. Reference [3] had attributed the low protein intake to low level of animal protein production and high cost of animal products and suggested the intensification of production of highly reproductive animals with short generation intervals such as poultry, pigs and rabbits [4]. However, the major factor militating against intensive animal production in Cameroon is the high cost of energy and protein feed ingredients like maize, soybean groundnut and cotton cakes. The ever–increasing cost in animal protein shows that there is need to explore the use of alternative feed ingredients that are cheaper and locally available [1]. One of such ingredients is Bambara groundnut [*Vigna subterranean* (L.) *Verdc*]. It (BGN) is widely cultivated in the five agro-ecological zones of Cameroon where the seeds are locally consumed [5]. BGN seed has been reported to contain 63% carbohydrates, 14-24 crude protein and 6.5% oil. The gross energy value of BGN is higher than that of cowpea (Vigna unguiculata) and pigeon pea (Cajanus cajan) [6]. The seed protein is richer in essential amino acids including lysine (6.6%) and methionine (1.3%) than other legume grains [7]. However, its used in the feeding of monogastric animals is limited by the presence of such ant-nutritional factors (ANFs), as protease inhibitors, haemaglutinins, tannins, cyanogenic glycosides and flatulence factors in the row BGN [8]. The successful use of legumes grains as a source of protein in diets of broilers thus depends on the form of presentation of the feed and the type of treatment used to eliminate the antinutritional factors (ANFs) they contain [9]. The inclusion of raw grain legumes indeed, usually resulted in the depression of both feed intake and growth rate [10]. A high blood level of ANFs could also negatively affect the animal body capacity to excrete metabolic waste via the kidneys [11] and a serum content of creatinine above 0.5 mg/dl is a good indicator of ANFs toxicity [12]. Fermentation treatments are among the most efficient techniques and were found to be more effective in reducing the trypsin inhibitor activity in the cotyledon of BGN than was heat treated, germination and cold socking [13]. Fermentation method is easier and less costly to be dealt with in developing countries with limited technologies and funding, particularly by the rural farmers. The aim of this study was to determine the effect of fermentation duration of BGN's meal on the growth parameters (feed intake, body life weight, weight gain, fed conversion ratio), the cost of production of a kg life weight, carcass quality and creatinine blood test of finisher broilers hen.

2. Materials and Methods

2.1. Experimental Site

The study was conducted at the poultry unit of the Department of Animal Production Research and Teaching Farm of the University of Dschang – Cameroon. The experimental place is located at an altitude of 1420 m (as coordinates 5˚ 26' N and 10˚ 26' E). Annual temperatures varies between 10 ˚C' and 25 ˚C [14]. Rainfall ranges from (1500- 2000) mm per annum over a 9 month rainy season (March to November)

2.2. Plant Material

Bambara groundnut (*Vigna subterranean* (L.) *Verdc.*) was as an experiment material for this experiment and it was purchased from local markets in the Western Highlands agro-ecological zone of Cameroon in the dry state. Samples of the untreated experimental material (BDN) were analysed for the crude protein, crude fibre, and ash content using the [15] method Table 2. Metabolisable energy (kcal/kg DM) was calculated according to [16] The BGN were either socked in water for 12 hours and sun dried (F0) or socked for 12 hours, put in airtight bags and allowed to ferment for 12, 24 and 36 hours. The socked and fermented BGN were then sun dried and milled before inclusion in the diets. Five experimental diets were formulated to contain no BGN (control) C0 or 15% of BGN either soaked (F0), or fermented for 12 hours (F12), 24 hours (F24) or 36 hours (F36) respectively. Minor adjustments were made in the other ingredients to make the diets iso-nitrogenous and iso-caloric. The composition and proximate analysis of the experimental diets are presented in Table 1.

