



(RESEARCH ARTICLE)



## The physico-chemical characteristics of fresh and old pig dungs collected from three pig farms in Port Harcourt Metropolis

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### Abstract

The need to source for alternative use of pigs dung to reduce environmental challenges arising from its application as farm manure prompted the study into the physico-chemical attributes of both the fresh and old pig dung in three pig farms (A,R,U) in Port-Harcourt metropolis. The study examined the pH levels, exchangeable nitrate, extractable phosphate, the total organic carbon and the sulphate using methods described by the pH meter, APHA-4500-O3-B, ASTM D515, Walkley black and ASTM D516 respectively. The results indicated that the dung were alkaline ranging from pH 9-12, the nitrate content was high in fresh dung (16.03-19.40) but considerably low in the dry dung (2.36-2.92), the phosphate values were between 7.59-20.81, the sulphate level falls within 1.84-3.79 whereas the total organic carbon were between 2.36-2.92. The result obtained have showed that the fresh dung could be supplemented with other organic substrate to initiate bioremediation of crude oil polluted soil due to its high nitrate content and the dry dung used as feedstuffs for animal nutrients or feedstock for bioenergy generation because of its high fibre content which will help in reducing the ecosystem contamination by pig waste through recycling.

**Keywords:** Pigs Dung; Environmental Contamination; Alternative Use; Physic-Chemical Attributes; Recycling

### 1. Introduction

Pork meat has been dubbed “the other white meat”. There is an increase demand for pork meat due to health issues as most people are advised not to consume red meat because of its many health complications. In order to meet up with the rising demand of pork meat, a commensurate expansion and establishment of piggeries has been seen especially in Nigeria which is in line with Food and Agricultural Organization [1] report that pork meat still remains the most popularly consumed and also a well-sort-out meat worldwide, particularly in Africa[2]. In recent times, Nigerian farmers have rapidly embraced the business of rising pigs as an avenue of financial upliftment due to its lucrative and prolific nature. Accordingly, Cole *et al.* (2000) and Spencer *et al.* (2008) reported the rearing of animals on relatively small land areas i.e. animals raised in captivity or the use of Confined Animal Feeding Operations (CAFO) has given rise to the increase in accumulation and the need to get rid of large amounts of animal dung [3,4]. Animal wastes were regarded as valuable fertilizer resources for more than 75 years ago inclusive of pig wastes. Constantini *et al.* (2007) demonstrated that animal production creates a lot of potential nuisances like odors, flies, noise, antimicrobial agents and vast amount of manure (poorly composted) [5]. Apparently, the application of these manure on farmlands have been considered a worldwide practice which adds to the pollution of the environment (soil and water). With the advent of intensive animal production systems, the animal wastes were regarded as pollutants and nuisances as they contain lots of nutrients which leads to eutrophication and pollution of ground water sources.

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The uneven or disproportionate influence of these manures in the environment cannot be quantified, but in the few past years, animal wastes have been recognized as valuable resources for use as farm inputs for plant growth, as feedstuffs and also as feedstock for energy due to the usual high fibre content and frequently high levels of non-proteinous nitrogen wastes.

## 2. Material and methods

### 2.1. Study Area of Research

This investigation was carried out in three (3) local government areas in Port Harcourt meteropolis, Rivers State; the three (3) piggeries houses were selected based on the willingness of the operators to participate.

### 2.2. Collection of Pig Dung and Manure

The fresh morning pig dung were collected along the pens and aseptically transferred into sterile bottles. Also, some quantities of the dumped manure waste (old dung) were collected aseptically from the deposit site and transferred into sterile bottles which were already labeled appropriately. The samples were then transported to the laboratory in an ice chest for determination of the physico-chemical attributes of the samples [6].

