NSAP 47th Annual Conference (JOS 2022) CONFERENCE PROCEEDINGS
THEME: SECURING ANIMAL AGRICULTURE AMIDST GLOBAL CHALLENGES

# EFFECTS OF DIETARY SILICON OXIDE LEVELS ON GROWTH PERFORMANCE AND FEET WELFARE OF BROILER CHICKS

**[*]Opoola, E., [**]Lawal, A. N and [**]Oyebanji, O. A.**
**[*]Department of Animal Science. Ahmadu Bello University, Zaria**
**[**]Kabba College of Agriculture, Ahmadu Bello University**

**emmycom123@yahoo.com**

**Abstract**
This experiment was conducted to evaluate the effect of silicon oxide supplementation on growth performance of broiler chicks reared from 0 to 21 days. A total of 120 mixed sex day-old chicks were allocated to 12 pens and assigned to 4 dietary treatments with three replicates in a Completely Randomized Design. Treatments were as follows: Treatment A was basal diet without silicon oxide supplement; Treatment B was basal diet supplemented with 10mg silicon oxide/100kg diet; Treatment C was basal diet supplemented with 20mg silicon oxide /100kg diet and Treatment D was basal diet supplemented with 30mg silicon oxide/100kg diet silicon oxide. Dietary treatments had significant ($P<0.05$) differences on feed intake (FI), body weight gain (BWG), feed conversion ratio (FCR) and feed cost per kg weight gain.Wet litter was not observed across the treatment groups. Hence, no footpad dermatitis and toe damage was noticed. Chicks fed 20g silicon oxide/100kg diet had the best results for weight gain and feed conversion ratio.

**Keywords:**Silicon oxide, performance, footpad dermatitis, toe damage

## INTRODUCTION

Supplementation of trace minerals in poultry diets are important to avoid deficiencies that cause disturbances in metabolic processes including loss of appetite, lower performance, impaired immune system, and reproductive disorders (Van der Klis and Kemme, 2002).Trace minerals including silicon (Si), manganese (Mn), copper (Cu) and zinc (Zn) are essential in various body functions and optimal growth and health (Aksu *et al*., 2011). In commercial diets, inorganic trace minerals are typically used at levels higher than recommended by National Research Council (Inal *et al*., 2001) due to abundance and low cost. Feeding nutrient and mineral dense diets to broilers to maximize performance may result in excessive mineral excretion (Aksu *et al*., 2011). Supplementation with high levels of inorganic trace minerals may be harmful to the environment and wasteful to the cost of operation.Over the last decade silicon has been recognized as an essential trace element participating in the normal metabolism of higher animals. More recent in vivo studies have demonstrated that silicon plays an important role in connective tissue, especially in bone and cartilage (Burton *et al*., 2020). A study by Trans *et al*. (2015), Trans *et al*. (2015) showed that adding Silica+ to feed significantly improves animal growth performance and litter quality. Footpad dermatitis and toe damage are common in broiler chickens (Burton *et al*., 2020). However, silica increases dissolved oxygen in water and therefore helps reduce ammonia in litter and manure making the problems of footpad dermatitis and toe damage minimal. A research conducted by Trans *et al*. (2015) showed that the inclusion of 200 ppm of Silica+ supplement in feed significantly improved weight gain and FCR in turkey production,

offering potential economic benefits to turkey producers. Therefore, this study aimed at evaluating the inclusion of silicon oxide in the diets of broiler chickens on their performance, footpad dermatitis and toe damage.

## Materials and Methods

### Birds and management

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm of Kabba College of Agriculture, Ahmadu Bello University, Kabba, Kogi state, Nigeria. In this experiment, 120, one-day old, mixed sex broiler chicks of *Abor acre* strain were allotted to 4 dietary treatments in a Completely Randomized Design. Each treatment was replicated 3 times with 10 chicks per replicate. The chicks were reared on deep litter system with pens measuring 1.5 x 1.5m. Heat and light were provided throughout the brooding period. Birds were housed in an environmentally controlled room initially maintained at 35°C and provided with 12 hours light daily and water *ad libitum*. Routine vaccinations and all necessary medications were administered as and when due. The diets were isocaloric (3010(Kcal/kg) and isonitrogenous (23.10%) and formulated to meet or exceed the nutrient requirements according to the National Research Council requirements (1994) for broiler starter phase (Table 1). The treatments were administered at level of 0.00, 10, 20 and 30mg silicon oxide/100kg diet to make up the 4 dietary treatments. The proximate analyses of the diets are shown in Table 2 and were determined according to the Association of Official Analytical Chemists (AOAC, 1990).