Table 1. *Ingredients, nutrient composition and cost of production of the experimental diets.*

Ingredients (kg)	**Control diet**	**Experimental diets with 15% Bambara groundnut meal**
Maize (Zea mïis)	50	38
Wheat middling	11	11
Concentrate*	5	00
Cotten (*Gossupium hirscutum)* seed cake	8	7
Fish meal	5	6.5
Soybean (*Glycine max)* cake	16	14.5
Bambara groundnut (Vigna subterraenea (L.) Verdc*)*	00	15**
Oyster shell of marine *(Mullusk)*	0.25	6
Bone meal	0.5	00
Common salt	0.25	0.35
Synthetic methionine	00	0.3
Vitamin premix	0.25	0.35
Palm *(Elaeis guineensis)* oil	3.75	1
Total	100	100
Analysed chemical composition of the experimental diets		
Metabolisable energy (kcal/kg)	2900.1	2858.84
Crude protrin (%)	20.54	20.18
Crude fibre (%)	4.156	4.419
Energy protein ratio	141.17	141.55
Amono acids (%)		
Lysine	1.21	2.03
Methionine	0.468	0.833
Minerals		
Phosphorous	0.49	0.63
Calcium	1.03	2.94
Cost of production of ration (FCFA/kg)	287.95	200.64

* concentrate composed of 40% CP, 3.3% lysine, 2.4% methionine, 8% Ca, 2.05% P, ME=2.078 kcal/kg

** F0, F12, F24 and F36 had each 15% Bambara groundnuts, control (C0) = no Bambara groundnut.

2.3. Birds and Management

Two hundred 21-day old female Arbor acre broiler hens weight 570g were used for the experiment. The chicks were procured from the brooding unit of the University of Dschang teaching and research farm. The birds were housed in a deep litter pen in an open sided poultry house portioned with play-wood and wire gauze. The birds were vaccinated in drinking water against Newcastle disease and infectious bronchitis at 3 days old with booster in water on the 20th day. At 8 day old there were vaccinated against Gumboro disease at 10 days of age. Birds were administered anti-stress at the start of the experiment, before and after vaccination and manipulation. There were administered Vetacox® or amprolium® in water as coccidiostat on three successful days every week until six weeks of age.

2.4. Experimental Design and Parameters Measured

The experimental design was adjust as completely randomized design. The birds (200) were randomly allotted to five treatment diets that were formulated to contain no BGN (C0) control or 15% of BGN either socked in water for 12 hours (F0) or socked in water, put in airtight bags and allowed to ferment for 12 hours, (F12), 24 hours (F24) and 36 hours (F36). Each treatment was replicated five times with eight birds per replicate in 3.0 x 3.5 m deep litter pens of fresh wood shavings. The birds were fed and offered good quality drinking ad libitum. The birds were subjected to standard broiler management procedure.

2.5. Measurements and Parameters Calculated

The birds were weighed at the start of the experiment and subsequently on a weekly basis. Subtracting the initial live weight from the final live weight gave weight gain. Feed offered to broilers were weighed daily and left over were also weighed at the end of the week and feed intake was determined by subtracting leftover feed from offered to the birds. The weighing of birds and feed was done using a top loading weighing scale with an error of 50g. Weighing of birds took place in the morning hour (7.00-8.00 am local time) each week. Feed conversion ratio (FCR) was calculated from the data on live weights and feed intake as quantity (g) of feed consumed per unit (g) weight gained over the same period.

2.6. Carcass Characteristics

At the end of the trial 49 days, 10 birds per treatment (2 hens per replicate) were staved for 24 hours (water served) and slaughtered for carcass evaluation according to [17]. The ready-to-cook carcass and the following parts were separately weighed for each bird: liver, gizzard, pancreas, shanks, and abdominal fat. The dressing percentage and proportion of each organ or part to life weight were calculated using [17].method as follows:

Dressing percentage = (weight of ready-to-cook carcass / life weight after fasting) x 100

Proportion of organ = (weight of organ / carcass weight) x 100

2.7. Creatinine Concentration in Blood (Mg/Dl)

During slaughter of the birds for carcass evaluation, blood samples were collected from the jugular vein and used for creatinine blood test. The creatinine level in the serum was evaluated by calorimetric method using creatinine liquicolor kit.

2.8. Cost of Production

This was estimated based on the on the cost of feed required to produced one kg life body weight of chicken. This was calculated by multiplying the average feed conversion ration by the cost of 1 kg of feed at the time of the trial.

2.9. Statistical Analysis

All data collected or calculated were submitted to one analysis of variance [15] for a completely randomized design and where necessary, treatment means were compared using the least significant difference. All statistical analysis were carried out using JMPIN 4.04 [16].

