PERFORMANCE AND COST IMPLICATION OF FINISHER TURKEYS FED VARYING LEVELS OF RICE MILLING WASTE

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ABSTRACT

A 28-day experiment was conducted to determine the effect of feeding varying levels of rice milling waste as a substitute on maize on the performance, nutrient utilization and the economics implication on finisher turkeys. Five turkey finisher diets were formulated by substituting maize with rice milling waste at 0%, 25%, 50%, 75% and 100%, respectively. One hundred Grower Turkeys were used for the survey. The birds were randomly allotted to the five treatment diets. Each treatment group of 20 turkeys was replicated 2 times with 10 turkeys per replicate in a completely randomized design. Feed and water were provided ad-libitum. The experiment lasted twenty-eight days. Parameters measured include productive performance, economics of production and efficiency of nutrient utilization. Results obtained showed that substituting maize with 50% rice milling waste produced enhanced performance that was next to the control in terms of mean final weight, mean final weight gain best nutrient utilization and highest benefit while 100% substitution showed the poorest response in all the parameters studied. This result showed that rice-milling waste can be used to the tune of 50% in finishing local turkeys.

KEY WORDS: Finisher, Turkeys, Performance, Nutrient, Utilization, Production cost, Rice milling waste.

INTRODUCTION

The inadequate production of maize and other cereal grains which are widely used as major energy sources in livestock feeding, coupled with the keen competition between man and livestock over the available ones, are the major factors limiting the growth of poultry industry in developing countries like Nigeria. These have resulted to rise in feed cost and shortfall in animal protein supply and intake in Nigeria. If the future of poultry industry is to be adequately protected, then cheap and easily available alternative feed source that are of low human preference and also of little or no industrial use, that can meet the nutritional requirements of poultry need be sought for (Nwoche *et al.*, 2006).

One of such feedstuffs which has the potential of being used in poultry feed is Rice milling waste. Rice milling waste is the by-product resulting from industrial rice milling. The potential advantage of utilizing rice-milling waste (fibre source) in poultry feed has been reported to include, lowering of production cost, production of lean meat, reduction in carcass fat and dietary energy wastage associated with production of excess fat (Nwoche *et al.,* 2004) and supply of nutrients like vitamins, minerals and other unidentified factors which improve growth (Ojewola 2005).

It is a known fact that, poultry industry is being built on chicken alone at the expense of other poultry species, which are better as regards rate of feed conversion and meat production. Local turkey (*Meleagridis gallopavo*) in Nigeria is one class of poultry that has been neglected and the production left in the hands of subsistence poultry farmers (Ojewola *et al.,* 2001). Turkey is a class of poultry that is generally cherished as good gifts during festive periods like Christmas, and Easter. The birds' large size, fast growth rate, high fecundity and excellent meat quality (Nixty, 1989), provides unassailable reasons why the turkey industry must be encouraged.

Effort must be geared towards tapping the resource pool that is readily available in turkey, using readily available and cheap feedstuff like rice milling waste.

MATERIALS AND METHODS

Experimental Birds and Design

This study was conducted with 100, 16 week-old local grower turkeys previously raised on experimental diets formulated by substituting maize with graded levels of rice milling waste in the following sequence: 0%, 25%, 50%, 75% and 100% respectively (Experiment 1). At the end of the experiment (16 weeks). The Grower Turkey were pulled together according to their previous treatment groups and randomized to obtain an initial average body weight range of 2400 2418. This was to remove the carry over effect from the previous Experiment (Grower phase), on the performance of the finisher turkeys.

Experimental Diets and Design.

Five experimental turkey finisher diets were formulated by substituting maize with Rice milling waste at varying levels: 0, 25, 50, 75 and 100% respectively (Table 1).