### 2.3. Physico-Chemical Analyses of Pig dungs

The physico-chemical characteristics of both the fresh and old pig dungs were evaluated to ascertain the nutrients for alternative use. The subsequent variables were analysed; pH, total organic carbon (TOC), extractable phosphate ( $\text{PO}_4^{3-}$ ), exchangeable nitrate ( $\text{NO}_3^-$ ) and sulphate ( $\text{SO}_4^{2-}$ ) using methods described by [7,8,9,10] and ASTM D516 respectively.

### 2.4. Determination of the Total Organic Carbon Content (Walkey Black Method)

This approach determines the level of oxidizable carbon which could react with potassium dichromate (vi) and tetraoxosulphate (vi) acid in samples. The residual chromate is determined spectrophotometrically at 600 nm wavelength by calculating the organic carbon content based on organic matter containing 58 % carbon. A standard curve was first prepared by measuring 0-8 mg of sucrose in different centrifuge tubes. Subsequently, 2.0 ml of 10%  $\text{K}_2\text{Cr}_2\text{O}_7$  (0.3M) solution and 5.0 ml  $\text{H}_2\text{SO}_4$  were added. The mixture was permitted to cool and stand for 30 minutes before 18mls of distilled water (DW) was dispensed into the tubes. Then, the pig dung sample was prepared by weighing out 1g of the dung into Erlenmeyer flask. Two milliliters of 10 % (0.34M)  $\text{K}_2\text{Cr}_2\text{O}_7$  solution was dispensed to 5milliliters of  $\text{H}_2\text{SO}_4$  and allowed to cool for 30 minutes. In the mixture, 20 milliliters of DW was added and allowed to stand overnight. The absorbance of the calibrated standard and the sample (pig dung) was read in a spectrophotometer set at 600 nm wavelength [8].

The percentage (%) of the total organic carbon was determined by calculating

$$\% \text{Oc} = \frac{\text{MgC}_{\text{samples}} - \text{MgC}_{\text{blank}}}{W \text{ (mg)}}$$

where %Oc=Organic carbon of the dung (%)  
 $\text{MgC}_{\text{samples}}$ =Analyte/concentration of C in dung  
 $\text{MgC}_{\text{blank}}$ =Analyte/concentration of C in blank  
 W=Mass of the dried sample (mg)

### 2.5. Determination of Extractable Phosphate using American Society for Testing and Materials (ASTM) D515 Method

This method was used in assessment of a unique form of phosphorus in the samples. The diammonium molybdate and potassium antimonyl tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony phosphor-molybdate complex. This complex is lowered to an intensely blue colored complex by ascorbic acid. The color is proportional to the phosphorus content in the sample. Firstly, the dung sample pH was adjusted to  $7 \pm 0.2$  using a pH meter. To that sample, 8.0 ml of combined reagent of 50 ml of 5N  $\text{H}_2\text{SO}_4$ , 5 ml of antimony potassium tartrate solution, 15 ml of ammonium molybdate solution and 30 ml of ascorbic acid solution were introduced, after addition of each reagent and the mixture was allowed to reach room temperature before it is mixed thoroughly to avoid formation of turbidity. Then, about 10 minutes, the color absorbance of each sample was measured at 650 nm with a spectrophotometer using the reagent blank as the reference solution. Then a calibration curve was prepared using a

straight line of absorbance against phosphorus concentration. The concentration value of sample was extrapolated or deduced from the prepared standard curve and reported as P, mg/l [9].

## 2.6. Determination of Exchangeable Nitrate using American Public Health Association (APHA)-4500-NO<sub>3</sub>-B Method

The technique was used to screen samples with low organic matter contents. To 1g of the sample, fifty milliliters (50 ml) of distilled water was dispensed, the solution formed was then filtered and to the filtrate 1ml of Hydrochloric acid solution was added and mixed vigorously. NO<sub>3</sub><sup>-</sup> calibration was prepared using ranges from 0 to 7 mg NO<sub>3</sub><sup>-</sup>-N/L by diluting to 50 ml to the following volumes of intermediate nitrate solution in order to obtain the standard curve. The absorbance was read using a spectrophotometer at 360nm and was blanked, tried again with water at zero absorbance and at wavelength 220nm to obtain NO<sub>3</sub><sup>-</sup> concentration and also at 275nm to determine inference from organics. For the samples and standards, two times the absorbance reading at 275nm and the reading at 220nm was subtracted to obtain absorbance due to NO<sub>3</sub><sup>-</sup> in the sample against the standard. Using corrected sample absorbance, the sample concentrations is obtained from extrapolation from the standard [10].

