Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 2, 2023
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

EFFECTS OF A PECKING STONE-BASED FEED SUPPLEMENT ON ZOOTECHNICAL PERFORMANCE AND SOME BIOCHEMICAL PARAMETERS IN COBB 500 BROILERS

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Abstract

In order to reduce problems linked to mineral deficiency during broilers production, as well as to improve digestive capacity of nutrients, the present study was conducted to evaluate the effects of pecking stone on broilers production. The study was conducted from October 2022 to February 2023 on 207 chicks of COBB 500 strain. The chicks were divided from the first day into three (3) batches of 69 birds and each batch was split into 3 sub-batches serving as repetitions. A batch T used as a control did not receive any mineral block, while, batch A and B were respectively supplemented with pecking stones A (peck A) and B (peck A). The results obtained showed that the feed conversion ratio of the animals fed the diet supplemented with pecking stones decreased significantly (2.73 and 2.70 for the Peck A and Peck B batches respectively) compared with the control batch (2.97). Body weight gain carcass weight and the feed cost of producing one kilogram of body weight of chicken was significantly ($p<0.05$) ameliorated with the use of pecking stones. In general, the feed supplement based on pecking stones improved the zootechnical and biochemical parameters of the chickens.

***Key words**: biochemical parameters, broiler, COBB 500, growth performance, pecking stone.*

INTRODUCTION

The number of people suffering from undernourishment worldwide reached 1.02 billion in 2009, with sub-Saharan Africa accounting for 30% of this number (FAO, 2009). Effectively combating this problem requires an increase in the production of both plant and animal resources. The population is rising sharply and is set to increase from 6.8 billion to 9.1 billion by 2050, i.e. a third more people to feed than today (FAO, 2013). Despite the selection and intensification of animal production, animal protein intake is still insufficient. Given this situation, there is an urgent need to find alternatives for quantitative and qualitative production at lower cost.

In Cameroon, according to statistics reported by GIZ (2018), the poultry sector accounts for 42% of national meat production, and has now become an important sector. This has been helped by the introduction of policies to increase meat products, such as the promotion of short-cycle species such as poultry (Ohouko, 2017).

Under these conditions, feed is the highest cost item in breeding and can therefore contribute to nearly 70% of the production cost of broilers. To achieve good performance, it is necessary to formulate balanced diet (energy, proteins, amino acids, vitamins, essential fatty acids and minerals). As a result, farmers' limited purchasing power means that they cannot afford to buy them on a regular basis. However, animals selected for their rapid growth and high feed conversion efficiency, such as broilers, suffer from numerous skeletal disorders (rickets and osteomalacia) due to mineral and vitamin D deficiency. In addition, phosphorus in the form of phytic acid (contained in plant seeds) is often poorly utilized, and this also reduces the bioavailability of calcium. As a result, practical diets fed to broilers are in most cases deficient in calcium and phosphorus unless supplemented with inorganic salts (Bao & Choct, 2009). To solve this problem locally, the population uses natural mineral resources and the uncontrolled use of which would lead to poor production performance, hence the importance of this study. In addition, growth promoters are widely used in poultry farming and there is growing interest in finding alternative solutions (Kiki et al., 2013). Feed supplements such as pecking stones made from natural by-products (oyster shells, calcium carbonate, bone meal, etc.) can be used as an alternative to chemical additives in order to compensate for deficiencies that occur during the various stages of poultry development.

The mineral block or pecking stone is a feed supplement made available to poultry with the aim of playing a number of roles, namely providing additional minerals as part of the feed through its composition, improving the degradability of feed as well as the digestive capacity of nutrients, animal welfare by guaranteeing natural pecking behaviour, and finally its usefulness in combating boredom. In addition, chemical mineral additives are increasingly expensive on the market and do not always guarantee poultry welfare and product quality (Chaouchi & Benattia, 2017). It is in this context that this study was initiated with the general objective of contributing to further improving knowledge of feed supplements for chickens based on pecking stone formulated from local by-products.

MATERIALS AND METHODS

Study site and period

This study was conducted between October 2022 and February 2023 on an experimental farm in the Bamyanga district. This district is located in the municipality of Ngaoundere 1st, Vina department, in the Adamawa region of Cameroon. The climate of the Ngaoundere municipality is humid tropical. It is characterised by an average annual rainfall of 1,500 millimeters. Peak rainfall is usually recorded in August. During the rainy season, it is affected by the monsoon, responsible for torrential rains sometimes accompanied by tornadoes. The average temperature is 22°C and diurnal temperature variations are very wide during the dry season. Total monthly evaporation is very high between December and March. It can reach 1,982.4 mm. Between June and September, however, it decreases very rapidly and stabilizes at between 34.6 and 40.4 mm, before rising again rapidly to reach a maximum in February.