Table 1: Percentage Composition of Experimental Diets used in Finishing Local Turkeys (16-20 weeks)

Ingredients	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)
Yellow maize	62.00	46.50	31.00	15.50	0.00
Rice milling waste	-	15.50	31.00	46.50	62.00
Soya bean meal	30.00	30.00	30.00	30.00	30.00
Fish meal (72 CP)	1.20	1.20	1.20	1.20	1.20
Palm oil	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Vit. mineral premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Crude protein (%)	20.07	20.95	1982	1970	1958
Crude fibre (%)	3.46	7.65	11.88	15.94	20.31
ME (Kcal/kg)	3184.64	2881.12	2578.28	2275.1	1971.92
Determined Percent Composition					
Crude Protein (%)	21.03	20.82	20.72	20.50	20.42
Ether Extract EE (%)	9.20	9.56	7.86	7.50	6.85
Crude fibre (%)	4.34	9.85	13.76	17.85	22.30
Total ash (%)	10.60	14.80	16.00	20.20	20.00
Nitrogen Free Extract (NFE) (%)	54.83	45.97	41.66	33.95	30.43
Nitrogen Energy (Kcal/g)	4.10	3.72	3.43	3.14	2.60

* Composition per 25 kg (Bio premix) Vit. A 4,000 iu; Vit. D 800,000 iu; Vit. E1 500 mg; Niacin 10,000 mg; Panthotenic acid 3,500 mg; Biotin, 15 mg; Vit. B 10mg; Folic acid 200 mg; Chlorine chloride, 130,000 mg; Manganase 60,000 mg; Iron 15,000; Zinc 15,000 mg; Copper 800 mg; Iodine 400 mg; Cobalt, 80 mg; Selenium, 400 mg, Antioxidant 40,000 mg.

The experimental diets were analyzed for proximate composition, mineral and fibre components. The birds were randomly allotted to the five treatment diets having 20 turkeys per treatment. Each treatment group was replicated two times having 10 birds per replicate in a completely Randomized Design. (CRD).

Data Collection and Statistical Analysis

The birds were weighed at the beginning of the trial and thereafter on weekly basis. Feed and water were provided ad-libitum. Data on the daily feed intake and weekly body weight changes, feed conversion ratio and mortality were subjected to analysis of variance (Snedecor and Cochran, 1980) and Least square Difference (L.S.D) was applied to separate means found to be statistically significant among the treatments. The trial lasted 28 days.

Nutrient Digestibility

Five days to the end of the trial, six turkeys were randomly selected and placed in individual metabolic cages for nutrient balance trial. The birds were fed ad-libitum and allowed free access to water. They were allowed 3 days adjustment period, thereafter, the faecal droppings were collected whole every 24 hours for 3 days, oven dried and analyzed for chemical composition.

Production Economy:

The economic of producing the finisher turkeys fed diets substituted with varying levels of rice milling waste were calculated. Feed cost was evaluated based on the prevailing market price of the feed ingredients at the period of the study. Feed cost per bird was estimated based on the quantity of feed consumed per bird till the termination of the trial.

RESULTS AND DISCUSSIONS

Mineral Components

Results of the mineral components of the Turkey finisher diet substituted with varying levels of rice milling waste is shown in Table 2.

Table 2: Mineral Composition of Rice Milling Waste Based Diet fed to Finisher Turkeys.

Mineral components	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM
Calcium (mg/g)	2.60^a	2.42^b	2.30^c	2.10^d	1.90^e	0.14
Phosphorus (mg/g)	0.70^a	0.65^b	0.55^c	0.50^d	0.48^e	0.03
Magnesium (mg/g)	0.56^a	0.54^b	0.46^c	0.43^d	0.40^e	0.02
Potassium (mg/g)	0.99^a	0.92^b	0.86^c	0.84^d	0.72^e	0.01
Sodium (mg/g)	0.95^a	0.77^b	0.75^b	0.68^c	0.65^d	0.02
Iron (mg/g)	0.08^a	0.06^b	0.05^c	0.04^d	0.03^e	0.002

^{abcde} means along the same row with different superscripts are significantly different ($P<0.05$).

The analysis showed that all the mineral components studied (Ca, P.K, Mg, Na and Fe) followed a downward trend, as the substitution levels increased from 0 100%, indicating that the higher the substitution level, the lower the mineral contents. This could be attributed to the high fibre substitution, which neutralized the mineral contents of the feed (Keng, 2006). This is in agreement with the report of Kohwo (2001) who showed that very high substitution levels of fibre may lead to mineral deficiency due to fibre binding ability.

Fibre Components

Considering the fibre components of the experimental diets (Table 3),

Table 3: Crude fibre Components of Rice Milling waste based Diet, fed to Finisher Turkeys.

