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Effect of organic and inorganic manure on the nutritional value and heavy metal uptake of upland rice in Imo State Nigeria

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ABSTRACT

A research was conducted to assess the nutritional value and heavy metal uptake of upland rice grown using organic and inorganic fertilizer on an *Ultisol* at the Centre for Agricultural Research and Extension, Federal University of Technology, Owerri. The experiment comprised of Control (Cl), Urea (Ua) at 400kg.ha^{-1}, Rumen digesta (Rd), Poultry dropping (Pd) and Pig slurry (Ps) at the rate of 40t.ha^{-1} each. The 5 treatments were replicated five times to give a total of 25 plots. Each plot measured 2×2 m with a 1 m alley between plots. The test crop was CP 306 upland rice variety. The proximate analysis and heavy metal content of the rice grain were conducted. The experiment was laid out in a randomized complete block design. The data resulting from the experiment was subjected to analysis of variance (ANOVA) and significant differences were separated using fisher's least significant difference at P = 0.05. The nutritional value of the rice (%Mc, %Fat, %Protein, %Fiber, %Ash and, %CHO) showed significant difference when the control was compared with the treatments and when the treatments were compared with one another. The rice grown on pig slurry treated plot had the highest value of % Mc, %Fat, %Protein, %Ash and significantly higher concentration of CHO while the largest % Fiber content was recorded from the rice grain grown on urea fertilizer. The heavy metal content of the rice grain also showed significant difference when the control was compared with the treatments and when the treatments were compared with one another. Relative comparison of these metals with standards showed that none of them were present in concentrations exceeding the permissible limits.

Keywords: Manure, Nutrition, Heavy metal, Uptake, Upland rice

1. INTRODUCTION

Rice (*Oryza sativa* L.) is a major dietary component of people in most countries of the world and it is highly consumed in Nigeria. It is usually consumed as a whole grain after cooking, and in a regular Nigerian diet, can contribute 40 to 80% of the total calorie intake. Being a major cereal grain, evaluating the nutritional qualities of rice has been given highest priority (Tan *et al*., 1999; FAO, 2004; Jiang *et al*., 2005; Dong *et al*., 2007). The nutritional value of rice varies with different varieties, soil fertility, fertilizer application and other environmental conditions. Therefore a critical comparison of rice grain cultivated using different sources of manures on soil of same parent material with a view to determining their nutritional worth and advising farmers and consumers accordingly is of paramount importance.

Soil, air and water pollution are contributors to the presence of harmful elements, such as Cadmium, Lead, Selenium etc in food stuffs (Zukowska*, et al*., 2008), similarly, the use of fertilizers and other farm inputs could also contribute to the presence of heavy metals in soil and consequently in food products. Heavy metals occur as natural constituents of earth crust and are persistent environmental contaminants since they cannot be easily degraded or destroyed (Ioan *et al*., 2008). However, these heavy metals become toxic when they do not get metabolized by the body and end up accumulating in the soft tissue (Otitoju *et al*., 2014). Digestion is the most common route of exposure to heavy metals. In plants, uptake of heavy metals depends on the plant species and bio-availability of the metal in the soils. Heavy metals enter the body system through food, air and water and bio-accumulate over a period of time (Duruibe *et al*., 2007). Once they enter the food chain, large concentrations of heavy metals may accumulate in the human body. If the metals are ingested beyond the permitted concentration, they can cause serious health disorders (Babel *et al*., 2004) which can seriously deplete some essential nutrients in the body causing a decrease in immunological defenses, intrauterine growth retardation, disabilities associated with malnutrition and a high prevalence of upper gastrointestinal cancer (Otitoju *et al*., 2014).

The objectives of this study were therefore; to evaluate the effect of organic and inorganic manure on the nutritional value and heavy metal uptake of upland rice in Imo state Nigeria.

2. MATERIALS AND METHOD

A. Description of Study Area

The study was conducted at the Centre for Agricultural Research and Extension (CARE) of the Federal University of Technology Owerri (Fig. 2). CARE is situated in FUTO which is bounded by the communities of Eziobodo, Umuchima, Ihiagwa, and Obinze. The study site lies in the high rainfall humid tropics located between latitude 5° 22^{I}N and longitude 6° 59^{I}E with elevation of 55m above sea level. It has a mean annual rainfall of between 1800 - 2,500 mm and mean temperature range of 27^{0}C – 30^{0}C. The rainfall pattern is bimodal with peaks in the months of July and September, and short dry spell in the month of August, known as August break. The hydrology of the area is governed by Otamiri River. The main vegetation of the area is rainforest which has been reduced to secondary plant due to anthropogenic activities.

B. Land preparation

Materials used in the field included;

Matchet, spade, hoe, core sampler, masking tape, net, scare crow, insecticide, herbicide, polythene bags, book, auger, Global Positioning System (GPS). Land preparation was done as by ploughing and harrowing using farm tools. Sunken beds were made using hand hoes.

C. Experimental Layout

The experiment was laid out in Randomized Complete Block Design (RCBD) Fig.3. Each plot measured 2×2 m and 1m alley within plots and within blocks. A total of 14×14 m size of land was used for the research.