Experimental birds

A total of 207 one-day-old Cobb 500 chicks with an average weight of 42 g were used in this study over a period of 49 days. They were randomly assigned following a completely randomized design to 3 treatments replicated 3 times with 23 chicks each and reared under the same conditions on litter made of white wood shavings at a density of 20 chicks/m^2 at the starter phase (1-21 days) and 10 chickens/m^2 at the growth and finishing phase (22-49 days). Water and feed were provided to the animals according to the method proposed by Rossilet (2004).

Prophylaxis

Birds were vaccinated against Newcastle disease (Hitchner B1®) and infectious bronchitis (H120®) on the 4th day with a booster dose on the 18th day. The vaccine against Gumboro disease (IBA Gumboro®) was administered on the 11th day. From the second week, the anticoccidial (Vetacox®) was administered three days a week in the drinking water. An anti-stress was administered to birds via drinking water for the first three days upon entry into the henhouse and each time before and after vaccination, weighing and transfer of birds to the finisher house.

Pecking stones

The pecking stone formulation process was carried out manually. The stones were made from bone meal; limestone powder; oyster shell; cooking salt; blood meal (from blood collected from Ngaoundere II slaughterhouse, then boiled for 5 hours to reduce potential pathogens and dried for 24 hours in the sun) and plant sap from the thorny *Acacia raddiana* tree, which served as a binder. This plant sap was dissolved in water at a ratio of 0.4 kg to 1 liter of water. Thus, for the formulation of the pecking blocks, two formulas were applied with different proportions as presented in Table 1.

Table 1. Proportion of ingredients for the two pecking stones

Components \ Pecking stones	Peck A	Peck B
	Proportion (%)	
Bone meal	15	15
Limestone powder	20	10
Oyster shell	30	40
Cooking salt	15	15
Blood powder	20	20

The molded blocks were exposed to the sun for 48 h to stabilize before being fed to the animals. The frequency of feed distribution depended on the growth phase of the animals (Ndiaye, 2006). During the start-up phase, feed was given *ad libitum*. From the growth to the finishing phase, diets were served twice a day (7 a.m. and 16 p.m.).

Chemical composition of pecking stones

The composition of the Peck A and Peck B pecking stones was determined by the complexometric titration method. It was carried out at the Soil Analysis and Environmental Chemistry Research Unit (SAECRU) at the Faculty of Agronomy and Agricultural Sciences, University of Dschang. Table 2 shows the mineral composition of the Peck A and Peck B pecking stones.

Table 2. Mineral composition of Peck A and Peck B pecking stones

Mineral composition	PECK A	PECK B
Calcium (mg/100 g)	1570.00	1810.00
Magnesium (mg/100 g)	437.40	413.10
Potassium (mg/100 g)	39.23	60.70
Sodium (mg/100 g)	479.25	589.06
Total Phosphorus (mg/100 g)	532.35	471.95

Experimental Rations

Three experimental rations were used in this study, depending on the development stage of the birds (start-up - days 1 to 21, growth - days 22 to 35 and finishing - days 36 to 49). These feeds were supplied by feed mill Company of Cameroon and their chemical composition is presented in Table 3.

Table 3. Chemical composition of diets depending on growth stage

Composition	Start-up	Growth	Finishing
Crude protein (%)	22	21	19
Moisture (%)	12	12	12
Fat (%)	6	6	8
Crude cellulose (%)	3.5	5	5
Calcium (%)	0.9	1	1
Phosphorus (%)	0.7	0.6	0.6
Crude ash (%)	5	5	5
Methionine (%)	0.6	0.58	0.55
Lysine (%)	1.3	1.2	1.15
Metabolizable energy (Kcal/kg)	2870	2950	3000

Experimental Design

At the start of the study, birds were divided into three batches: a control batch (T), two experimental batches (batch A and batch B), and each batch was subdivided into 3 sub-batches to allow repetition of each treatment:

- Control batch: made up of 69 birds receiving standard minerals (OLIGOPHOS®) in drinking water as positive controls, with the day of administration depending on prophylaxis,
- Batch A: Consisting of 69 birds not receiving standard minerals, but supplemented with Peck A pecking stone served ad-libitum throughout the cycle;
- Batch B: Consisting of 69 birds not receiving standard minerals but supplemented with Peck B, served ad-libitum throughout the cycle.