Fibre Composition (%)	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM
Natural detergent fibre (%)	35.04^e	43.25^d	48.00^c	52.45^b	58.50^a	2.40
Acid detergent fibre (%)	19.25^c	25.21^d	28.00^c	30.05^b	33.51^a	1.85
Acid detergent lignin (%)	3.17^c	6.00^d	7.01^c	8.23^b	8.85^a	0.34
Hemicellulose (%)	16.20^c	22.00^d	25.17^c	27.02^b	30.25^a	1.56
Cellulose (%)	11.32^c	19.03^d	22.04^c	24.32^b	26.24^a	0.25

[abcde]-Means along the same row with different superscripts are significantly different ($p<0.05$).

It was observed that, as the substitution level of rice milling waste increased from 0% to 100%, all the fibre components significantly increased with T_5(100%) having the highest value and the control the lowest.

Performance of the experimental birds

Data on the performance of the experimental birds is shown in table 4.

Table 4: Performance of Finisher Turkeys fed varying level of Rice milling waste (16-20 weeks)

Parameters	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM
Mean initial weight (g)	2408.00	2428.00	2418.00	2424.00	2420.00	2.50
Mean final weight (g)	3800.00^a	3480.00^c	3640.00^b	3000.00^d	2820.00^c	100.00
Mean final weight gain (g)	1392.00^a	1052.00^c	1222.00^b	567.00^d	400.00^c	90.50
Mean daily weight gain (g)	49.71^a	37.57^c	43.64^b	20.57^d	14.28^c	2.56
Mean total feed intake (g)	1611.66^d	1648.64^c	1589.00^c	1694.00^b	1720.60^a	20.05
Mean daily feed intake (g)	57.56^d	58.88^c	56.76^e	60.50^b	61.45^a	1.50
Feed conversion ratio	1.15^e	1.56^c	1.30^d	2.94^b	4.27^a	0.10
Mortality (%)	0.00^c	0.00^c	0.00^c	10.00^b	20.00^a	0.20

[abcde]: mean within rows with different superscripts are significantly different ($P<0.05$).

Turkey fed 50% RMW (T_3) exhibited significantly higher values that were next to the control, in terms of mean final weight (3640.00) mean final weight gain (1222.00) and mean daily weight gain (43.64), while T_5(100%) group showed the least values (2820.00 and 14.28) respectively.

Mean total feed intake and daily feed intake were maximized at T_5 (100%) and lowest at T_3 (50%). The control diet showed the best-feed conversion ratio, followed by 50% substitution. The over all depressed performance observed in Turkeys fed high levels of RMW (75% and 100%) could be due to high fibre content of the feed which might have interfered with the nutrient availability in the diet, resulting to reduction in nutrient availability for growth and maintenance.

This observation upholds the findings of Onifade (1993) and Onifade and Babatunde (1997) who reported that high fibre diets interfered with nutrient availability of birds at the tissue level, and reduces the nutrient availability for growth and maintenance.

Nutrient Digestibility

Results of the nutrient utilization trial, Table 5 showed that, percent nutrient utilized were optimized at the control (0%) in terms of Dry matter, CP. CF and EE. Ash and NFE values were highest at 50% (T_3), T_5 (100%) showed the poorest response in all the parameters considered.

Table 5: Nutrient Utilization by Finisher Turkeys fed varying levels of Rice Milling Waste. (16 20 weeks).

Percent nutrient utilized	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM
Dry matter	68.38[b]	67.50[b]	70.90[a]	66.80[b]	60.30[c]	0.75
Crude protein	78.43[a]	76.87[b]	78.55[a]	75.34[c]	73.70[d]	0.92
Crude fibre	70.77[b]	72.84[a]	80.03[a]	68.79[c]	65.88[d]	1.25
Either Extract	80.73[b]	81.87[b]	85.18[a]	80.78[b]	75.96[c]	1.32
Ash	54.10[d]	66.23[b]	67.32[a]	65.34[b]	60.41[c]	0.95
NFE	62.19[a]	62.52[a]	57.74[c]	53.13[d]	60.14[b]	1.45

[abcde:] means in the same row bearing different superscripts are significantly <0.05).

