THE EFFECT OF TREATMENT WITH CORN COB EXTRACT ON PHYSICO-CHEMICAL PROPERTIES OF SOILS

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ABSTRACT

Corn cob juice extracted with water was used to treat soil samples collected from twelve sites located in different parts of Edo State of Nigeria. The juice was analysed for its nutrient composition while the treated soil samples were examined for the possible changes in its physicochemical properties. The results showed that there was a marked increase in organic carbon, total nitrogen, available phosphorus, exchangeable potassium and magnesium, cation exchange capacity, percentage base saturation and soil buffering capacity. There was marked decrease in exchangeable sodium percentage, calcium and hydrogen saturation. The pH and sodium levels of both the untreated and treated soils were about the same. The results showed overall that corn cob may be a veritable source of organic fertiliser in soils.

INTRODUCTION

Corn cob, the thick, cylindrical part of an ear of maize on which the grain cereal grow may appear as an unutilisable material and is therefore discarded as waste in farm lands and municipal dump sites. In developing economies where agricultural practices are mainly subsistent, maize is a seasonal product common in the rainy season as a dominant staple food. The volume of corn cobs that litter the environment is large, causing disposal problems to municipal sanitary authorities. The tonnage released annually creates social and economic problems and is largely responsible for the blockage of drains.

Waste recycling is an essential component of worldwide management of solid waste, aiming at cleaning up the environment as well as energy generation. Corn cob may be infused into the soil as compost manure or organic fertilizer. The extent to which soil quality may be enhanced by corn cob and other agricultural wastes[1,2] has not received adequate attention. The present work seeks to examine the effect of corn cob water extract on the physicochemical properties of top soil in the hope that such first hand information may suggest the economic importance and better corn cob disposal management.

EXPERIMENTAL

Corn cob samples

Fresh corn cobs used for this study were collected from a small-hold farmer located in Ekpoma. The fresh cobs were crushed and 50g of it was soaked in 500cm^3 of distilled water for 24 hours and filtered.

Soil samples

The soil samples used were previously collected from twelve sites of arable land located in carefully selected areas of Edo State of Nigeria (Fig. 1. A-L)[3,4]. In all the sites, aggregate top soil samples were taken by the use of augur at 0 - 15cm depth and at points spaced 5 - 10cm apart. The soils were bulked into cellophane bags and later air dried, crushed, mixed and sieved through a 2mm sieve. The sieved samples were than stored in plastic containers for analysis.

Treatment of soil samples

Using a fine hose watering can, 30cm^3 of the 24 hour corn cob filtrate was applied evenly to and properly mixed with 50g of a sieved soil sample.

Physicochemical analysis

Total nitrogen was determined by the macro Kjejdahl method[5]. Particle size analysis was done by the hydrometer method[6] with calgon as the soil dispersing agent. Soil pH was determined with a Bechman pH meter using glass electrode. Organic carbon was determined by dichromate wet oxidation method[7]. Available phosphorus was determined by Bray P1 mehtod[8]. Exchangeable cations and cation exchange capacity (CEC) were determined titrimetrically[10]. Exchangeable sodium, calcium and potassium were determined by flame photomerty[11] while exchangeable magnesium was determined by atomic absorption spectrophotometry.

RESULTS AND DISCUSSION

The nutrient composition of the extract corn cob assayed is presented in Table 1. The pH of the

