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# THE EVALUATION OF THE IMPACT OF ADDITIVES ON PROXIMATE & MINERAL CONSTITUENTS OF PIG DUNG FOR SUSTAINABLE PIG PRODUCTION

[1]ANUKAM K.U., [1]NKWOCHA, G.A., [2]PRUDENT, O.I. AND [3]Nwachukwu, M.O.

[1]Department of Animal Production and Health Technology, Imo State Polytechnic, Umuagwo, Ohaji, PMB 1472, Owerri, Nigeria.

[2]Department of Agricultural Technology, School of Science Tech, Bayelsa State College of Arts and Science, Yenagoa, Nigeria.

[3]Department of Biology, Parasitology and Entomology Unit, Federal University of Technology, Owerri, Nigeria.

Corresponding author: * Nkwocha, G.A.
Tel.: +…. Email: geffmacnkwo@gmail.com

**ABSTRACT:**

This study was carried out at the Teaching and Research Farm of the Federal University of Technology, Owerri, Imo State, Nigeria to evaluate the effects of additives on proximate and mineral composition of pig dung. Dung were collected fresh from three different piggery farms in Imo State, homogenized at the experimental site and stored for 48 hours for bacterial activities. The treatment involved four chemicals which included borax, carbide, Dry cell battery and kerosene applied at three concentration levels of 50, 100 and 150 g respectively. The proximate and mineral analysis of the treated and untreated pig dung were assayed for the determination of the crude protein, the ether extract, ash, moisture content, crude fibre and nitrogen free extracts while the minerals evaluated are the calcium, sodium, magnesium, potassium and phosphorus.

Data were subjected to analysis of variance (ANOVA), at 5% probability level. The result of the study indicated that the chemical treatment of the pig dung decreased the crude protein content and hence reduced the generation and release of green house gases into the environment. Moreover, moderate correlations observed from the additives indicated that increase in the concentration of borax, carbide and kerosene will not reduce the presence of these macro and micro elements in the dung thus fertility of the soil when applied is ensured. It is therefore concluded that additives can be used in the swine industry to solve monumental waste challenges since after treatment, the bioavailability of nutrients notably nitrogen, potassium and phosphorus are not negatively affected. It was therefore recommended that additives be used to solve monumental waste challenges in the swine industry.

**KEYWORDS:** Additives, proximate composition, mineral constituents, pig dung.

## Introduction

Pig production in the last two decades has witnessed tremendous growth due to the adoption of modern scientific practices and the application of genetic principles in the breeding line and this has directly increased the volume of waste generated therein inadvertently causing environmental pollution (Kwasny et al., 2011; Nkwocha and Anukam, 2012).

Pork production as a major enterprise has monumental waste treatment challenges. However, in under-developing countries like Nigeria, the challenge becomes more paramount especially where integration of livestock and crop production system are not practicable. In an integrated system, the manure from livestock can be recycled as source of plant nutrient and soil amendments, in a cost-effective and environmentally sound manner (Babcock, 1998). Pig manure improves soil quality and promotes carbon sequestration by building or maintaining organic matter (FAO, 2001). In most developing countries, pig operators does not possess the financial muscle to buy reasonable landed property so as to manage the waste emanating from the piggery and hence contributes to the production of green house gases.

The obnoxious odour and pathogenic agents emanating from pig dung or slurry is becoming a very big threat to human and animal health. Thus, there are strict regulations being considered by governments even to the extent of closing down piggery farms due to the fear of environmental pollution (Hunt and Vanotti, 2001; Okoli et al., 2004).

Pig dung is a raw material which, if treated inadequately may pose a serious hazard to the environment, but it also constitutes a substrate for obtaining various products. To increase its fertilizer effectiveness, pig dung are treated with additives to convert readily degradable compounds into more stable and more useful aromatic substances. This reduces the adverse effect of manure on the environment vis –a-vis additional value to the by-product.

Different additives have been used in the treatment of pig waste notably digestive additive, acidifying additives, base precipitating salt, labile carbon, absorbents, urease inhibitors, disinfectants etc (Bertora et al., 2008). Nevertheless, the impact of these additives on the waste products especially on the nutrient assay is still dearth.

Closure of some pig farms due to environmental pollution would tantamount to shortage of animal protein and its associated malnutrition problems. There is therefore the need to research practicable local technologies for odor control in the Nigerian pig industry.

## Materials and Methods

### Study location

The experiment was carried out at the Teaching and Research Farm of the Federal University of Technology, Owerri, and Imo State, Nigeria. Federal University of Technology, Owerri lies between latitude$05^{o}21^{1}$ and $05^{o}42^{1}$N and longitudes $07^{o}45^{1}$ and $06^{o}53^{1}$E. The ---SW of tropical rain forest zone with average annual rainfall distribution of 2,250-2800mm. The annual temperature ranges 26-30oC with annual relative humidity range of 85-90% (NMA, 2011).