**Table1:** Ingredients composition of broiler starter diets containing graded levels of silicon oxide

| **Ingredient** | **Silicon oxide (mg)** | | | |
|---|---|---|---|---|
| | **0.00** | **10.00** | **20.00** | **30.00** |
| Maize | 52.80 | 52.80 | 52.80 | 52.80 |
| Groundnut cake | 13.74 | 13.74 | 13.74 | 13.74 |
| Soya cake | 28.00 | 28.00 | 28.00 | 28.00 |
| Palm oil | 1.20 | 1.20 | 1.20 | 1.20 |
| Limestone | 0.50 | 0.50 | 0.50 | 0.50 |
| Bone meal | 2.80 | 2.80 | 2.80 | 2.80 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix ** | 0.30 | 0.30 | 0.30 | 0.30 |
| Lysine | 0.18 | 0.18 | 0.18 | 0.18 |
| Methionine | 0.18 | 0.18 | 0.18 | 0.18 |
| Silicon oxide (mg) | 0.00 | 10.00 | 20.00 | 30.00 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |
| **Calculated Analysis** | | | | |
| ME (Kcal/kg) | 3010 | 3010 | 3010 | 3010 |
| Crude protein (%) | 23.10 | 23.10 | 23.10 | 23.10 |
| Ether extract (%) | 5.84 | 5.84 | 5.84 | 5.84 |
| Crude fibre (%) | 3.73 | 3.73 | 3.73 | 3.73 |
| Calcium (%) | 1.33 | 1.33 | 1.33 | 1.33 |
| Lysine (%) | 1.28 | 1.28 | 1.28 | 1.28 |
| Methionine (%) | 0.80 | 0.80 | 0.80 | 0.80 |

| | | | | |
|---|---|---|---|---|
| Available P (%) | 0.83 | 0.83 | 0.83 | 0.83 |
| TSAA (%) | 0.85 | 0.85 | 0.85 | 0.85 |

Total sulfur amino acid =TSSA, Try = Tryptophan; P=Phosphorus; ME=Metabolizable energy;**Biomix Premix Supplied per kg of diet: Vit. A, 10,000iu; Vit.$D_3$, 2000iu; Vit E, 23mg;Vit. K, 2mg: Vit.B1,1.8; Vit. $B_2$, 5.5mg; Niacin, 27.5mg; Pantothenic acid, 7.5mg; Vit. $B_{12}$, 0.015mg: Folic acid, 0.75mg; Biotin, 0.06mg; Choline Chloride, 300mg; Cobalt, 0.2mg; Copper, 3mg; Iodine, 1 mg; Iron, 20mg; Manganese, 40mg; Selenium, 0.2mg; Zinc, 30mg; Antioxidant, 1.25mg.

**Performance parameters**

At the end of the experiment (0-21 days), the weight gain, feed intake and feed conversion ratio were calculated. The birds, the offered feed and the feed residue were weighed at the beginning and end of the experiment (0-21 days). Mortality was recorded daily for the correction of performance parameters.

Welfare scores

On day21 footpad dermatitis was scored according to Bilgili *et al.* (2006) where 0 indicated no lesions, 1 indicated mild irritation, and 2 indicated severe irritation. Toe damage included broken toes or nail was scored similarly to keel blisters as present (1) or not present (0).

**Statistical analysis**

Data were analysed using the General Linear Model Procedures (GLM) of the Statistical Analysis Software package. Significant differences between treatments means were separated using Duncan Multiple Range Test (SAS 2001).

**Experimental Model**

$Y_{ij} = \mu + T_i + e_{ij}$

$Y_{ij}$ = performance of $j^{th}$ animal fed $i^{th}$ levels of silicon oxide inclusion

$\mu$ = Overall mean

$T_i$= $i^{th}$ effect of treatment at varying levels of silicon oxide inclusion

$e_{ij}$= Random residual error

**Results and discussion**

The proximate composition of broiler starter diet is shown in Table 1. Table 3 shows the effects silicon oxide supplementation on growth performance in the starter period (0–21days). It was observed that dietary treatments had significant ($P<0.05$) effects on weight gain, average daily weight gain (ADWG), feed conversion ratio (FCR) and feed cost per kg gain. Dietary treatments had no significant ($P>0.05$) effects on feed intake and mortality. Chicks fed 20mg silicon oxide/100kg diet had the best results in terms of weight gain, ADWG, feed cost per kg gain and FCR. Also, during the 1 to 21 days period, there was a strong tendency for higher performance for chicks fed silicon oxide supplemented diets compared to broiler chicks fed diet without silicon oxide or with low silicon oxide supplementations. The results of this study agree with the findings of Burton *et al* (2020) who reported a significant increase in both body weight gain (BWG; $P = 0.045$) and feed intake (FI; $P = 0.037$) in response to silicon supplementation, but no effect on feed conversion ratio (FCR). The significant increase in growth up to day 21 observed in study was surprising as, although studies have commonly observed reduced growth rates of birds fed artificially low Silicon diets (Seaborn and Nielsen, 1994). This improvement in performance in response to bio-available silicon supplementation suggested that modern strains of broiler chickens may be silicon deficient when fed a standard broiler diet (Burton *et al*., 2020).

Furthermore, it is accepted that rapid growth of modern broiler strains has increased requirements for a number of nutrients, compared with the strains used 30 years ago, lending support to the theory that the requirement for bio-available silicon may have increased beyond the amount naturally supplied in commercial diets (Burton *et al*., 2020; Applegate and Angel, 2014). In addition, silica is known to dissolve oxygen in water and therefore helps reduce ammonia in litter and manure (Scholey *et al*., 2018). There were no or little observable differences across the treatment groups in relation to the wetness of litter. Hence, there was no observable footpad dermatitis and toe damage in all the treatment groups.