3. Results and Discussions

The proximate composition and M.E. content of row BGN used in the experimental diets is presented in Table 2. The proximate values of raw BGN obtained in the present study seems to differ from the values (91.61 and 90.18% DM, 3781.07 and 3620.04 Kcal/kg M.E., 20.46 and 22.46% CP, 7.51 and 5.8% crude fat and 4.1 and 3.1% ash) obtained by [17]. However, values for crude protein and ash content (20.46 and 4.1%) agreed with the values reported by [18]. The observed differences may have resulted from the varieties of seed used, the agro-ecological zone and the processing and storing methods (milling and sieving) adopted. Also, differences in proximate compositions of legumes and oil seeds have been attributed to differences in the varieties of seeds used [19]. There were no wide variations in the proximate composition of the experimental diets as they were formulated to be iso-energetic and iso-nitrogenous.

The effect of fermented BGN on the average growth performance and cost of production of 1 kg live body weight of finisher broiler hens are presented in Table 3. There were significant differences ($P<0.05$) among treatments in average fed intake, final body weight, average weight gain, Feed conversion ratio and average cost per kg live weight. The total average feed consumption increased numerically with fermentation duration. Feed intake was significantly ($P<0.05$) higher (3061.25±74.71 g) with soaked BGN (F0) diet and least (2851.125±133.25 g) with BGN diet fermented for 12 hours. The poor feed intake observed in diets containing fermented BGN (F12, F24 and F36) compared to the control (C0) is contrary to the findings of [20] and [21] who reported that the processing steps involved in fermentation, such as soaking and microbial action are known to reduce the content of anti-nutritional factors present in legume grains. Total feed intake was significantly higher ($P<0.05$) with birds fed diets containing soaked BGN (F0) as compared to the rest of the treatments. This could mean that soaking was very effective in reducing the bitterness of BGN caused by alkaloids or tannins which are known to be responsible for the astringent taste of the feed inducing higher palatability of the diet and hence higher feed intake. Also, the higher feed intake by chicks fed soaked BGN (F0) diet over chick fed fermented BGN (F12, F24 and F36) diets could mean that the fermentation process and durations used on BGN in this trial did not allow for extensive protein hydrolysis, a process necessary to improve the quality of the grain. This supports the observations of [22] who stated that in most fermented high-protein products, the level of protein hydrolysis is one of the most important factors that affect changes in the texture and flavour. No significant difference ($P>0.05$) in feed consumption was observed among birds fed diets containing fermented BGN thus suggesting that the time differences used in fermentation was too short to have significantly affected consumption differently.

The final body weight gain and total weight gain were significantly ($P<0.05$) higher with birds fed the control diet compared to the rest of the treatments. No significant difference ($P>0.05$) was observed in the final body weight gain and total weight gain for birds fed on BGN diets. The inclusion of BGN in the diets resulted in a reduction in the final body weight and total weight gain of the birds. This could be attributed to the decrease in feed consumption that might have led to an insufficient level of essential amino acids which affected protein synthesis and the metabolic processes. The low weight gain observed in this trial with the inclusion of BGN are in-line with the findings of [23] who reported that BGN seeds did not support weight gain of broiler chicks but gave a negative protein efficiency value. However, these authors used BGN in the raw state and attributed the low weight gain to the presence of ant-nutritional factors such as protein inhibitors presence in the grains that reduces protein digestibility. The role of ant-nutritional factors in growth depression and reduction in feed intake, carcass weight in broiler birds as a result of low nutrient availability had been earlier documented [24]. Further, the soaked BGN diet (FO) induced numerically lower weight gain compared to the rest of the treatments. The depression in weight gain could be attributed to low availability of nutrient, particularly amino acids, and the presence of polyphenols that could not be effectively removed by soaking for 12 hours. This support previous findings that fermentation method in more effective in reducing trypsin inhibitors activity in the cotyledons than cold soaking [25].

The feed conversion ratio of birds fed the control (C0) diet was significantly ($P<0.05$) lower compared with birds fed BGN diets. Birds fed diet containing BGN soaked for 12 hours (F0) recorded the poorest feed conversion ratio. Although soaking effectively improved the palatability of F0 diet than fermentation, the poor efficiency of feed utilization of this diet confirms the fact that tannins and protease inhibitors were not well removed by soaking and hence raised the feed conversion ration as explained by [26]. The feed costs of producing 1 kg live weight gain was significantly ($P<0.05$) lower in the fermented BGN diets (F12, F24 and F36) compared to diet containing soaked BGN (F0) and the control (C0) diet. Although growth performance was not effectively improved, the inclusion of fermented BGN in finishing broiler diet was of economic advantage compared to including soaked BGN and also cheaper than the control diet.