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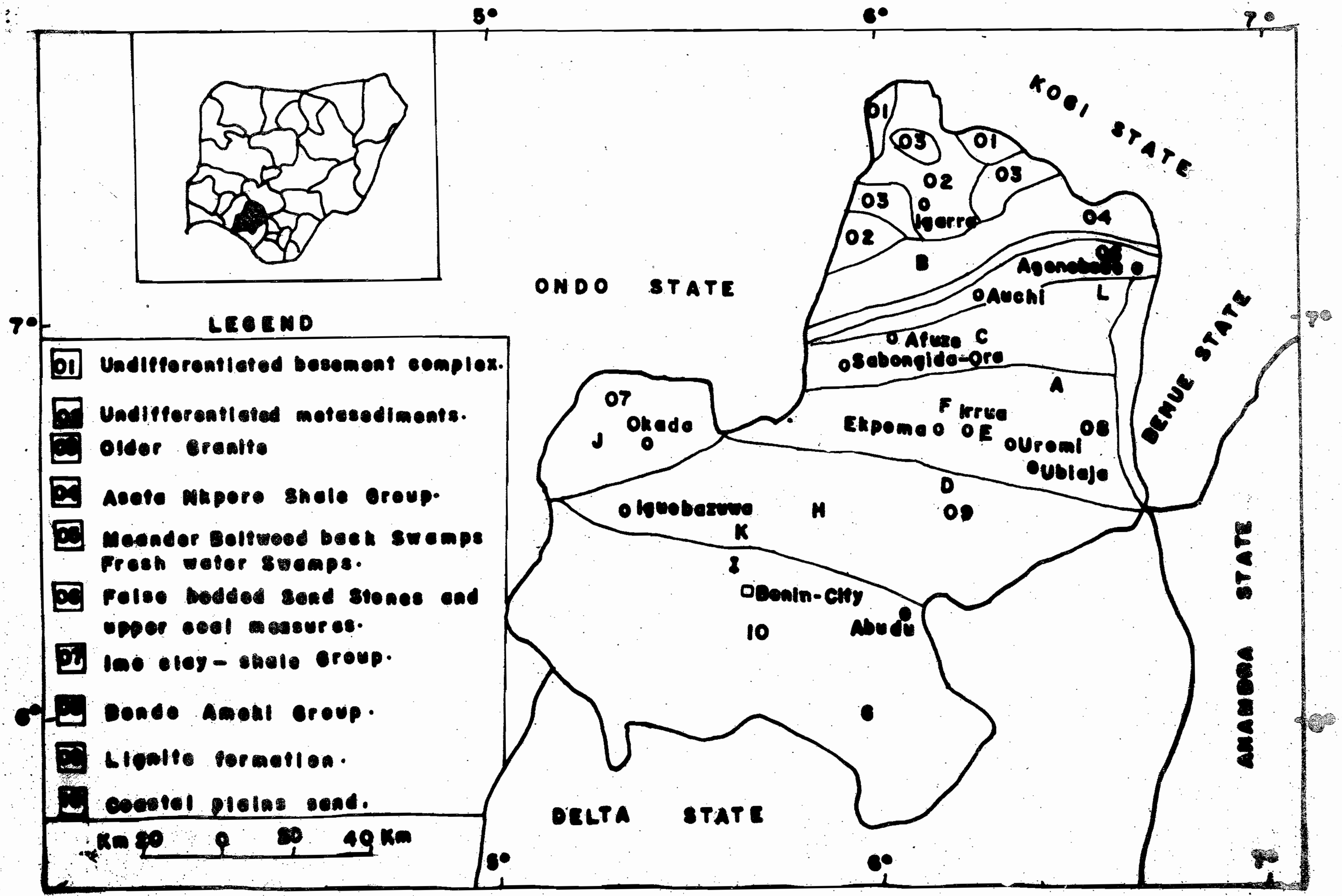

Fig. 1: Sample Locations (A-L) Geological map of Edo State (3-4.

Table 1. Nutrient composition of corn cob extract

Nutrient element	Composition
C(%)	0.012
N(%)	0.000037
P(mg/kg)	0.0014
Na(cmol/kg)	3.17
K ”	26.68
Ca ”	0.52
Mg ”	0.08
H ”	0.07
Al ”	0.00

extract was shown to be 4.19 which indicates that the extract was acidic. Potassium and calcium levels were appreciably high compared to the other elements. Tables 2 and 3 show the physicochemical properties of the soils before and after treatment respectively.

Table 2. Physicochemical properties of soil samples before treatment

S/N	Location	US Taxonomy	pH	C	N	P(mg/kg)	Na	K	Ca	Mg	H	CEC
				(%)			(cmol/kg)					
1	A	Lithic Haplustaf	5.90	0.80	0.07	84.00	0.66	0.24	4.96	1.36	0.50	7.72
2	B	Oxic Tropudafs	5.50	1.38	0.12	63.00	0.62	0.37	4.56	1.36	0.40	7.31
3	C	Typic Paleudult	4.80	1.34	0.12	14.88	0.81	0.31	5.04	1.52	0.70	8.38
4	D	Typic Tropudafs.	4.40	0.48	0.03	8.75	0.61	0.27	6.24	0.96	0.40	8.48
5	E	Lithic Ustorhents	5.00	2.05	0.20	23.63	0.62	0.12	4.64	0.72	0.90	7.00
6	F	Rhodic Paleustafs	5.30	0.02	0.19	31.50	0.58	0.17	5.20	0.64	0.70	7.29
7	G	Typic Paleudults	4.60	0.70	0.02	14.00	0.70	0.16	3.68	0.56	0.70	5.80
8	H	Rhodic Paleudults	5.40	0.83	0.06	28.00	0.62	0.13	3.60	3.25	0.50	8.10
9	I	Typic Paleudults	5.10	0.61	0.05	29.75	0.60	0.11	4.08	0.88	0.60	6.27
10	J	Rhodic Paleudults	4.90	1.28	0.11	26.25	0.69	0.20	3.04	2.24	0.50	6.67
11	K	Rhodic Paleudults	4.50	0.70	0.05	31.50	0.70	0.11	3.60	0.96	0.40	5.77
12	L	Typic ustipsamment	4.70	0.83	0.06	28.00	0.62	0.12	4.08	0.72	0.30	5.84
		Average	5.01	1.09	0.08	31.94	0.65	0.19	4.39	1.26	0.55	7.05