## 2.7. Determination of pH

The pH was determined by adopting the method described by association of analytical chemists [11]. The air-dried dung was separated using a ¼ inch mesh-sieve. The 30 g of the sample was weighed into a glass beaker. Also, 30 ml of distilled water was added to produce a slurry. The dung solution was allowed to stand for one hour and intermediately stirred every 10-15 minutes to allow the pH of the sample slurry to stand for a while. After one hour, the temperature of the substance was stabilized, measured and adjusted to the temperature controller of the pH meter using standard solution, the pH meter was standardized and the pH electrode(s) inserted into the sample slurry making sure that the slurry is in contact with the electrodes. The electrodes were allowed to be immersed for at least 30 seconds before the reading was taken. The pH value was recorded to the nearest tenth of a whole number [7].

## 2.8. Determination of Sulphate Level Using American Society for Testing and Materials (ASTM) D516 Method

The sample was prepared by sieving through ¼ inch material sieve. One gram of the sample was dispersed in a beaker with 25 ml of water. Then the mixture was swirled to ensure uniformity. While swirling, 5 ml of HCL was added and diluted immediately to 50 ml before digested for 15 min. The suspension was filtered and the residue was washed thoroughly with hot water. Then the filtrate was diluted to approximately 300 ml. A blank was run for the sample using same procedure as for the standard measurement of barium chloride turbidity of the sample and the standard was done. Thereafter, the correct reading was obtained by subtracting the blank reading from that obtained for the sample and then the sulphate was calculated as stated below;

$$\text{Concentration of SO}_4(\text{mg/Kg}) = \frac{\text{M(g) of SO}_4 \times 3000}{\text{Volume of the sample}}$$

## 3. Results

### 3.1. Physico-chemical composition of pig waste

The physico-chemical composition of pig waste obtained from the three (3) study locations in Rivers State as presented in Table 1. The pH of the fresh pig dung from Oyigbo Local Government (site A) was 9.33 while the pH of the dry dung from the same location was 11.47. Nitrate content of the fresh pig dung from the Site A was 17.27 mg/kg while the dry dung had a nitrate content of 3.64 mg/kg. The sulphate contents of the fresh and dry dung were 2.79 and 2.9 mg/kg respectively. Phosphate content of the fresh dung sample from the same farm was 16.05 mg/kg while the dry form had 16.86 mg/kg phosphate. The TOC had values of 2.52 and 2.69 mg/kg respectively for both fresh and dry pig dungs in site A. The fresh dung samples obtained from a farm in Aluu (Site U) had a pH of 9.35 while the dry form of the dung had a pH of 11.37. The nitrate contents of the fresh and dry pig dung were 16.03 and 3.52 mg/kg respectively. The sulphate content of the fresh pig dung was 1.84 mg/kg while the dry form had sulphate content of 2.60 mg/kg. The phosphate content of the fresh dung was 7.57 mg/kg while the dry dung had a phosphorous concentration of 6.22mg/kg. The total organic carbon of the fresh pig dung for the site U was 2.36 while the dry form had a TOC of 2.89mg/kg. Pig dung obtained from a farm in Rumuodumaya (site R) had pH values of 10.06 and 12.10 respectively for fresh and dry forms. The nitrate compositions of the fresh pig dung samples from the site R was 19.40 mg/kg while the dry dung had a nitrate content of 3.495 mg/kg. The sulphate content of the samples was 3.79 and 2.88 mg/kg for the fresh and dry samples respectively. The phosphate composition of the fresh and dry dung were 20.81 and 22.07 mg/kg while, Total organic carbon contents for the fresh and dry dung were 2.92 and 2.88 mg/kg respectively.