Each sub-lot was evenly distributed throughout the henhouse.

Data Collection and Studied Parameters

Growth performance

Data were collected every 7 days on feed intake, live weight, weight gain and feed conversion ratio. Feed was weighed and distributed to the animals daily and at the end of each week, the left overs were collected then weighed. Feed intake was calculated as the difference between the quantity served and the left over in each experimental unit. At the beginning of the trial and every 7 days thereafter, birds in each experimental unit were weighed and weekly weight gain was calculated as the difference between two consecutive week's weights. Feed conversion ratio (FCR) was calculated as the ratio of the amount of feed intake during the week and the weight gain of the same week.

Carcass characteristics

At 49 days old, 12 chickens (6 males and 6 females) per treatment were randomly selected and submitted to a 24-hour fasting, then weighed, sacrificed, plucked and eviscerated for carcass evaluation (Kana et al., 2015). The relative weight of each organ (gizzard, liver, heart, legs, etc.) was respectively calculated by dividing the weight of carcass or that of corresponding organs by the live body weight of the bird.

Evaluating the quantity of mineral block pecked

The amount of mineral block pecked by the subjects was compared between Batch A exposed to the Peck A pecking stone and Batch B exposed to the Peck B pecking stone. This amount was determined by taking the difference between the weight of the starting block (Week 4) and that at the end of the trial (Week 7). The different pecking stones were weighed per week and per sub-batch.

Biochemical determination of minerals: Ca, K and Na

Blood sampling was carried out at the end of the experimental cycle, in the 7th week (49 days old), on 36 birds at the time of slaughter, including 4 birds per sub-batch taken at random. These determinations were carried out as describe by Abdel-Fattah et al. (2008)

Evaluation of feed production costs

The evaluation of the feed production cost per kg live weight considered the average feed conversion ratio for each treatment during the growth and finishing periods (4^{th} and 7^{th} week) and the price per kg feed. The feed cost per kg live weight of chicken was estimated by multiplying the price per kg feed by the feed conversion ratio (FCR) defined as the ratio of feed consumed to weight gain for the same period.

$Cx\ (Fcfa) = \mathrm{FCR}x * Px\ (Fcfa)$

With: Cx: cost per kg live weight (Fcfa); FCRx: feed conversion ratio; Px: Price per kg diet (Fcfa); x: period considered.

Data analysis

Data on feed intake, live weight, feed conversion ratio, biochemical parameters and carcass characteristics were submitted to one-way analysis of variance (ANOVA). When there was a significant difference between treatments, Duncan's multiple range test at a 5% threshold was used to separate means. SPSS 20.0 (Statistical Package of Social Sciences) software was used for the analyses.

RESULTS AND DISCUSSIONS

Feed consumption

Individual feed consumption (Table 4) did not differ significantly ($p>0.05$) between the different batches from Week 4 to Week 7, although the highest values were recorded with batch B (Peck B).

These observations are similar to those reported by Pizzolante et al. (2007), on the different levels of calcium in Japanese quail aged 54, 39 and 45 to 57 weeks, respectively, who observed no influence on food consumption. This is because the ingredients used to make these blocks do not significantly improve the taste of the diets.

Table 4. Individual feed consumption according to treatments (IFC)

Age (In weeks)	Individual food consumption (means ± standard deviation)			
	Batch Control	Batch A	Batch B	*p*-value
4^{th} Week	677.67^a±18.60	677.99^a±21.25	681.67^a±19.95	0.964
5^{th} Week	726.91^a±19.36	726.91^a±19.36	738.09^a±0.00	0.630
6^{th} Week	923.88^a±24.61	923.88^a±24.61	938.09^a±0.00	0.630
7^{th} Week	797.25^a±21.24	797.25^a±21.24	809.52^a±0.00	0.630
IFC Average	**781.43^a±20.95**	**781.51^a±21.62**	**791.84^a±4.98**	**0.720**

a, b: Means followed by different letters within the same line are significantly different

Weight growth

Growth rate and live weights

The evolution of the Average Daily Gain (ADG) according to the treatment (Figure 1) shows that the ADG was not significantly influenced ($p>0.05$) by the use of the pecking blocks. However, although no significant difference was observed, the mean ADG of batch A (41.25±2.97g) and batch B (42.56±1.79g) were higher than that of the control batch.