**Table2:** Proximate composition of broiler starter diet

| Nutrients | % or (Per cent composition) |
|---|---|
| DM | 92.24 |
| Crude Protein | 22.86 |
| Crude Fibre | 6.97 |
| Ether Extract | 4.67 |
| Ash | 6.56 |
| Nitrogen Free Extract | 51.18 |

**Table 3: Performance of Broiler Chicks fed Graded Levels of Silicon oxide Supplemented Diets**

| | Levels if silicon supplementation (mg/100kg) | | | | |
|---|---|---|---|---|---|
| Parameters | 0.00 | 10 | 20 | 30 | SEM |
| Initial weight (g) | 45.01 | 45.00 | 45.34 | 45.01 | 0.38 |
| Final weight(g) | 999.99$^{c}$ | 1172.67$^{b}$ | 1286.00$^{a}$ | 1001.63$^{c}$ | 9.33 |
| Weight Gain (g) | 954.99$^{c}$ | 1127.66$^{b}$ | 1239.66$^{a}$ | 956.62$^{b}$ | 9.26 |
| Ave daily gain (g) | 34.11$^{c}$ | 40.27$^{b}$ | 44.27$^{a}$ | 34.17$^{c}$ | 0.33 |
| Feed Intake (g) | 1996.33 | 1958.00 | 1893.33 | 2002.33 | 19.44 |
| Feed Intake (g/b/d) | 71.30 | 69.93 | 67.62 | 71.52 | 0.69 |
| FCR | 2.09$^{c}$ | 1.74$^{b}$ | 1.53$^{a}$ | 2.08$^{c}$ | 0.03 |
| Feed cost/kg gain (₦/kg) | 104.12$^{b}$ | 93.63$^{a}$ | 89.93$^{a}$ | 122.77$^{c}$ | 0.76 |
| Mortality (%) | 1.41 | 1.75 | 0.00 | 0.00 | 0.64 |

$^{a, b,c}$ = Means with different superscripts on the same row differ significantly (P<0.05)
SEM = Standard Error of Means
FCR = Feed conversion ratio

**Conclusion and recommendation**

In the course of the study, broiler chickens fed 0.20mg silicon oxide /100kg diet had the highest weight gain, the best feed conversion ratio and feed cost per kg weight gain. However, further studies should be conducted on the effect of silicon oxide on apparent nutrient digestibility and bone mineralization of broiler chickens.

## References

Aksu, D. T., Aksu, M..,Yoruk, M. and Karaoglu, M.(2011). Effects of organically-complexed minerals on meat quality in chickens. *Journal of Animal Science*. 52:558–563.

A.O.A.C. (1990).Association of Official Analytical Chemists.Official Methods of Analysis, 15th Ed.Washington, D.C.

Applegate, T. J. and R. Angel. (2014). "Nutrient Requirements of Poultry Publication: History and Need for an Update." *The Journal of Applied Poultry Research* 23 (3): 567–575. doi:10.3382/japr.2014-00980.

Bilgili S.F., Alley M.A., Hess J.B, and Nagaraj, M. (2006). Influence of age and sex on footpad quality and yield in broiler chickens reared on low and high density diets. *Journal of Applied Poultry Research*. 15: 433–441.

Burton , E. J., Scholey, D. V. Belton, D. J. Bedford,M. R. and Perry, C. C. (2020). Efficacy and stability of a novel silica supplement for improving bone development in broilers. *British Poultry Science*. 61(6); 719-724.

Inal, F., Coskun, B., G¨ul¸sen, N. and Kurto˘glu, V. (2001). The effects of withdrawal of vitamin and trace mineral supplements from layer diets on egg yield and trace mineral composition. *British Poultry Science*.42:77–80.

National Research Council (NRC), (1994).Nutrient Requirements of Poultry.9th rev. ed. National Academic Press, Washington, DC.

SAS, (2001).SAS User's Guide Version 6.11. SAS Institute, Inc. Cary, NC.

.

Seaborn, C. D, and Nielsen, F. H.(1994). "Effects of Germanium and Silicon on Bone Mineralization." Biological Trace Element Research 42: 151–164. doi:10.1007/BF02785386.

Scholey, D.V., Belton,D.J. and Burton, E. J. (2018). Bioavailability of a novel form of silicon supplement. *Scientific Report*.8,17022. https://doi.org/10.1038/s41598-018-35292-9

Tran S.T., Bowman M.E. and, Smith T.K. (2015).Effects of a silica-based feed supplement on performance, health and litter quality of growing turkeys. *Poultry Science*. 94:1902-1908. https://doi.org/10.3382/ps/pev158.

Van der Klis, J. D., and Kemme P. A. (2002). An appraisal of traceelements: inorganic and organic. Pages 99–108 in Poultry Feedstuffs:Supply, Composition, and Nutritive Value. J. M. McNab,and K. N. Boorman, eds. CAB Int., Wallingford, UK.