D. Treatments Application

Urea was sourced from FUTO Farms Ltd, Rumen digesta was sourced from Obinze Abattoir in Owerri West L. G. A and Poultry dropping was sourced from FUTO Farms Ltd while Pig slurry was sourced from Doorway Farms in Ubowalla Emekuku, Owerri North L.G.A. The treatments were applied 2weeks before seeding except the urea which was applied 2 weeks after germination. The treatments were allocated to the plots randomly and a total of 5 treatments with 5 replicates were used. The treatments comprised of;

Control (Cl) (no treatment applied)
Urea (Ua) at 800 kg.ha^{-1}
Rumen digester (Rd) at 40 t.ha^{-1}
Poultry droppings (Pd) at 40 t.ha^{-1}
Pig slurry (Ps) at 40 t.ha^{-1}

E. The Test Crop

The test crop was CP 306 upland rice. CP 306 was sourced from Ebonyi State Agricultural Development Program (EBADP).The rice seedlings were sown directly by dibbling at a seed rate of 60Kg/ha. Thinning was done 3 weeks after germination (WAG) to maintain 3 stands per hole and a planting distance of 30cm within row and 25cm between row spacing with a plant population of 399,999 stands per hectare. The farm received 2inches of irrigation water per/day to give about 60cm water penetration into the soil using 3arm rotary sprinkler system. Irrigation application continued until after dough stage of the seed formation. No water was applied during the grain drying. Weeding of the farm was done manually as frequently as the need arose.

F. Yield and Yield Components

Grain yield weight were obtained by harvesting rice from one meter square area in each of the plots and then weighed. The paddy was then adjusted to 14% moisture content using the formula in equation 1, and then the grain weight for each plot was recorded and converted into t.ha^{-1} as described by Gomez (1972).

$$\text{Adjusted grain yield} = (A \text{ x } W) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \, equ\ (1)$$

$$\text{Adjusted Coefficient Computed by A} = \frac{100-M}{86} \ldots\ldots\ldots\ldots\ldots \text{equ (2)}$$

Where A is adjustment coefficient, M is the moisture content (%) of the harvested grains and W is the weight of the harvested grains.

G. Moisture Content (%)

Moisture content was determined by Gravimetric Method described by AOAC (1990) and calculated as follows:

$$\text{Moisture Content (\%)} = \frac{W2-W3}{W2-W1} \text{ x } \frac{100}{1} \ldots\ldots\ldots\ldots\ldots \text{equ (3)}$$

Where

W_1 = weight of empty moisture can
W_2 = weight of empty can + sample before drying
W_3 = weight of can + sample dried to constant weight.