**Table 1** Physicochemical composition the Pig Dung obtained from various pig farms in Rivers State

Sample	pH	SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub>	PO <sub>4</sub> <sup>3-</sup>	TOC
A-Fresh	9.33±0.02 <sup>a</sup>	2.79±0.03 <sup>c</sup>	17.27±0.05 <sup>d</sup>	16.05±0.02 <sup>c</sup>	2.52±0.01 <sup>b</sup>
A-Dry	11.47±0.05 <sup>b</sup>	2.9±0.02 <sup>c</sup>	3.64±0.01 <sup>b</sup>	16.86±0.01 <sup>d</sup>	2.69±0.01 <sup>c</sup>
U-Fresh	9.35±0.05 <sup>a</sup>	1.84±0.04 <sup>a</sup>	16.03±0.02 <sup>c</sup>	7.57±0.01 <sup>b</sup>	2.36±0.01 <sup>a</sup>
U-Dry	11.37±0.28 <sup>b</sup>	2.60±0.01 <sup>b</sup>	3.52±0.02 <sup>a</sup>	6.22±0.01 <sup>a</sup>	2.89±0.01 <sup>d</sup>
R-Fresh	10.06±0.02 <sup>a</sup>	3.79±0.04 <sup>c</sup>	19.40±0.02 <sup>c</sup>	20.81±0.01 <sup>e</sup>	2.92±0.01 <sup>d</sup>
R-Dry	12.10±0.03 <sup>b</sup>	2.88±0.01 <sup>d</sup>	3.495±0.01 <sup>a</sup>	22.07±0.01 <sup>c</sup>	2.88±0.00 <sup>d</sup>

Key: Data represent the mean ± Standard Error (n=2); similar/ same superscripts indicates no significant variance between the parameters in the same column while different superscripts suggests a significant difference between the parameters within the same column at p-value < 0.05. A= Oyigbo site; R=Rumuodumaya site; U= Aluu site; TOC = Total Organic Carbon; SO<sub>4</sub><sup>2-</sup>=Sulphate; Nitrate = NO<sub>3</sub>; Phosphate =PO<sub>4</sub><sup>3-</sup>

#### 4. Discussion

Pig dung and other waste associated with pig farming or piggeries have been identified by a number of scholarly works as being a veritable tool for a number of agricultural biotechnological and industrial purposes which was evident in this study. The current study identified that the pH of the fresh dung from sites A, R and U were 9.33, 10.06 and 9.35 while the pH of the dry forms of the pig dung were 11.43, 12.10 and 11.37. The data obtained show that the dried form was more alkaline than the fresh ones. The significant variation in the pH of the dry and fresh dung is an indication of loss of some functional groups such as carbonyl and amino compounds. This trend is in tandem with the report of Huang *et al.* (2017) who identified that the swine manure which composed primarily of the dung had pH 6.63 which he compared with the chicken and cattle manure which had pH of 7.86 and 7.73 respectively [12]. In a related study, Dhawan and Kaur (2002) reported a range of pH of 8.03 to 9.24 in their separate investigations for the pig dung [13]. Antezana *et al.* (2015) further reported the pig slurries they obtained in Spain had a pH of 7.66 and suggested that concentration of volatile fatty acids has the tendency of altering the pH of the pig dung in its dry form which is in proximity with the alkaline range of pH reported in the dry form [14]. The report of Mofokeng *et al.* (2016) identified a pH range of 6.5 to 9.0 for a 6-month study they carried out on an effluent consisting of fresh rich dung from a piggery [15]. The process of hydrolysis, drying and oxidation of bonds could have led to reduction in pH of an agro-residue or manure [16,17]. In a related study Prata and Lavorenti (2000) observed that increasing the pH of agro-wastes used as manures can help in increased absorption of its nutrients by plants in the soil and also aid in neutralizing the effects of herbicidal residues in the soil [18].