The general decline in all the nutrient utilization parameters exhibited by local turkeys fed 100% Rice Milling Waste, could be attributed to high fiber content of the feed resulting in poor nutrient intake and absorption. The observation upholds the report of Hedge *et al* (1978), and Woodman and Evans (1987) who observed that high fiber diets seem to decrease digestibility of crude protein and other nutrients.

Economic Analysis

Economic indices (Table 6) showed that feed cost (N12.30), feed cost per bird (N711.44) and cost of production (N2551.44) were optimized at the control diet (0%) and lowest at 100% (T_5) (N3.37, N207.08, and N2047.08 respectively.

Table 6: Economics of Production of Finisher Turkeys Fed Varying Levels of Rice Milling Waste.

Economic indices	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM
Feed cost/kg (₦)	12.30[a]	10.10[b]	7.81[c]	5.61[d]	3.37[e]	0.36
Feed cost per/bird (₦)	711.44[a]	594.60[a]	443.00[c]	339.40[d]	207.80[c]	6.61
Cost of 16 wks old turkey (₦)	1800.00	1800.00	1800.00	1800.00	1800.00	0.00
Operational cost (₦)	40.00	40.00	40.00	40.00	40.00	0.00
Cost/kg /bird (₦)	671.43[c]	699.61[b]	627.19[d]	726.46[a]	725.91[a]	5.03
Cost of production (₦)	2551.44[a]	2434.66[a]	2283.00[b]	2179.40c	2047.08[d]	43.77
Revenue per bird (₦)	3325.00[a]	3045.00[c]	3185.00[b]	2625.00[d]	2567.50[e]	8.42
Benefits (₦)	773.56[b]	610.34[c]	902.00[a]	445.60[d]	420.42[e]	3.20
Costs saving (₦)	-	4.57[d]	10.51[c]	14.58[b]	19.76[a]	1.40

[abcde:] means along the same row with different superscripts are significantly different (P<0.05).

Cost/kg maize as at the period of this study = N150/kg.

Cost/kg Rice milling waste N5/kg.

Revenue accruing from the sales of turkeys fed the control diet (0%) was highest, (N3325.00), followed by T_3 (50%), N3185.00) and lowest at 100% ($T_{5;}$ N2567.00). As the substitution level of Rice milling waste for maize, increased from 0-100% benefit was optimized at 50% (T_3; N902.00), further substitution up to 100% produced the lowest benefit ((N420.42).

The high feed cost observed, could be attributed to the high cost of maize ((N150.00/kg) which is a conventional feedstuff compared to rice milling waste which was sold at ((N5/kg) as at the period of the study.

Generally, the enhanced performance observed in finisher turkeys fed 50% rice milling waste, could be attributed to better availability and utilization of nutrients which in turn enhanced growth and maintenance, an indication that rice milling waste can be used as a substitute for maize to the tune of 50% in finishing local turkeys.

CONCLUSION

Based on the results of this study, rice-milling waste can be used to the tune of 50% in finishing local turkeys.

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MAIZE PRODUCTION AND CHEMICAL PROPERTIES OF AN ULTISOL AMENDED WITH DIFFERENT ASH SOURCES IN SOUTHEASTERN NIGERIA

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ABSTRACT

The soils in Ebonyi State agro-ecological zones of southeastern Nigeria are poor in their native availability of basic nutrients for optimal crop production. In order to arrest the declining productivity of the soils in these zones, three different ash materials (wood ash-WA, rice husk ash-RHA, and leaf ash-LA) applied at the rate of 3 tons/ha were incorporated in a Typic-Haplustult planted with maize (Zea mays L.) to evaluate their immediate effects on the productivity of the soil using maize as a test crop. Soil chemical properties tested were soil pH, total nitrogen, organic carbon, exchangeable K^+, Ca^{2+}, and Mg^{2+}. Others include CEC, exchangeable acidity and available phosphorus while the maize grain yield was measured. The soils are loose, low in pH and poor in plant nutrient elements except in magnesium. In spite of that, the ashes were able to improve the pH of the soil by raising it two times the original level in two of the ash amended soils (wood ash and leaf ash).Generally, essential plant nutrients such as exchangeable K^+, and Ca^{2+}, including fertility index as the CEC, were statistically improved by the application of the ashes. Available phosphorous was also significantly improved by the soil amendments. Also, maize plant height, number of leaves and grain yield increased statistically by the ash applications with RHA significantly improving the maize grain yield (5.75 ton/ha) higher than others. The study showed that rice husk ash is more superior to other ashes used, in the improvement of most of the plant nutrients and increased production of maize in southeastern Nigeria.