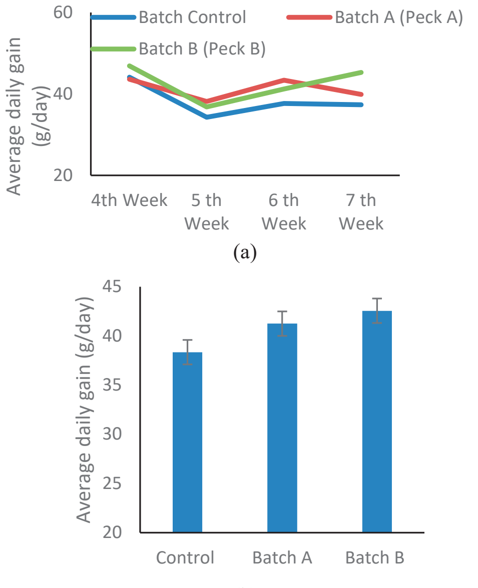

Figure 1. Average daily gain according to treatments

The data on the evolution of the average live weight of the subjects in relation to age and treatment (Table 5) show that no significant difference ($p>0.05$) was recorded between the batches during growth (4th and 5th week). On the other hand, the mineral supplements (Peck A and Peck B) significantly ($p<0.05$) influenced the live weight of the animals at week 7. The live weights of batches A and B remained comparable and significantly ($p<0.05$) higher than that of the control batch.
The live weight values recorded are higher than those of Gbodo (2021) in Benin, who obtained live weights of 1407.5 g and 1592.75 g at 8 weeks of age by incorporating oyster shells and eggshells respectively into the broiler ration. This difference would be due to an imbalance of ingredients in the feed formulation caused by the incorporation of calcium sources such as oyster shells and eggshells directly into the basic broiler ration. Indeed, it has been reported by Bao & Choct (2009) that phosphorus in the form of phytic acid (contained in large quantity in minerals of plant origin) is poorly utilized, and phytic acid also reduces the bioavailability of calcium (Ca). Consequently, practical diets fed to broilers are always deficient in calcium and phosphorus (P) unless supplemented with inorganic salts. This is why it is necessary to formulate a fully-fledged source of mineral intake that can be used as a feed supplement.

Table 5. Effect of pecking stone on live weight of chickens

Age (weeks)	Live weights in grams (mean ± standard deviation)			
	Batch Control	Batch A	Batch B	P
4th	825.22^{a}±37.85	811.52^{a}±13.24	848.16^{a}±53.89	0.540
5 th	1065.16^{a}±36.04	1078.62^{a}±31.26	1105.87^{a}±33.79	0.383
6 th	1328.85^{a}±40.28	1415.63^{a}±57.19	1405.26^{a}±81.30	0.251
7 th	1680.47^{a}±50.58	1694.58^{a,b}±16.29	1755.77^{b}±31.64	0.048

a, b: Means followed by different letters within the same line are significantly different.

Feed conversion ratio

The feed conversion ratio (FCR) of broilers in the different batches as a function of age (Figure 1a) did not vary significantly ($p>0.05$) from week 4 to week 7. However, the average feed conversion of batches A and B (Figure 1b) remained comparable and significantly ($p<0.05$) lower than that of the control batch.

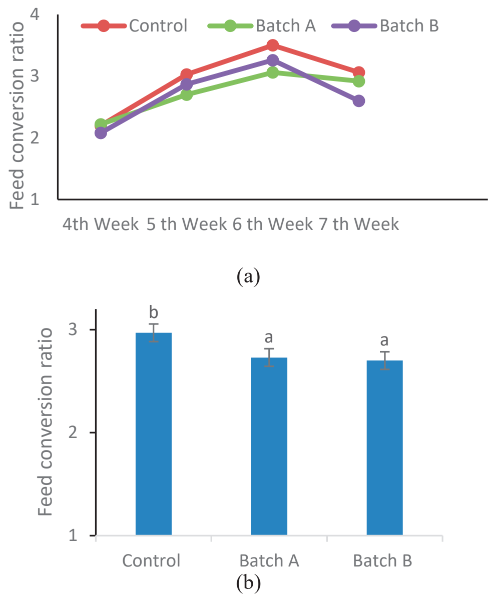

Figure 2. Feed conversion ratio according to treatments

These results do not corroborate those of Sultana et al (2007), who investigated the effects of calcium sources and levels, but found no significant difference in the feed conversion ratio. The lower feed conversion rate recorded in these studies with the use of pecking stones would be linked to their composition and texture, which would improve diet degradation and digestive utilization capacity of nutrients.