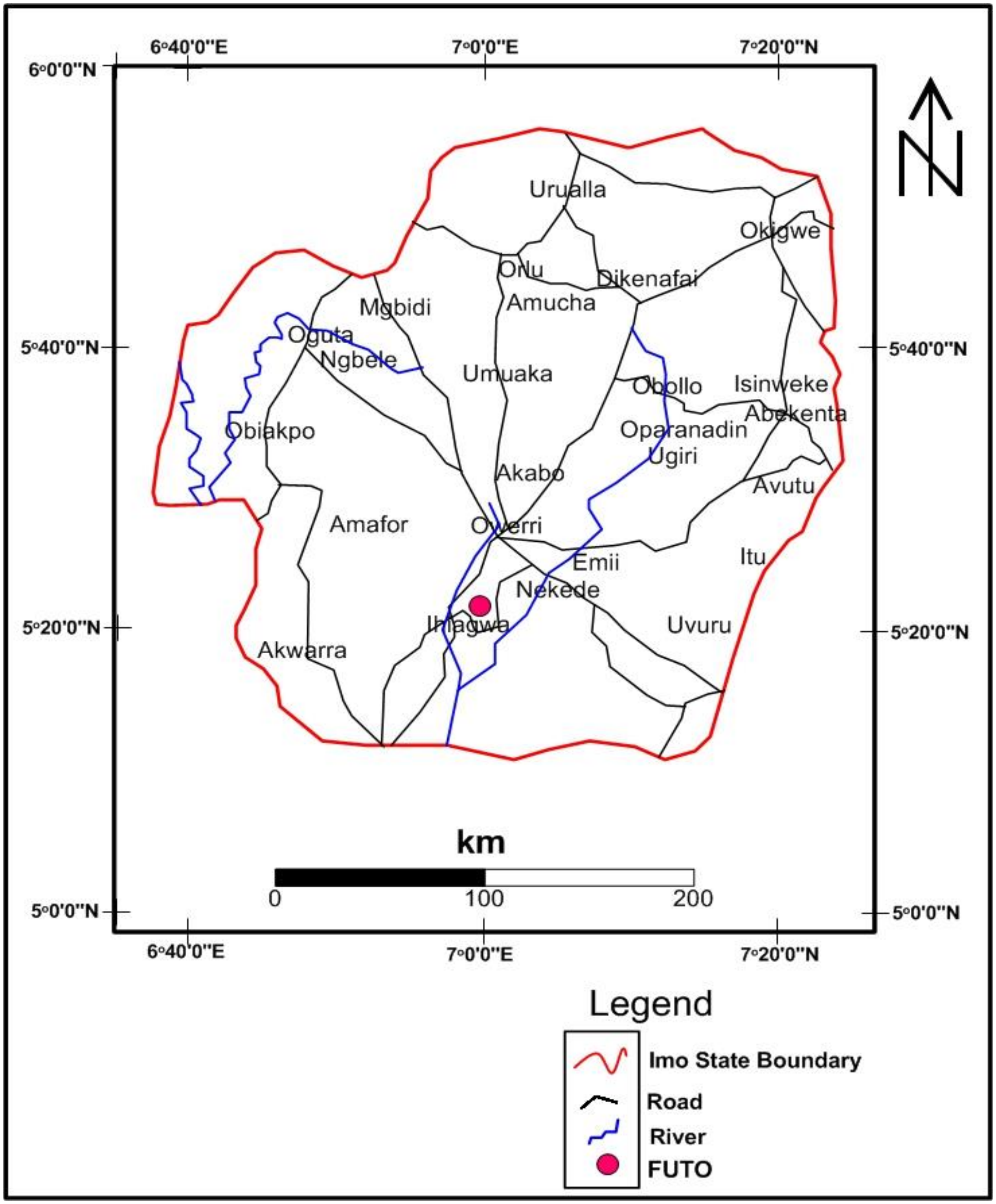

Figure 1: Map of Imo state showing study area (FUTO)

Protein (%)

Determination of protein was done by Kjeldahl Method as described by Chang (2003) and calculated as follows:

1ml of $1NH_2SO_4$ =14mg

$$\text{Protein } (\%) = \mathrm{N_2}\ (\%)\ \mathrm{x}\ 6.25 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ \mathrm{equ}\ (4)$$

$$N_2\ (\%) = \frac{100}{W} \times \frac{N \times 14}{100} \times \frac{vt}{va} \times T.B$$

Where

W = Weight of sample (0.5g)

N = Normality of titrate ($0.02NH_2SO_4$)

vt = Total digest volume(100ml)

va = Volume of digest analyzed(10ml)

T = Sample titre value

B = Blank titre value.

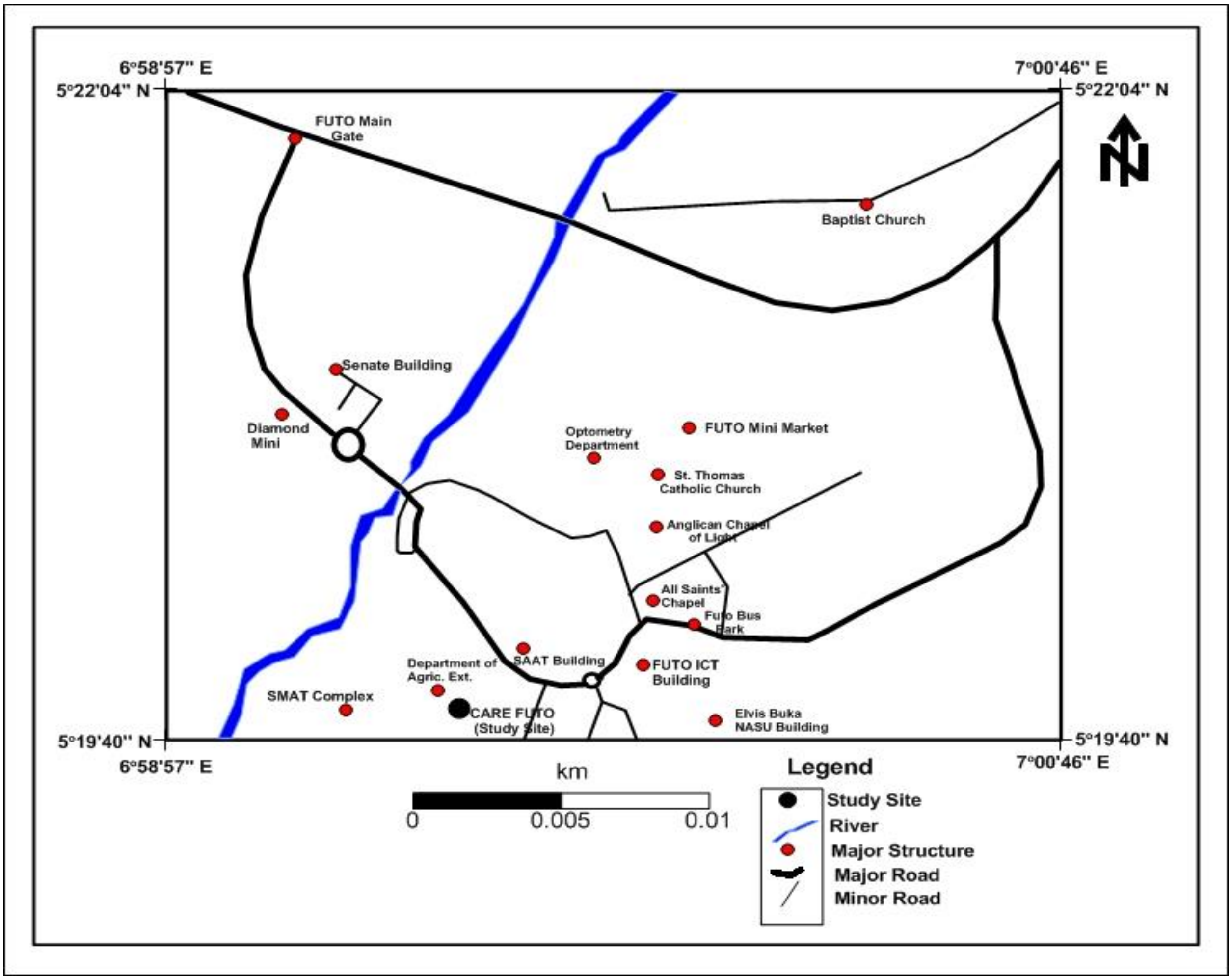

Figure 2: Map of Federal University of Technology Owerri Showing Study Site.