Pigs being omnivorous animal utilize elemental components that constitute its feed which indicates the nutrients components [19]. In this study, sulphate content in the fresh and dry dung obtained from the study area ranged from 1.84 and 2.60 mg/kg for Site U and from 2.79 and 2.9 mg/kg for site A. In Site R, the sulphate concentration of the fresh and dry dung ranged from 3.79mg/kg and 2.88mg/kg. The nitrate content of the pig dung obtained from site A were 17.27 and 3.64 mg/kg for fresh and dry pig dung and the fresh dung sample obtained from location R had a nitrate concentration of 19.40 mg/kg while the dry dung had 3.495 mg/kg. For Site U, nitrate concentrations of 16.03mg/kg and 3.52mg/kg were obtained respectively for both fresh and dry pig dung. The concentration of nitrates suggests the presence of high protein diets given to the pigs as well as the presence of organic nitrogen which is usually derived from the animal gut microboita, intestinal linings and undigested plant cell constituent [20] thus, reflecting the digestion inefficiency of the crude protein in the rudimentary of the animal [21]. The findings in this study agreed with the report of Kowalski *et al.* (2013) whose investigations identify the dynamics in the properties of the pig manure [22]. In their study, changes in the physicochemical attributes of pig dung were attributed to the loss of the volatile components of the pig dung. The level of these nutrients as observed in the assessed animal dung could be as a result of the variability of feed, rearing technologies and feeding practices stated in [23] as the feed component of a given animal also indicate the nature and richness of the waste and its nutrients. The TOC had values of 2.52 and 2.69 mg/kg respectively for both fresh and dry pig dung in site A, 2.36 mg/kg and 2.89 mg/kg accordingly for Site U while for site R, TOC levels were 2.92 mg/kg and 2.88mg/kg respectively. The study identified that the phosphate content of the fresh dung from site A, R, and U were 16.05, 20.81 and 7.57 while dry dungs were 16.86, 22.07 and 6.22mg/kg respectively. A high increase in total organic carbon is a clear indication of enhanced biomass and diversity of dung microflora which could be used as agents of bioaugmentation in soils undergoing bioremediation. Due to the increased organic nutrients in pigs dung, their discharge to the environment without recycling will tends to pollute the land, resulting in excessive accumulation of nitrogen and phosphorus which also can be toxic to plants. While the oxides of nitrogen and carbon may also contribute

to the level of greenhouse gases within the atmosphere, due to high nitrogen and carbon content in the waste which agreed with earlier results obtained by Okoli et.al.,2011 [24]. Wang and Zhang (2016) in their study of the physicochemical properties of red soil affected by organic manure observed it also had a buffering effect on the soil qualities due to its veritable nutrients; indicating also that the pig dung also will cushion the same conditioning effect on red soil when applied [25].

Certain nutrients such as nitrate, phosphate, potassium and sulphate concentrations in animal droppings quite function as limiting nutrients in biotechnological processes. The nutrient composition of the pig dung buttresses the point that it is a veritable nutrient resource which is significantly different from both fresh and dry forms for diverse environmental purpose, and if not properly handled could impact on the pathogen vector-disease transmission, eutrophication, aesthetic loss of farm site and disease spread as it has been showed to be a conducive breeding place for multiple microbial activities.

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## 5. Conclusion

In this work, we have showed that the high nutrient webbed in pig waste could be a breeding ground for multiple microbial activities, eutrophication, pathogen disease transmission and other environmental crisis. Its alternative use as agents of bioaugmentation when mixed with other organic materials, feedstuffs for animal nutrients especially in aquaculture, feedstock for bioenergy generation will ensure its recycling and can help solve the burden created by its direct disposal into the environment.

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## Compliance with ethical standards

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### *Conflict of interest*

The authors of this paper do not have any financial relation with any company, agricultural sectors that might lead to a conflict of interest for any of the authors.

### *Statement of ethical approval*

The experiment was carried out in the various pig farms with the approval of the relevant authorities.

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