Data on the dressing percentage, proportion of different parts (as % live weight) and creatinine blood test are presented in Table 4. The carcass yield was significantly ($P<0.05$) higher for birds fed the control (C0) diet compared to birds fed diet F0, F24 and F36. The carcass yield recorded for all the treatment groups were lower than the value recommended for Agbor Acre line of birds (63.92%) as reported by [14]. Similar results were previously reported by [1] when birds of same strain were fed raw cowpea and BGN and the low dressing percentage was attributed to the presence of ANFs in the diets and management techniques.

The gizzard and the liver were significantly ($P<0.05$) higher in weight for birds fed diet F0 compared with treatment F12 and the control (C0). The high percentage weight recorded by these organs in diet F0 could be due to higher physiological activities couple with metabolic stress triggered by the presence of ANFs which neither were effectively removed by soaking nor fermentation as reported by [28]. The proportion of the heart and pancreas were not affected ($P>0.05$) by fermentation duration thus indicating that the increase of the test ingredient did not create any additional metabolic stress or toxicity for the birds. There was no significantly difference among treatment groups in the serum creatinine level thus indicating that the test diets were free from toxin.

Table 2. *Proximate composition of raw BGN.*

Dry matter (%)	M.E. Kcal/kg	Organic matter (OM) (%)	Crude protein (CP) (%)	Crude Fats (%)	Crude fibre (CF) (%)	Ash (%)
91.61	3781.0	95.9	20.46	7.51	4.64	4.10

Table 3. *Effect of feeding soaked and or fermented BGN on the average growth performance and cost of production of 1 kg live body weight of finisher broiler hens.*

Diets	Average feed intake (g ±SD)	Final life body ;ht (g ±SD)	Total weight gain (g ±SD)	Cumulative feed conversion ratio (g ±SD)	Total feed cost per kg live weight (FCFA±SD)
C0	2958.75±238ab	1852.50±94.01a	1282±94.01a	2.31±0.09c	663.85±26.19a
F0	3061.25±74.71a	1532.62±72.44b	962.475±72.44b	3.19±0.19a	640.40±39.69a
F12	2851.125±133.25b	1579.37±90.34b	1009.22±90.35b	2.83±0.14b	568.83±28.66b
F24	2906.475±61.83ab	1571.90±33.19b	1001.75±33.19b	2.90±0.08b	582.47±16.25b
F36	2927.38±81.43ab	1578.00±21.29b	1007.85±21.28b	2.90±0.06b	582.79±12.27b

a, b, c: means in column carrying the same letter are not significantly different (P>0.05); 1 1€ = 650 FCFA

Table 4. *Carcass characteristics (% body weight) and creatinine test of broiler hens as affected by feeding fermented Bambara groundnut meal.*

Parameters	Treatments				
	C0	F0	F12	F24	F36
Dressing %	56.77±4.02a	52.39±6.52b	56.86±6.38a	53.67±1.85b	53.16±3.5b
Abdominal fat	0.709±1.02a	0.339±0.38bc	0.496±0.72b	0.174±0.38c	0.171±0.30c
Gizzard	2.344±0.30b	2.737±0.58a	2.357±0.27b	2.503±0.11a	2.66±0.77a
liver	2.54±0.39b	3.20±0.50a	2.599±0.32b	3.06±0.39a	3.23±0.054a
Heart	0.597±0.10b	0.768±0.16a	0.61±0.05b	0.677±011ab	0.691±0.13ab
Pancreas	0.283±0.08c	0.348±0.08bc	0.430±0.70a	0.371±0.08ab	0.405±0.07ab
Shanks	4.310±0.40b	4.720±0.45ab	4.330±0.40b	4.739±0.56ba	4.810±0.57ab
Creatinine concentration x	4.220±2.36a	4.130±2.05a	3.700±1.03a	3.380±0.84a	3.700±1.03a

a,b,c: means in column carrying the same letter are not significantly different.
X creatinine concentration (μmol/l)

4. Conclusion

The results of this research indicate that fermentation process duration had no effect on body live weight, weight gain, feed conversion ratio and feed cost per kg live body weight. Although the growth parameters for diet F12 were comparable with those of diets F24 and F36, in addition it shows diet F12 seems to be the best treatment method.

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