KEY WORDS: Rice-mill wastes. Saw-mill wastes. Typic- Haplustult. Soil amendments. Ashes. Maize grain

INTRODUCTION:

Maize is an important food for man and livestock. The grain is also used industrially for starch and oil extraction. In recognition of this need and the current global food crises, Nigeria currently pursues policy of expanding the land area under cultivation as well as intensifying crop production by continuous cropping system which maize is included.

Earlier before now, the intensive cultivation of introduced high yielding crop varieties has resulted to depletion and leaching of mineral nutrients hence increased soil acidity. Furthermore, the supply of organic manure is not enough especially in urban areas to substitute the use of chemical fertilizer that has been increasing the acidity levels of tropical soils, as a quick means of restoring the soil fertility without possible increase in pH of the soils.

In Ebonyi State of southeastern Nigeria, large quantities of fresh partially burnt rice-mill and saw-mill wastes accumulate from numerous rice mills and saw mills located at different parts of the state. Despite the magnitude of these wastes generated daily and the possible effects on the environment, no serious attempts have been made either for their effective utilization or safe disposal. The only disposal attempt they do is the partial burning of the wastes at the various dumping grounds after which no agricultural uses for the wastes have been applied as a way of recycling. Ash is the substance that remains after any material has been burnt. A chemical analyses of the ash of burnt foodstuffs determines the amounts of minerals they contain (Lickazz, 2002; and Claphan and Ziblske, 1992). Continued agricultural production can gradually decrease the organic matter content of soils, which can decrease soil fertility and crop yield. Applying ash and animal waste to farmland after recycling has been one effective way to improve the physical, chemical and microbiological properties which remained extremely acidic.

Ash is as valuable as fertilizers and insecticides. Also ash from leaves yield iodine and that of wood is a source of potash. Also the concentrations of soluble carbohydrates decreased in harmony with the applied leaf ash amounts. The effect of leaf ash did not depend on the amount applied and that the concentrations of soluble carbohydrates and biomass were obviously decreased by leaf ash (Entry et al. 1996; Klo-eiko 2003 and Ots and Haugas 2004). However, changes in the mineral composition of the soil and plants usually result in serious alterations in plants metabolism. Increased magnesium and iron in the needles under the influence of wood ash may favour biosynthesis, and changes in potassium and phosphorous concentrations may alter several pathways in plant metabolism (Mandre and Korsjukov 2004; Mandre *et al* 2004). Wood ash usually increase the pH and base saturation in the O horizon, which is described to be more drastic if raw ash is used. In the soil, an increase was observed in the concentration of almost all nutrients except nitrogen. It is evident that the enrichment and confirmed mineral composition of soil may cause changes in the metabolism and physiological activity of plants (Bramryd and Fransman 1995; Saarsalmi *et al.* 2001; Arvidsson and Lundkvist 2003).
The study aimed at evaluating the different ash source on soil chemical properties and yield of maize as to ascertain the best ash that will give optimal maize production as well as improve the soil chemical properties in an Ultisol of southeastern Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the research farm complex of Federal college of Agriculture, Ishiagu. The area lies within latitude $05^0 56^/$N and longitude $07^0 41^/$E in the derived Savannah zone of southeastern Nigeria. The annual rainfall for the area is 1,350 mm, spread from April to October with average air temperature being 29^0C. The underlying geological material is Shale formation with sand intrusions locally classified as the 'Asu River' group. The soil is hydromorphic and belongs to the order Ultisol and also classified as Typic-Haplustult (FDALR, 1985). They are sandy loam with moderate soil organic carbon (OC) content on the topsoil, low in pH (3.7) and low in cation exchange capacity (CEC). The exchange complex site is dominated by calcium and magnesium with 1.0 and 3.5 cmolkg^{-1} respectively.