Aviagen (2012) also reports that if live weight gain correlates with feed intake, then higher feed intake improves feed conversion rate because the required slaughter weight is reached more quickly.

Carcass weight, yield and relative organ weights

The results for carcass weight and yield (Table 6) show that the carcass weight of the chickens increased significantly with the use of mineral supplements (Peck A and Peck B). The carcass weights of batch A (1443.41±29.05) and batch B (1466.66±25.81) remained similar and significantly ($p<0.05$) higher than those of the control batch. However, carcass yield was not significantly ($p>0.05$) influenced by the use of mineral supplements.

Table 6. Effect of pecking stone on carcass yield

	Carcass weight and yield (averages ± standard deviation)			
Parameters	Batch Control	Batch A	Batch B	*P*
Carcass weight (g)	1379.83^{a}± 40	1443.41^{a,b}± 29	1466.66 ^{b}±25.81	0.03
Yield (%)	81.00^{a} ±2	80.33^{a} ±1.52	79.66^{a} ±3.21	0.79

a, b: Means followed by different letters within the same line are significantly different

Various organs weighed at slaughter according to treatment (Table 7) show that, apart from liver weight, which increased significantly ($p<0.05$) with the use of mineral supplement pecking blocks, no significant difference ($p>0.05$) was recorded between the relative weight of different organs irrespective of treatment.

These results are not in line with those recorded by Makinde et al. (2013); Attia et al. (2013). The block proportions used in this work would not influence the relative proportions of the organs.

Table 7. Relative weight of organs according to treatment

Organs	Traitments	Means±SD	*P*
Heart	Control batch	9.08^{a}±0.87	0.645
	Batch A (Peck A)	9.08^{a}±0.52	
	Batch B (Peck B)	9.50^{a}±0.25	
Liver	Control batch	30.25^{a}±0.75	0.001
	Batch A (Peck A)	33.08^{b}±0.62	
	Batch B (Peck B)	36.25^{c}±1.50	
Gizzard	Control batch	40.00^{a}±1.08	0.492
	Batch A (Peck A)	38.91^{a}±2.50	
	Batch B (Peck B)	40.58^{a}±0.76	
Abdominal fat	Control batch	22.58^{a}±2.12	0.068
	Batch A (Peck A)	18.08^{a}±2.32	
	Batch B (Peck B)	21.41^{a}±1.18	
Intestinal mass	Control batch	221.58^{a}±10.75	0.817
	Batch A (Peck A)	221.83^{a}±4.01	
	Batch B (Peck B)	226.50^{a}±14.05	
Legs	Control batch	84.58^{a}±3.75	0.205
	Batch A (Peck A)	90.50^{a}±7.39	
	Batch B (Peck B)	92.75^{a}±2.81	
Head	Control batch	43.00^{a}±0.75	0.390
	Batch A (Peck A)	44.08^{a}±1.62	
	Batch B (Peck B)	45.16^{a}±2.51	

a, b: Means followed by different letters within the same column for the same organ are significantly different ($p<0.05$).

Effects of the pecking stone on some biochemical parameters

The plasma concentration of the three minerals measured (Table 8) shows a significant increase ($p<0.05$) in plasma concentration in batches receiving the pecking block compared to the control. Plasma concentrations of sodium and potassium, on the other hand, remained comparable irrespective of treatment, although the highest values were obtained with the batch receiving Peck B mineral supplement (127.35±22.01 mEq/L and 7.27±1.94 mEq/L for sodium and potassium respectively).

Table 8. Plasma mineral concentrations in chickens

Plasma Concentrations	Treatments	Mean ± SD	Minimum	Maximum	*P*
Sodium (mEq/L)	Control batch	106.60^{a}±21.53	72.72	144.79	0.097
	Batch A	116.59^{a}±24.43	82.00	159.92	
	Batch B	127.35^{a}±22.01	94.20	164,64	
Potassium (mEq/L)	Control batch	6.82^{a}± 1.98	3.53	11.02	0.844
	Batch A	7.07^{a}± 1.74	3.83	9.30	
	Batch B	7.27^{a}± 1.94	4.53	11.51	
Calcium (mg/L)	Control batch	75.40^{a}± 4.47	67.8	83.5	**0.011**
	Batch A	80.19^{b}± 4.61	72.4	89.5	
	Batch B	80.90^{b}± 4.62	73.3	87.7	

a, b: Means followed by different letters within the same column for the same parameter are significantly different ($p<0.05$).