### Waste preparation and Treatment application

Dung (slurry) was collected from local pig farms, mixed properly and allowed to stand for a two day pre-treatment period after collection to allow bacterial activities. The equipment used for the collection includes plastic buckets, thermometer, pH meter, weighing balance and meter rule. The treatment involved four chemicals which included borax, carbide, Dry cell battery and kerosene applied at three concentration levels of 50, 100 and 150 g respectively. Each treatment was replicated three times. Each replicate was mixed with 2 kg of the pig dung, thus having nine buckets for each chemical and one specific control of 0g of each chemical for each treatment (Table 1).

The bacteria load change in the pig dung was analyzed on the $2^{nd}$, $4^{th}$ and $6^{th}$ day after the treatments. Samples from each treatment bucket were collected using sterile bottles and subjected to bacterial culture.

### Procedure for Bacterial Culture

### Bacterial culture

The special inoculation plate count was employed, Davidsohn et al., 1982 for the quantitative enumeration of microbial population of the fecal sample (pig dung).

Adopting strict aseptic precautions, 1ml of each (homogenized dung slurry) specimen was transferred into 99ml of 0.85% normal saline dilution bottle to obtained 1.100 dilution was taken and transferred into another 99ml dilution bottle to produce 1:10,000 dilution of sample.

This was continued with 1ml of 1.10, 000 to obtain 1:1,000,000 dilution of sample after which 15mls of sterilized melted agar (culture medium) cooled to 45oc was aseptically introduced into the 1ml of the sample contained in a sterile petridish, carefully mixed by gentle rotation and allowed to solidity, then incubated at 37oc for 24 to 48hrs. Following this incubation, culture agar plates containing bacterial colonies mere obtained.

### Isolation/Identification

Isolation/Identification on nutrient agar plate for discrete colonies was done and sub culturing for pure cultures carried out for use in bacterial identification on the basis of their cultural and morphological characteristics.

Accordingly each isolate was subjected to standard biochemical tests according to methods by cappuccino and Sharman (1983), as well as carbohydrate utilization fermentation tests. Final identification of the isolates was accomplished by marching with the cultural characteristics of known taxa using Buchanen and Gibbon (1974), and Cowan and steel (1974).

### Proximate and Mineral analysis of treated and untreated faecal samples

The proximate and mineral analysis of the treated and untreated pig dung was carried out at standard Animal nutrition Laboratory and compositional components assayed are the crude protein, the ether extract, ash, moisture content, crude fibre and nitrogen free extracts while the minerals are the calcium, sodium, magnesium, potassium and phosphorus.

**Table 1. Experimental treatments**

| **Chemicals.** | | **Concentration level** |
|---|---|---|
| Borax | | |
| $B_0$ | | 0g (control) |
| $B_1$ | = | 50g |
| $B_2$ | | 100g |
| $B_3$ | | 150g |
| Carbide | | |
| C | = | 0g (Control) |
| $C_1$ | = | 50g |
| $C_2$ | = | 100g |
| $C_3$ | = | 150g |
| Dry cell battery | | |
| D | = | 0g (Control) |
| $D_1$ | = | 50g |
| $D_2$ | = | 100g |
| $D_3$ | = | 150g |
| Kerosene | | |
| K | = | 0ml (0g) (Control) |
| $K_1$ | = | 110ml (50g) |
| $K_2$ | = | 220ml (100g) |
| $K_3$ | = | 330ml (150g) |

## Results and Discussion

### Proximate and mineral composition changes in additives treated dung

The results of the proximate compositions of the treated and untreated pig dung (Tables 2), indicated that there was a wide variation in the trend of the result. Dry cell battery treated dung recorded the highest protein content of 13.51% followed by Borax and carbide which recorded 10.92 and 10.86% in that order. Kerosene recorded the highest Ash and fibre content of 38.66% and 11.70% respectively.

Carbide recorded the highest nitrogen free extract (NFE) Value of 30.78% followed by Dry cell battery which pulled 28.02%. NFE is an indication of the carbohydrate status of the tested samples. The inability of the Dry cell battery to reduce the odour emanating from the pig dung may be attributed to the high production of volatile compounds notably, indole and skatole, which are generated from the breakdown of tryptophan (Varel *et al.,* 1997). The highest crude protein level of 19.2% was recorded by the untreated dung. The result of the study indicated that the chemical treatment of the pig dung decreased the crude protein content and hence reduced the generation and release of green house gases into the environment. However, according to Bertora *et al.*, (2008) excess amount of nitrogen and phosphorus compounds discharged into the environment if not reduced causes environmental pollution due to chemical and biochemical transformations by anaerobic bacteria.