Total Ash

This was determined by the Furnace Incineration Gravimetric Method described by James (1995) and AOAC (1984) and calculated as follows;

$$\text{Ash Content (\%)} = \frac{W2-W1}{\text{Weight of sample}} \times \frac{100}{1} \ldots\ldots\ldots\ldots\ldots..\text{equ } (5)$$

Where

W_1 = Weight of empty crucible

W_2 = Weight of crucible + ash

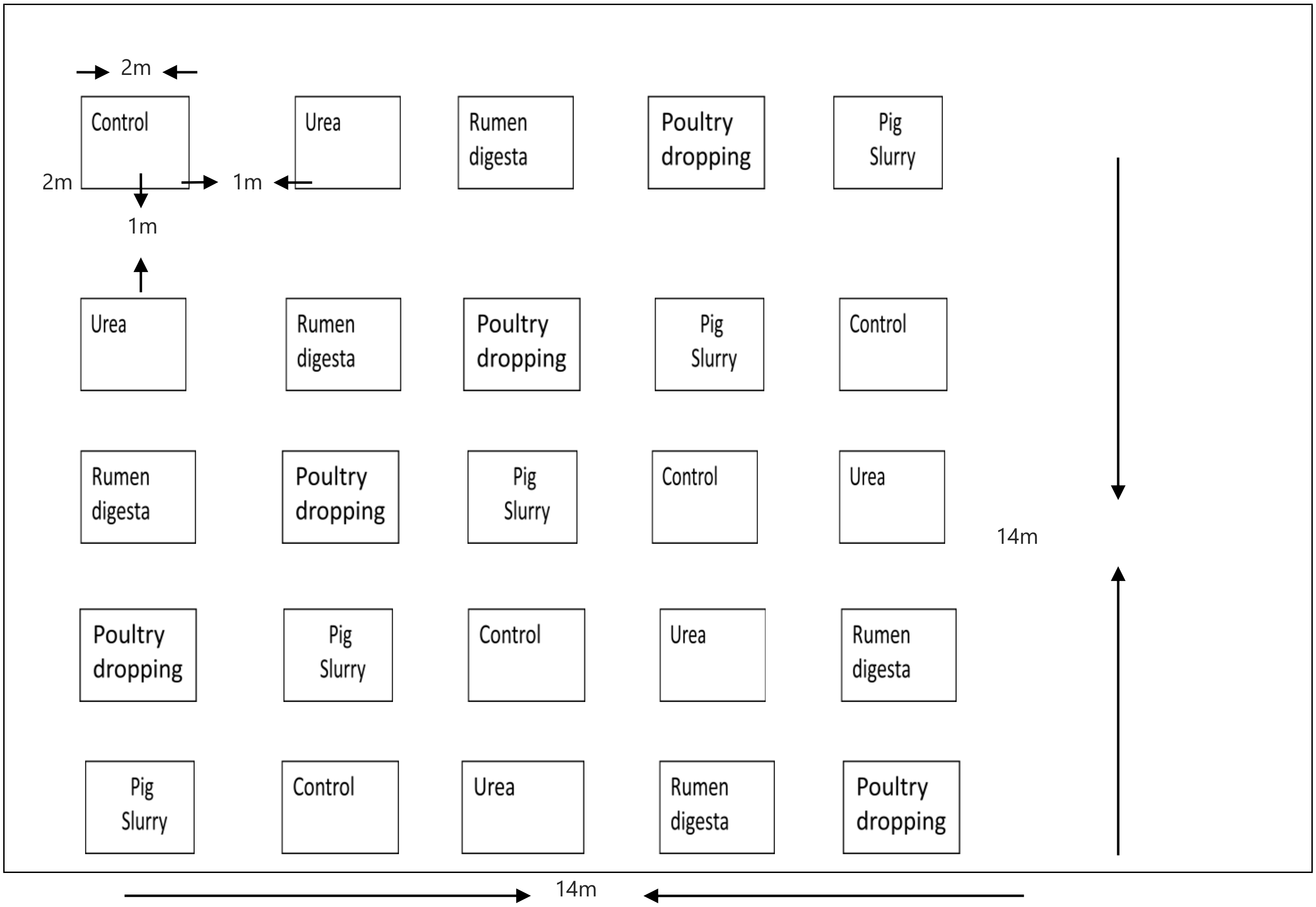

Figure 3: Field Layout and Treatment Allocation

Crude Fat

Crude Fat was determined by Solvent Extraction Gravimetric Method described by Kirk and Sawyer (1980) and calculated as follows;

$$\text{Fat Content (\%)} = \frac{W2-W1}{\text{Weight of sample}} \times \frac{100}{1} \ldots\ldots\ldots\ldots \text{equ (6)}$$

Where:

W_1 = Weight (g) of empty extraction flask

W_2 = Weight of flask + oil (fat) extract

Crude Fiber

This was determined by the method of James (1995) and calculated as follows;

$$\text{Fiber Content (\%)} = \frac{W2-W3}{\text{Weight of sample}} \times \frac{100}{1} \ldots\ldots\ldots\ldots \text{equ (7)}$$

Where:

W_2 = Weight of crucible + sample after washing, boiling and drying

W_3 = Weight of crucible + sample of ash

Carbohydrate (%)

This was determined using the method of James (1995) and calculated as follows;

$$\text{Glucose (\%)} = \frac{25A1}{X \times A2} \times \frac{100}{1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{equ(8)}$$

Where:
X = Weight of sample (g)
A1 = Absorbance of diluted sample
A2 = Absorbance of diluted standard

Determination of Heavy Metals

Cupper (Cu), Cadmium (Cd), Lead (Pb), Chromium (Cr) and Selenium (Se). Heavy Metals were determined using Perchloric Acid/Nitric Acid Digestion Method by Pratt, (1965), and read out using AAS equipment.