Plasma calcium concentration increased significantly ($p<0.05$) in chickens fed mineral supplements (Peck A and Peck B), and fell within the ranges recommended by Fontaine (1992) and Campbell (2004), which are 88-240 mEq/L and 80-110 mEq/L respectively. It is also comparable to those reported by Gbodo (2021), which are 81.78-91.91 mEq/L. Thus, this increase in blood calcium levels in Batch A and B compared with the Control Batch would be due to the ingredients making up the pecking blocks. Bone meal, oyster shells and calcium carbonate are the by-products that are essentially rich in calcium. Eggshell contains 95.6% of the mineral calcium carbonate, while bone meal contains 85.5% of the mineral (Pion, 1970). In addition, given the extraction and statistical distribution of variables according to the treatment elucidated by Principal component analysis (PCA), calcium (Ca), sodium (Na) and potassium (K) measured in this trial are strongly associated with Batch A and B, unlike the Control Batch. This strong association may be due to the ad-libitum supplementation of Batch A and B subjects, which would have favored the progressive assimilation of these minerals, which constitute the Peck A and B pecking stones.

In addition, although no significant differences ($p>0.05$) were recorded in sodium and potassium concentrations. Chickens supplemented with Peck A and Peck B pecking stones nevertheless showed higher blood sodium and potassium levels than chickens in the control batch. Thus, the Sodium value is lower than that proposed by authors such as Fontaine (1992) and Campbell (2004). This could be explained on the one hand by the low proportion (15%) of salt (NaCl) incorporated at the time of formulation of the pecking stones and on the other hand it has been reported by Nedjoua (2013) that vegetable feed is largely deficient in sodium, but rich in potassium. Furthermore, Bao & Choct (2009) report that there is little to worry about in terms of practical Na and Cl deficiency in chickens. Hence, there is no need to incorporate a high proportion of salt in their feed.

Effects of pecking stone on feed production costs

Evaluation of the production feed cost per kilogram live weight of broilers as a function of treatment during growth and finishing (Table 9) shows that Peck A and Peck B feed supplements significantly ($p<0.05$) influenced the production feed cost of broilers in the finishing phase.

Results concerning the production feed cost per kilogram live weight of chickens supplemented or not with pecking stone show that the lowest feed costs were recorded with the batches receiving mineral supplements (Peck A and Peck B).

Table 9. Production feed costs according to treatments

PFC (CFAF) per kg of live weight	LOTS			*p*
	Control batch	Batch A (Peck A)	Batch B (Peck B)	
Growth	1098.63[a]	1040[a]	1041.5[a]	0.148
Finishing	1186.46[b]	1142.10[a]	1121.19[a]	0.024

a, b: Means followed by different letters within the same line for the same growth phase are significantly different ($p<0.05$). PFC: Production feed cost.

This could be explained by the fact that the supplements had a significant effect ($p<0.05$) between treatments on the feed conversion ratio, which in turn influenced the food cost of producing one kg of chicken live weight. In fact, the similarity of the feed conversion ratio of batches A and B, combined with its strong representation on the control batch, probably reflects the improved feed conversion of chickens supplemented with Peck A and Peck B pecking stones.

CONCLUSIONS

At the end of this study on the effect of the pecking stone-based feed supplement on zootechnical performance and some blood minerals in COBB 500 broilers, it was found that live weight gain and feed conversion ratio were significantly improved by the use of pecking blocks in growing-finishing broilers. Feed consumption, average daily gain, carcass yield and relative organ weights were not significantly influenced by the use of pecking blocks. Carcass weight, plasma concentration of calcium and feed production cost of growing-finishing broilers were significantly improved by the use of pecking stones. Although the results of this study are satisfactory with peck A and peck B pecking stones, it would be desirable to carry out a similar study on other poultry strains, such as layers, in order to assess the impact of such a feed supplement on their production performance.

ACKNOWLEDGEMENTS

The authors are please to thank the University of Ngaoundere and Agricultural Research

Institute for Development of Wakwa where some analysis was carried out.

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