Again, carbide and Borax reduced the ash contents from the 59.28% recorded in the control to the range of 34.36 – 39.03 recorded in the carbide and dry cell battery treated dung respectively indicating the utilization of minerals in the chemical processes that took place during the treatment. Similar results were obtained for the ether extract component of the results.

The level of free sugars in the treated dung was highest in the carbide ($T_3$) (30.78) followed by the dry cell battery (28.02) and borax (26.07) while kerosene (19.61) was the least when compared to the untreated dung (control) which recorded 22.11 but statistically ($P>0.05$) similar with the control experiment. Generally, the level of free sugars in both the treated and untreated pig dung is very low and this prevented the early emergence of enzymes needed to break down the more complex carbohydrates in the pig waste (Taiganaides, 1998).

Okoli *et al.* (2005a) and Carcre *et al.,* (2009) reported similar significant reductions in the concentrations of crude protein, ash and ether extract levels as well as phosphorous in the pig dung digester from biogas production.

Table 3 showed the result of the mineral constituents of the treated and untreated pig dung. The highest calcium content was recorded by Dry cell battery (5.32%) followed by the untreated dung (4.60%). The least value was recorded by borax. These results, which indicated almost 50% reduction in phosphorous content of the treated dung is in agreement with the results earlier reported by Okoli *et al.* (2005a). The reduction in the phosphorous content of the treated dung again renders it more environmentally friendly since excessive phosphorous in animal dung used as fertilizer has been shown to contaminate underground water (Okoli *et al*., 2005a and b). Nevertheless, primary calcium phosphate ($ca(H_2PO_4)2$, is an ingredient of plant fertilizers. Phosphates are important to metabolism in both plants and animals. Bones contain calcium phosphate, $Ca_3(Po_4)_2$, and the first step in the oxidation of glucose in the body is the formation of a phosphate ester.

**Table 2.0: Proximate composition of the treated and untreated pig dung (%)**

| Parameters | Dry cell battery | Borax | Carbide | Kerosene | Untreated | SEM |
|---|---|---|---|---|---|---|
| Moisture | 10.76[b] | 11.06[b] | 11.29[b] | 13.32[a] | 6.01[c] | 1.56 |
| Ash | 37.41[b] | 39.03[b] | 34.36[b] | 38.66 | 59.28[a] | 5.76 |
| Ether Extract | 1.90[b] | 1.62[b] | 1.51[b] | 7.40[a] | 0.48[c] | 1.59 |
| Crude Fibre | 8.41[b] | 1.30[c] | 11.20[a] | 11.70[a] | 10.20[a] | 0.77 |
| Crude Protein | 13.51[b] | 10.92[c] | 10.86[c] | 9.31[c] | 19.20[d] | 2.54 |
| Nitrogen Free Extract | 28.02[b] | 26.07[b] | 30.78[a] | 19.61[c] | 22.11[c] | 2.59 |

[abc]** Means in the same column having different letters differs significantly.*

## Correlation of mineral composition in additive treated dung

Correlations of mineral composition in additive treated dung were shown in tables 3.0 - 3.5. Data on the dry cell battery showed that as the level of ash increased, there was a reduction in the level of calcium.

From the findings, it appears that the use of the dry cell battery in controlling odour from pig dung has to be regulated since increase in the ash content reduces the level of calcium in the dung.

Calcium plays many roles in the structure and metabolism of plants (Verma, 2000). Maintaining $ca^{2+}$ ions within fairly narrow limits in the dung treated with Dry cell battery would imply that the concentration level of the dry cell battery should not exceed 150g/2000g of the pig dung to discourage excessive production of the ash which has negative effect on calcium.

Moderate Variations were observed when Ash was correlated with other minerals ($Na_2$-, P, K and Mg); Tables 3.0 - 3.5. This indicates that increase in the concentration of borax, carbide and kerosene will not reduce the presence of these macro and micro elements in the dung thus fertility of the soil when applied would be ensured.