H. Data Analysis:

The raw data collected were subjected to analysis of variance (ANOVA). The mean differences were separated using Fisher's least significant difference at 0.05 probability level. The heavy metal content of the grains were determined and compared with Commission Regulation Directive EC (2001), FAO/WHO (1992), Pilc *et al.*, (1994), CODEX Alimentarius Commission (2006), European Food Safety Authority, EFSA, Jim Butterworth and Wu Bugang (2006) to ascertain levels of contamination.

3. RESULT AND DISCUSSION

Soil characteristics before treatment

Some properties of the soil before treatment and the mineral composition of the organic fertilizers used are presented in Table1and 2.

Table 1: Soil characteristics before treatment

Soil properties	Value
Heavy Metal Analysis	
Cupper	0.129mg.100g^{-1}
Cadmium	0.095 ,,
Lead	0.284 ,,
Chromium	0.297 ,,
Selenium	0.100 ,,

Table 2: Mineral Composition of Organic Manure used for the study

Organic Fertilizers	OC%	pH in H_2O	TN %	Av.P mg.kg^{-1}	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	TEB	TEA	ECEC	BS (%)
					→			Cmol.kg^{-1}		←		
Rumen digesta	37.1	8.0	0.68	14.2	3.2	4.6	24.21	28.6	60.69	33.46	94.15	64.46
Poultry droppings	23.14	7.20	1.89	10.5	3.08	0.45	0.12	8.03	11.68	-	11.68	100
Pig slurry	32.12	6.6	2.58	4.60	2.42	0.45	0.60	0.20	3.67	0.16	3.83	95.82

%OC = Per cent Organic Carbon, TN = Total Nitrogen, Av.P = Available Phosphorus, TEB = Total Exchangeable Base, TEA = Total Exchangeable Acid, ECEC = Effective Cation Exchange Capacity, BS (%) = Percentage Base Saturation.

Effects of Treatments on Proximate Value of Upland Rice

The Effects of Treatments on Upland Rice Proximate Value are presented on Table 3.

Moisture Content (%)

There were no significant differences when the Moisture content of the rice grain from the Control plot was compared with those from Urea and Rumen digesta treated plots. However, the Control plot recorded 0.83 more and 0.03 % less values than Urea and Rumen digesta treated plots respectively. There were significant differences when the moisture content of rice grain from Control plot was compared with that from Poultry droppings and pig slurry treated plots. The Control plot recorded 2.1 more and 2.64 (%) less moisture content than Poultry droppings and Pig slurry treated plots respectively. There was no significant difference when the moisture content of rice grain from Urea amended plot was compared with that from Rumen digesta treated plot. However the moisture content of rice grain from Rumen digesta treated plot recorded 0.86 more moisture content than control treated plot. There were significant differences when the rice moisture content from Urea treated plot was compared with that from Poultry droppings and Pig slurry treated plots. Urea treated plot recorded 1.27 more and 2.84(%) less rice moisture content than Poultry droppings and Pig slurry treated plots respectively. There were significant differences when the moisture content of rice grain from Rumen digesta treated plot was compared with that from Poultry droppings and Pig slurry treated plots. Rumen digesta recorded 2.13 more and 1.98(%) less moisture content than Poultry droppings and Pig slurry treated plots respectively. Again there was significant difference when rice grain from Poultry droppings treated plot was compared with that of Pig slurry treated plot. Pig slurry treated plot recorded a rice grain moisture content of 4.11% more than Poultry droppings treated plots.

(%) Fat Content

There were significant differences when the Fat content of rice grain from the Control plot was compared with the treated plots. The Control plot recorded 0.44, 0.89, 0.27 and 2.17 % fats more than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Furthermore, there was significant difference when the fat content of rice grain from Urea treated plot was compared with other amended plots. Urea treated plot recorded 0.15, 0.17 and 1.73 less fat content than Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Again there were significant differences when the fat content of rice grain from Rumen digesta treated plot was compared with those from Poultry droppings and Pig slurry. Rumen digesta treated plot recorded 0.32 more and 1.58 less % fat Content than Poultry droppings and Pig slurry treated plots respectively. Also, there was significant difference when the fat content of rice grain from Poultry droppings treated plot was compared with that of Pig slurry treated plot. The fat content of rice grain from Poultry droppings treated plot recorded 1.9 % less fat than Pig slurry treated plot.

Table 3: Effects of Treatments on Nutritional Value of the Rice

Treatments	% Moisture Content	% Fat	% Protein	% Fiber	% Ash	% Carbohydrate
Control	14.06^a	4.11^a	11.64^a	0.12^a	0.96^a	70.66^a
Urea	13.23^a	4.55^b	8.99^b	0.50^b	1.25^b	69.94^a
Rumen digesta	14.09^a	4.70^c	9.04^c	0.45^c	1.21^c	70.51^a
Poultry droppings	11.96^b	4.38^d	10.90^a	0.13^d	1.11^d	71.52^a
Pig slurry	16.07^c	6.28^e	12.14^a	0.19^e	1.32^e	86.2^b
FLSD (p=0.05)	1.0	0.12	1.2	0.01	0.02	1.62

Note: figures with the same superscript are not significantly different.