Table 1: Some properties of the topsoil (0-20 cm) before tilling and amendment

Soil property	Value
Clay %	10
Silt %	21
Total sand %	69
Organic matter %	1.52
Organic carbon % (OC)	1.42
Total nitrogen % (N)	0.090
pH (H_20)	3.7
pH (KCl)	1.7
Exchangeable bases (cmolkg^{-1})	
Sodium (Na)	0.40
Potassium (K)	0.80
Calcium (Ca)	1.0
Magnesium (Mg)	3.5
Cation exchange capacity (CEC)	8.22
Exchangeable acidity (EA)	2.52
Available P (mg/kg)	4.30

The soil amendments:

The soil amendments comprised partially burnt rice-mill wastes, saw-mill wastes and *Acacia* plant leaf collected from the rice-mill industry and saw-mill industry close to the experimental station and also *Acacia* dried leaves within the study site. These were analyzed for their pH, organic matter, organic carbon, total nitrogen, exchangeable sodium, calcium, potassium magnesium and available phosphorus (Table 2a). The results of analyses indicated that wood ash contain higher calcium, potassium and pH (15.6, 3.08 and 12.7) respectively. Rice husk ash contains higher organic matter (6.71), organic carbon (3.89) and available phosphorus (11.94); while leaf ash contained higher organic carbon, total nitrogen and magnesium (3.89, 0.28 and 5.0) respectively. The burnt waste in this context refers to black coloured and recently burnt waste. The burning is the local disposal method. The ash wastes were applied at the rate of 3 ton/ha for each waste (Table 2b).

Table 2a: Nutrient compositions (%) of the amendments

Property	*Amendment*		
	Rice husk ash (RHA)	*Wood ash (WA)*	*Leaf ash (LA)*
pH (H_2O)	6.9	12.7	10.4
pH (KCl)	6.5	12.2	10.0
OC	3.89	1.07	3.89
OM	6.71	1.85	6.71
N	0.056	0.28	0.28
Na	0.33	0.33	0.45
K	0.65	3.08	1.77
Ca	1.0	15.6	10.4
Mg	1.4	3.6	5.0
P	11.94	4.98	1.94

Field preparation and experimental design:

The area was manually cultivated into seed-beds using hoe. Prior to tilling composite soil sample was taken at a depth of 20 cm to characterize the soils (Table 1). The field layout was a randomized complete bock design (RCBD) with 4 treatments replicated 4 times each. The following treatments were applied:

Table 2b: **Treatment applied**

Treatment label	*Symbol*	*Treatment name*	*Rate of application*
I	RHA	Rice husk ash	3 ton/ha
II	WA	Wood ash	3 ton/ha
III	LA	Leaf ash	3 ton/ha
IV	CT	Control	0 ton/ha

The treatments were applied and incorporated within the top soil and left for two days before the maize which is the test crop was planted. This experiment was conducted in 2007 cropping season.

Measurements were taken from the height of the plant at 2 weeks intervals starting from week 4 after planting (wap), using measuring tape. Number of leaves for each plant was also counted at 2 weeks intervals. At maturity, maize dried cobs were harvested and de-husked. This was followed by shelling of the maize grains, which were later dried and the yield computed at 90% dry matter content. At the end of the harvest, soil samples were collected from each of the plots for chemical analyses.

Determination of soil chemical properties:

Soil samples were air-dried and sieved with 2 mm sieve. Soil fractions under 2 mm from each of the plots were then analyzed using the following methods; Soil pH was measured in a 1:2.5 soil:0.1 M KCl suspensions. The soil OC was determined by the Walkley and Black method described by Nelson and Sommers (1982). Exchangeable cations were determined by the method of Thomas (1982). The CEC was determined by the method described by Rhoades (1982), while exchangeable acidity (EA) was measured using the method of McLean (1982). Available phosphorus was measured by the Bray II method (Bray and Kurtz 1945).

Data analysis:

Data analysis was performed by the analyses of variance (ANOVA) test, and statistical differences among treatment means were estimated by Fishers Least significant Difference (PLSD).

RESULTS AND DISCUSSION:

Effect of wood ash, Rice husk ash and leaf ash (Soil amendments) on the soil pH, organic carbon and total nitrogen.