**Table 3.0: Mineral constituent (Mg/100g) of the treated and untreated pig dung.**

| Mineral (%) | Dry cell battery | Borax | Carbide | Kerosene | Untreated | SEM |
|---|---|---|---|---|---|---|
| Calcium | 5.32[c] | 3.92[b] | 4.56[a] | 4.12[b] | 4.60[a] | 0.31 |
| Sodium | 0.048[b] | 0.154[a] | 0.054[b] | 0.037[b] | 0.024[b] | 0.03 |
| Magnesium | 0.586[c] | 1.121[b] | 2.616[a] | 0.861[c] | 0.024[d] | 0.56 |
| Potassium | 0.138 | 0.122 | 0.134 | 0.091 | 0.110 | 0.01 |
| Phosphorus | 0.012 | 0.011 | 0.011 | 0.006 | 0.022 | 0.00 |

[abc] ** Means in the same column having different letters differs significantly.*

**Table 3.1: Correlating Ash to Ca**

| | | *C.V (%)* | | | *Ranking* |
|---|---|---|---|---|---|
| Sample | √ | $\surd^2$ | Ca | Ash | Ca/Ash |
| Dry cell battery | +0.292 | 0.085 | 5.32 | 37.41 | Little Variation |
| Borax | +1.000 | 1.000 | 3.92 | 39.03 | Moderate Variation |
| Carbide | +0.999 | 0.999 | 4.56 | 34.36 | Moderate Variation |
| Kerosene | +1.000 | 1.000 | 4.12 | 38.66 | Moderate Variation |
| Neutral | +1.000 | 1.000 | 4.60 | 59.28 | Moderate Variation |

*Key: C.V = Coefficient of Variation; V = correlation coefficient; $\surd^2$ = Regression Ca = Calcium.*

**Table 3.2: Correlating Ash to Na**

| | | *C.V (%)* | | | *Ranking* |
|---|---|---|---|---|---|
| Samples | √ | √2 | Na | Ash | Na/ Ash |
| Dry cell battery | +1.015 | 1.3030 | 0.048 | 37.41 | Moderate Variation |
| Borax | +0.990 | 0.999 | 0.154 | 39.03 | Moderate Variation |
| Carbide | +1.007 | 1.014 | 0.054 | 38.66 | Moderate Variation |
| Kerosene | +0.997 | 0.995 | 0.037 | 38.66 | Moderate Variation |
| Neutral | +1.073 | 1.151 | 0.024 | 59.28 | Moderate Variation |

*Key: C.V = Coefficient of Variation; V = correlation coefficient; $\surd^2$ = Regression Ca = Calcium.*

**Table 3.3: Correlating Ash to Mg**

| | C.V (%) | | | | Ranking |
|---|---|---|---|---|---|
| Samples | √ | √2 | mg | Ash | Mg /Ash |
| Dry call battery | +0.999 | 0.999 | 0.586 | 37.41 | Moderate Variation |
| Borax | +1.000 | 0.999 | 1.121 | 39.03 | Moderate Variation |
| Carbide | +1.000 | 1.000 | 2.616 | 34.36 | Moderate Variation |
| Kerosene | +1.037 | 1.075 | 0.861 | 38.66 | Moderate Variation |
| Neutral | +0.994 | 0.988 | 0.903 | 59.28 | Moderate Variation |

*Key: C.V = Coefficient of Variation; V = correlation coefficient; $\sqrt{}^2$ = Regression Ca = Calcium*

**Table 3.4: Correlating Ash to K**

| | *C.V (%)* | | | | *Ranking* |
|---|---|---|---|---|---|
| Samples | √ | √2 | k | Ash | K Ash |
| Dry cell battery | +1.001 | 1.002 | 0.138 | 37.41 | Moderate Variation |
| Borax | +1.000 | 1.000 | 0.122 | 39.03 | Moderate Variation |
| Carbide | +0.999 | 0.997 | 0.134 | 34.36 | Moderate Variation |
| Kerosene | +1.002 | 1.004 | 0.091 | 38.66 | Moderate Variation |
| Neutral | +0.999 | 0.998 | 0.110 | 59.28 | Moderate Variation |

**Table 3.5: Correlating Ash to P**

| | C.V (%) | | | | Ranking |
|---|---|---|---|---|---|
| Samples | √ | $\sqrt{}^2$ | p | Ash | P / Ash |
| Dry cell battery | +1.o19 | 1.038 | 0.012 | 37.41 | Moderate Variation |
| Borax | +1.003 | 1.006 | 0.011 | 39.03 | Moderate Variation |
| Carbide | +0.998 | 0.996 | 0.011 | 34.36 | Moderate Variation |
| Kerosene | +0.997 | 0.993 | 0.006 | 38.06 | Moderate Variation |
| Neutral | +0.996 | 0.993 | 0.022 | 59.28 | Moderate Variation |

# CONCLUSION

**Additives can be used in the swine industry to solve monumental waste challenges since after treatment, the bioavailability of nutrients notably nitrogen, potassium and phosphorus are not negatively affected.**

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