(%) Protein

There were significant differences when % Protein content of rice grain from Control plot was compared with those of Urea and Rumen digesta treated plots. The Control plot recorded 2.65 and 2.6 more protein content than Urea and Rumen digesta respectively, but there were no significant difference when the % protein content of rice grain from the Control plot was compared with those of Poultry droppings and Pig slurry treated plots. The Control plot, however recorded 0.74 more and 0.5 % less protein content than Poultry droppings and Pig slurry treated plots respectively. Furthermore, there was no significant difference when the protein content of rice grain from Urea treated plot was compared with that from Rumen digesta treated plot. However, Rumen digesta treated plot recorded a rice grain % protein content of 0.05 more than Urea treated plot. But there were significant difference when the % protein content of rice grain from Urea treated plot was compared with Poultry droppings and Pig slurry treated plots. Urea treated plot recorded a % protein content of 1.91 and 3.15 less than Poultry and Pig slurry treated plots respectively. Again, there were significant differences when the % protein content of rice grain from Rumen digesta amended plot was compared with those of Poultry droppings and Pig slurry amended plots. Rumen digesta treated plot recorded 1.86 and 3.1 % less protein content than Poultry dropping and Pig slurry amended plots respectively. Also there was significant difference when the % protein content of rice grain from Poultry dropping treated plot was compared with that of Pig slurry treated plot. Poultry droppings treated plots recorded 9.76 more % protein content in rice grain than Pig slurry treated plot.

(%) Fiber

There were significant differences when the % fiber content of rice grain from Control plot was compared with other treatment plots. The Control plot recorded 0.38, 0.33, 0.01 and 0.07 less % fiber content in rice grain than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Also, there were significant difference in % fiber content of rice grain when Urea amended plot was compared with Rumen digester, Poultry droppings and Pig slurry amended plots. Urea plot recorded 0.05, 0.37, 0.31 (%) fiber in rice grain than Rumen digesta, Poultry droppings and Pig slurry amended plots respectively. Again, there were significant differences when the % fiber content of the rice grain from Rumen digesta treated plot was compared with that of Poultry droppings and Pig slurry amended plots. Rumen digesta amended plot recorded 0.32 and 0.26 more % fiber content of rice grain than Poultry droppings and Pig slurry treated plots respectively. Also there was significant difference when % protein content of rice grain from Poultry droppings treated plot was compared with that of Pig slurry treated plot. Pig slurry treated plot recorded 0.06 more % fiber content of rice grain than Poultry droppings treated plot.

(%) Ash

There were significant differences when the Ash content of rice grain from the Control plot was compared with those of the treated plots. The Control plot recorded 0.29, 0.25, 0.16 and 0.36 less % ash content of rice grain than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Furthermore, there were significant differences when the ash content of rice grain from Urea treated plot was compared with other treated plots. Urea treated plot recorded 0.04, 0.13 higher and 1.32 less % ash content than Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Again, there were significant differences when % ash content of rice grain from Rumen digesta treated plot was compared with those of Poultry droppings and Pig slurry treated plots. Rumen digesta treated plot recorded 0.09 more and 0.11 less % ash content than Poultry droppings and Pig slurry treated plots respectively. Also, there was significant difference when % ash content of rice grain from Poultry droppings treated plot was compared with that of Pig slurry treated plot. Poultry droppings treated plot recorded 0.2 % less ash content than Pig slurry treated plot.

(%) Carbohydrate

There were no significant differences when the % carbohydrate content of rice grain from the Control plot was compared with those of Urea, Rumen digesta and Poultry droppings treated plots, but there was significant difference when the carbohydrate content of rice grain from the Control plot was compared with that of Pig slurry treated plot. However, the Control plot recorded 0.72, 0.15 more, 0.85 and 15.54 (%) less carbohydrate content than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. There were no significant differences when the carbohydrate content of rice grain from Urea amended plot was compared with Rumen digesta and Poultry droppings treated plots but there was significant difference when the Control plot was compared with Pig slurry treated plot. However the Control plot recorded 0.57, 1.56 and1 6.26 less carbohydrate content than Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Again, there was no significant difference when the % carbohydrate content of rice grain from Rumen digesta treated plot was compared with that of Poultry droppings but there was significant difference when it was compared with Pig slurry treated plot. However, Rumen digesta recorded 1.01 and 15.69 (%) less carbohydrate content than Poultry droppings treated plot. Also there were significant differences when the % carbohydrate content of rice grain from Poultry droppings treated plot was compared with that from Pig slurry treated plot. Poultry droppings treated plot recorded 14.68 less % carbohydrate content than Pig slurry treated plot. The significant differences and variations in the values of the treated plots within and among themselves could be associated with the differences in composition and quantities of nutrients contained in the various treatments used.

Effects of Treatments on Heavy Metal uptake of Rice Grain

The results of the effect of treatment on heavy metal uptake of the rice grain are presented in Table 4 and the different permissible limits are presented in Table 5.