The influence of the soil amendments on the soil pH, OC and N are shown in table 3. The pH of the amended soils was statistically improved at ($P< 0.05$) probability level, with increased pH higher in soils amended with wood ash and leaf ash. This result is in line with the work of Lickazz, (2002), that wood ash contains oxides and hydroxides of calcium, magnesium and potassium and to a lesser extent, sodium making wood ash similar to burnt or hydrated lime in its mode of actions. Moreso, soil pH and test values for plant nutrients are usually higher in areas where bushes were burnt. However, the lower pH recorded in the soil amended with RHA agrees with Nnabude and Mbagwu (2001) report, that production of organic acids during the decomposition of burnt rice wastes as well as the evolution of CO_2 during the same process accounted for the low pH in the soil.

The OC in the studied soils was found to have significantly improved by the amendments over the control. Generally, OC in the amended soils were very low in amount. The low percent of OC could be related to the fact that nitrogen and carbon were lost in form of gases to the atmosphere during burning. This agreed with the work of Sampson (1980), that if the straw of plant origin is burnt, there is a total loss of nitrogen and organic carbon, but phosphorus and potassium are retained in the ash thereby returning into the soil, provided wind and rain intensity is controlled or reduced. However, rice husk ash was also found to improve the OC higher than other amendments. This agrees with Kalinke and Betrand (1989) that rice husk is highly carbonaceous with relatively small amount of nitrogen.

Soil total nitrogen differs significantly with amendments. The entire ash sources were found to be statistically different from the control. However, RHA statistically increased soil total nitrogen higher than other amendments. Generally, soil total nitrogen in this study was slightly improved quite unlike other soil nutrients studied. This agrees with Arvidsson and Lundkvist (2003) and Saarsalmi *et al.* (2001), that a statistical increase was observed in the concentration of almost all the soil nutrients in ash amended soils except nitrogen.

Table 3: Effect of soil amendments on the soil pH, organic carbon and nitrogen on 0-20 cm topsoil

Amendments	pH	OC %	N%
RHA	5.88	0.57	0.070
WA	6.38	0.49	0.055
LA	6.38	0.53	0.062
CT	4.48	0.44	0.040
LSD (0.05)	1.33	0.015	0.015

Effect of soil amendments on the exchangeable potassium, calcium and magnesium

Exchangeable potassium increased significantly with the application of the ashes (Table 4). The result showed that leaf ash and wood ash statistically differ from rice husk ash and the control in the soil exchangeable potassium. It is interested to note that even though the RHA amended soil gave quite lower value of K^+ when compared to WA and LA, it statistically improved exchangeable K^+ more than the control.

The values for exchangeable magnesium varied significantly. It changed from 1.4 $cmolkg^{-1}$ in the control plot to 1.85 $cmolkg^{-1}$ in the RHA amended soil (Table 4). The result showed that all the amendments significantly performed better than the control, with RHA and WA statistically increased the exchangeable Mg^{2+} better than LA. In general terms, it will be concluded that well or better managed soil, as in the ash application in the present study, improved nutrient supply, reserve and release of their exchangeable forms, which are very essential in plant nutrition. Witt *et al.* (2005) showed that the management of these nutrients should be offered greater attention if appreciable yield was to be obtained. These soils are poor in their native availability of these nutrients as expressed by some researchers (Unamba-Oparah 1985; Mbagwu 1989 and Nwite et al. 2008). Therefore, ash application may help in the solution of low nutrient levels in this soil.

Effect of soil amendments on CEC, EA and Available phosphorus

Table 5 shows that all the amendments exerted positive and significant influence ($P< 0.05$) on the cation exchange capacity of the studied soil. However, the entire ash materials at 3 ton/ha application have made significant influence over the control. The best improvement over the control was obtained from soil amended with leaf ash and was followed by rice husk ash amended soil.