Copper (Cu)

There were significant difference when the Cu content of the rice grain from Control plot was compared with those of the treated plots and there were also significant differences when the Cu content of rice grain from the treated plots were compared with one another. The Control plot recorded 0.013 more, 0.006 less, 0.009 $mg.100g^{-1}$ more, and 0.028 less Cu content than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Urea treated plot recorded 0.019, 0.133 and 0.041 $mg.100g^{-1}$ less Cu content than Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Rumen digesta recorded 0.015 more and 0.022 $mg.100g^{-1}$ less Cu content than Poultry droppings and Pig slurry treated plots respectively. , while Poultry droppings treated plot recorded 0.037 less Cu content than Pig slurry treated plot.

Cadmium (Cd)

There were no significant differences when the Cd content of the control plot was compared with those of Urea, Poultry droppings, and Pig slurry treated plots but there was significant difference when it was compared with Rumen digesta treated plot. However, the Control plot recorded a Cd value of 0.007 more, 0.011 less, 0.008 more and 0.004 $mg.100g^{-1}$ more than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Furthermore, there was significant difference when the Cd content of Urea treated plot was compared with Rumen digesta treated plot but there were no significant difference it was compared with Poultry droppings and pig slurry treated plots. Urea treated plot recorded a Cd value of 0.018 less, 0.001 more and 0.003 $mg.100g^{-1}$ less than Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Again there was significant difference when the Cd content of Rumen digesta treated plot was compared with that of Poultry droppings and Pig slurry treated plots. Rumen digesta treated plot recorded 0.019 and 0.015 $mg.100g^{-1}$ more Cd content than Poultry droppings and Pig slurry treated plots respectively. Also, there was no significant difference when the Cd content of Poultry droppings treated plot was compared with that of Pig slurry. However Pig slurry treated plot recorded 0.004 more Cd value than Poultry droppings treated plot.

Lead (Pb)

There were significant differences when the Pb content of rice grain from Control plot was compared with the Pb content of the treated plots. There were also significant differences when the rice grains from the treated plots were compared with one another. The Control plot recoded 0.058, 0.012, and 0.008 more and 0.032 $mg.100g^{-1}$ less Pb content than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Furthermore, urea treated plot recorded 0.042, 0.050, 0.092 $mg.100g^{-1}$ less Pb content than Rumen digesta Poultry droppings and Pig slurry treated plots respectively. Again Rumen digesta treated plot recorded 0.004, 0.046 $mg.100g^{-1}$ less Pb content than Poultry droppings and Pig slurry treated plots respectively, while Poultry droppings treated plots recorded 0.042 $mg.100g^{-1}$ less Pb value than Pig slurry treated plot.

Chromium (Cr)

There were significant differences when the Cr contained in rice grain from the Control plot was compared with those of treated plots. There were also significant differences when the Cr contained in the rice grain from the treated plots were compared with one another. The Control plot recorded 0.084 more, 0.022 less, 0.007 less, 0.028 $mg.100g^{-1}$ less Cr content than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Urea treated plots recorded 0.106, 0.091 less and 0.112 $mg.100g^{-1}$ more Cr content than Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Also Rumen digesta recorded 0.015 more, 0.006 $mg.100g^{-1}$ less Cr content than Poultry droppings and Pig slurry treated plots respectively while poultry droppings treated plot recorded 0.021 $mg.100g^{-1}$ less Cr content than Pig slurry treated plot.

Table 4: Effects of Treatments on Heavy Metal Content of Rice Grain

Treatment	Cu	Cd	Pb	Cr	Se
			($mg.100g^{-1}$)		
Control	0.068^a	0.025^a	0.108^a	0.182^a	0.035^a
Urea	0.055^b	0.018^a	0.048^b	0.098^b	0.021^b
Rumen digesta	0.074^c	0.036^b	0.094^c	0.204^c	0.041^c
Poultry droppings	0.059^d	0.017^a	0.098^d	0.189^d	0.029^d
Pig slurry	0.096^e	0.021^a	0.140^e	0.210^e	0.038^e
FLSD (p=0.05)	0.001	0.01	0.003	0.004	0.002

Note: columns with the same superscript are not significantly different.

Selenium (Se)

There were significant differences when the Se content of rice grain from the Control plot was compared with the Se content of rice grain from the treated plots. There were also significant differences when the Se content of rice grain from the treated plots was compared with one another. The Control plot recorded 0.014 more, 0.006 less, 0.006 more, 0.003 $mg.100g^{-1}$ less Se content than Urea, Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Urea treated plots recorded 0.020, 0.008 and 0.17 $mg.100g^{-1}$ less Se content than Rumen digesta, Poultry droppings and Pig slurry treated plots respectively. Rumen digesta treated plots recorded 0.012 and 0.003 $mg.100g^{-1}$ more Se content than Poultry droppings and Pig slurry treated plots respectively. While Poultry droppings recorded 0.009 less Se content than Pig slurry treated plot.

The result of Heavy Metal analysis carried out on the soil and rice grain shows that the treatments increased the heavy metal load of the soil and the rice plant absorbed some quantities of these heavy metals. Although the quantities absorbed by the rice grain from the different treated plots did not exceed permissible limit.