Result of the effect of the amendments on exchangeable acidity (Table 5) shows that significant changes in EA occurred with application of ash to the soil. The rice husk ash amendment at the application level of 3 tons/ha significantly reduced the exchangeable

Table 4: Effect of soil amendments exchangeable potassium, calcium, and magnesium on 0-20 cm topsoil

Amendments	K^+ ($cmolkg^{-1}$)	Ca^{2+} ($cmolkg^{-1}$)	Mg^{2+} ($cmolkg^{-1}$)
RHA	0.14	0.98	1.85
WA	0.23	1.70	1.83
LA	0.24	2.38	1.65
CT	0.05	0.93	1.4
LSD (0.05)	0.10	1.28	NS

Table 5: Effect of soil amendments on CEC, EA and available phosphorus on 0-20 cm topsoil

Amendments	CEC ($cmolkg^{-1}$)	EA ($cmolkg^{-1}$)	Avail. P (mg/kg)
RHA	5.34	2.53	31.04
WA	4.78	2.40	22.05
LA	5.48	2.45	23.75
CT	3.24	3.05	8.22
LSD (0.05)	1.53	0.48	5.38

acidity relative to the corresponding level of the leaf h and wood ash. However, the greatest significant reduction in exchangeable acidity relative to the control occurred in wood ash. The amendments therefore effected significant reduction relative to the control. The lowering of the EA in the amended soils was considered to be a nice attribute for the ash amended soils.

Soil available phosphorus was statistically increased upon by the application of the amendments. The result showed that the highest available phosphorus was obtained in rice husk ash and was followed by wood ash. Though wood ash and leaf ash significantly improve available phosphorus over the control, there was no statistical difference between soil amended with leaf ash and wood ash. This means that rice husk ash exerted positive and significant improvement on available phosphorus over leaf ash, wood ash and control. Generally, this result is in line with the findings of Lickazz (2002); Claphan and Ziblske (1992); and Martins (1971) that most agricultural soils are deficient in phosphorus and it is likely that improved crop growth after living with wood ash may be done in part to increase phosphorus availability. Also, a significant amount of phosphorus, calcium and magnesium in form of potash is added to soil when wood ash is used as living materials. The increased available phosphorus in the amended soils could be attributed to increase in the soil pH which must have released the fixed phosphorus in the soil colloids.

Effect of soil amendments on plant height, number of leaves and shelled maize grain yield

Table 6 presents the effects of different ash sources on the plant height, number of leaves and shelled maize grain yield. The result showed that plant height at 6 weeks and 8weeks were significantly increased by the amendments. Plant height at 4 weeks after planting (wap) was not affected significantly by the application of ashes, though were large differences in the mean plant height among the treatments. On the other hand, mean number of leaves in all the weeks counted showed statistical difference among the treatments at both ($P< 0.05$ & 0.01) probability level. The grain yield ranged from 0.34 ton/ha in the control plot to 5.75 tons/ha in rice husk ash amended soil. Generally, amended soils yielded higher than the non- amended soil. Although there was a significant difference on the amended soil over the control,

Table 6: Effect of soil amendments on plant height, No. of leaves and shelled maize grain yield

	Plant height (cm)			No. of leaves			
Amendments	4 wap	6 wap	8 wap	4 wap	6wap	8 wap	maize grain yield (ton/ha)
RHA	69.41	116.36	172.14	14.75	20.63	25.25	5.75
WA	66.54	98.55	151.16	12.13	15.88	19.50	1.51
LA	70.51	93.83	148.29	10.25	14.50	17.75	0.60
CT	51.30	66.70	93.35	8.63	12.13	15.38	0.34
LSD (0.05)	NS	14.97	24.81	2.19	2.40	3.30	3.42

NS = Non significant

wap = weeks after planting

but there was no such difference between wood ash and leaf ash. The study in this regards shows the superiority rice husk ash in the improvement of major plant nutrients and increased production of maize in an ultisol.

CONCLUSION

From the present study, the following conclusions can be drawn. The soils are loose, low in pH and poor in plant nutrient elements. In spite of that, the ash positively improved the pH almost at 100% level. Generally, essential plant nutrients such as exchangeable K^{+}, Ca^{2+}, and Mg^{2+} including fertility index like the CEC were improved upon in the ash amended soils.

Also, the plant height, number of leaves and maize grain yield increased significantly with the application of the ashes; with the rice husk ash statistically increased all the plant parameters over other amendments and the control. On this however, rice husk ash has superiority over other treatments in improvement of soil nutrient status and the production of maize in an ultisol of southeastern Nigeria.

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