Table 5: Maximum permissive levels of heavy metals in cereals

Elements $\mu g.g^{-1}$	Commission Regulation Directive EC (2001)	FAO/WHO (1992)	Pilc *et al.*, (1994)	CODEX Alimentarius Commission (2006)	European Food Safety Authority, EFSA.	Maximum Levels of Contaminants in food
Cu		10				10
Cd	0.1		0.15	0.4	0.2	0.2
Pb	0.2		1.0			0.2
Cr						1.0
Se						2.0

Derived from Commission Regulation Directive EC (2001); FAO/WHO (1992); Pilc *et al.*, (1994); CODEX Alimentarius Commission (2006); European Food Safety Authority, EFSA; Jim Butterworth and Wu Bugang (Maximum Levels of Contaminants in foods 2006.GB 13106-1991; GB 2762-2005; GB 15199-1994; GB 4810-1994).

4. CONCLUSION

The rice grain from the different treatments used showed dissimilarities in their nutritional values and this may be as a result of the fact that the treatments have different nutritional make-up and quantities. The inherent heavy metal present in the soils which were practically increased by the treatments were absorbed by the rice grain although none of them exceeded the standard permissible limits in food.

Recommendation

Where dieting in human being is a major concern, Poultry droppings and Rumen digesta should be consider for soil enrichment in upland rice production in Owerri South East Nigeria.

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Conflict of Interest:

The authors declare that there are no conflicts of interests.

Peer-review:

External peer-review was done through double-blind method.

Data and materials availability:

All data associated with this study are present in the paper.

REFERENCE

1. AOAC., 1984. Official Methods of Analysis.14th Edn, The William Byrd press Inc., Richmond, Verginia, USA.
2. AOAC., 1990. Official Methods of Analysis the Association of Chemists. Analysis of the Association of Chemists, Washington, DC, 223 – 225, 992 -995.
3. Babel S, Kurniawan TA. 2004. Cr (VI) Removal from Synthetic Waste Water using Coconut shell, Charcoal and Commercial activated Carbon Modified with Oxidizing agent and/or Chitosan. Chemosphere, 54(7), 951-967.
4. Chang, S. K. C, 2003. Protein Analysis. In: Food Analysis, Neilson, S. S(Ed). Kluwer Academic Plenum Publisher, New York.
5. CODEX Alimentarius Commission (2006). Joint FAO/WHO Food Standards Programme; Report of the thirty ninth

Session International Conference Centre, CODEX, Geneva, Switzerland.

6. Commission Regulation Directive EC Commission Regulation (EC), No, 466, *Official Journal of the European Communities*, 2001.
7. Dong, M-H., Sang, D-Z., Wang, P., Wang, X-M and Yang, J-C. 2007. Changes in cooking and nutrition qualities of grains at different positions in a rice panicle under different nitrogen levels Rice Science 14: 141-148.
8. Duruibe, J. O, Ogwuegbu, M. O. C, Egwurugwu, J. N. (2007). Heavy Metal Pollution and Human Bio-toxic Effects. *International Journal of Physical Science* 2(5), 112-118.
9. European Food Safety Authority, EFSA, "Scientific Opinion-Cadmium in Food, scientific Opinion of the Panel on Contaminants in the Food Chain," *EFSA Journal,* vol.980, 1-139.
10. Food and Agriculture Organization (FAO). 2004. Rice is Life. Italy: FAO.
11. FAO/WHO Cadmium (EHC no. 134), Geneva, Switzerland, 1992.
12. Gomez, K. (1972). Techniques for Field Experiments with Rice. International Rice Research Institute, Los Banos, Laguna, Philippines., 48.
13. Ioan S, Constantin C, Mihai T, Sorana DB, Lorentz J. 2008. Analysis of Soil Heavy Metal Pollution and Pattern in Central Transylvania. *International Journal of Molecular Science 9, 434-453*
14. James, C. J., 1995.The Analytical Chemistry of Foods. Chapman and Hall press, New York, 86.
15. Jiang, G-H., Hong, X-Y, Xu, C-G, Li, X-H. and He, Y-Q. 2005. Identification of quantitative trait loci for grain appearance and milling quality using a doubled haploid rice population. Journal of Integrative Plant Biology 47: 1391–1403.
16. Kirk, B. and Sawyer, 1980. Pearson's Food Composition and Analysis. Longman press, England, 34.
17. Otitoju, G. T. O., Otitoju, O., Igwe, C. J. (2014) Quantification of Heavy Metal Levels in Imported Rice (*Oryza sativa*) consumed in the Northern Parts of Nigeria, *Journal of Biodiversity and Environmental Sciences* (JBES) ISSN: 2220-6663 (Print) 2222-3045 Vol. 4, No. 4, 202-207, 2014.
18. Pilc, L., Rosada, J., and J. Siepak, J. Heavy Metals Concentration in Soil, Water and Plants in the Emission Region of Copper Foundry 'Głogow,' Materiaty Sesji Naukowej Instytutu Ochrony Roslin, vol.2, 228-232,1994
19. Pratt, P. F (1965). Digestion with Hydrofluoric and Perchloric acid for Total Potassium and Sodium In: Methods of Soil Analysis, Agronomy No 9, American Society of Agronomy Inc. Madison, Wisconsin, USA, 1010-1021.
20. Tan, Y.F., Li, J.X., Yu, S.B., Xing, Y.Z. and Xu, C.G. 1999. The three important traits for cooking and eating quality of rice grains are controlled by a single locus in an elite rice hybrid, Shanyou 63. Theory Applied Genetic 99: 642-648.
21. Zukowska J, Biziuk M. 2008. Methodological Evaluation of Method for Dietary Heavy Metal intake. *Journal of Food Science.* 73(2) R 21-R29.