Table 3. Physicochemical properties of soil samples after treatment

S/N	Location	US Taxonomy	pH	C	N	P(mg/kg)	Na	K	Ca	Mg	H	CEC
				(%)			(cmol/kg)					
1	A	Lithic Haplustaf	6.10	0.93	0.37	749.54	1.14	6.30	3.00	0.40	0.30	11.14
2	B	Oxic Tropudafs	5.70	1.25	1.46	1072.82	0.59	5.18	2.60	5.80	0.20	15.00
3	C	Typic Paleudult	4.60	1.70	1.10	145.13	0.75	5.62	4.40	1.60	0.70	13.07
4	D	Typic Tropudafs	4.60	0.99	2.92	794.16	0.56	5.60	1.44	1.64	0.80	10.04
5	E	Lithic Ustorhents	5.40	1.40	1.46	513.40	0.66	5.81	4.00	2.00	0.30	12.77
6	F	Rhodic Paleustafs	5.80	1.12	2.56	1004.65	0.61	4.85	4.80	0.96	0.30	11.52
7	G	Typic Paleudults	3.90	1.22	1.46	261.79	0.57	7.56	3.80	3.80	0.80	16.53
8	H	Rhodic Paleudults	5.40	2.37	0.73	383.73	0.56	5.14	4.64	1.60	0.20	12.14
9	I	Typic Paleudults	5.20	0.51	0.37	162.70	0.87	5.52	4.64	1.76	0.30	13.09
10	J	Rhodic Paleudults	4.30	1.79	0.37	397.43	0.57	5.14	2.80	1.20	0.50	10.21
11	K	Rhodic Paleudults	5.10	2.37	0.37	315.91	0.54	6.78	1.20	0.60	0.30	9.42
12	L	Typic ustipsamment	4.80	1.15	0.37	234.03	0.53	6.49	1.60	1.60	0.30	10.52
		Average	5.08	1.48	1.13	502.94	0.66	5.89	3.24	1.91	0.42	12.12

The pH of the untreated soils varied from 4.40 to 5.90 with a mean of 5.01 while that of the treated soils varied from 3.90 to 6.10 with a mean of 5.08 (Tables 2 and 3). The pH of the treated soils on average was higher than the pH of the untreated soils by 1.39%. Both treated and untreated soils pH were in the weakly acidic range (pH 5 - 6). The slight increase in pH may not lead to any marked change in soil characteristics (colour, texture, structure and consistency).

The organic carbon content of the untreated soils varied from 0.48 to 2.05% with a mean of 1.09% while that of the treated soils varied from 0.93 to 2.37% with a mean of 1.48% (Tables 2 and 3). On average, the organic carbon content of the treated soils was higher than the untreated soils by as much as 38%. The increase in carbon content of the treated soils may be partly attributed to the contribution from corn cob and possibly from favoured activities of micro-organisms in the reduced acidity of the treated soils. In soils, bacteria convert organic matter to available carbon and this action is more favoured as pH increases from weakly alkaline to alkaline pH.

The total nitrogen level of the untreated soils varied from 0.02 to 0.20% with a mean of 0.08% while that of the treated soils varied from 0.37 to 2.92% with a mean of 1.13%. On average, the nitrogen levels of the treated soils was considerably higher than that of the untreated soils. From the low level of nitrogen in the extract (Table 1), it is unlikely that the contribution from the extract was substantial; the remarkable increase in nitrogen observed in this work is not understood. A conducive soil condition could however enhance nitrogen fixing processes and agents.

The available phosphorus of the untreated soils ranged from 8.75 to 84mg/kg with a mean of 31.94mg/kg while the treated soils phosphorus level varied from 145.13 to 1072.82mg/kg with a mean of 502.94mg/kg. The phosphorus content of the treated soils was considerably higher than that of the untreated soils. The critical level of available phosphorus using Bray P1 was given as 15mg/kg[12]. The results from this study showed that whereas 75% of the untreated samples were sufficient in available phosphorus (Table 2), all the treated samples were sufficient in available phosphorus (Table 3). However, because of the increase in the pH of the treated soils in most cases, there is the tendency of availably phosphorus to become fixed with time. The marked increase in phosphorus content of the treated soils may be attributed to contribution from corn cob but may be related to pH controlled release of available phosphorus in the soils[13].

The exchangeable sodium content of the untreated soils varied from 0.58 to 0.81cmol/kg with a mean of 0.65cmol/kg while the sodium level of the treated soils varied from 0.53 to 1.14cmol/kg with a mean of 0.66cmol/kg (Tables 2 and 3). The exchangeable sodium content of the treated soils on average was about the same with untreated soils. The exchangeable sodium percentage (ESP), the percentage of cation exchange sites of soil occupied by sodium is important in deciding whether a soil is highly dispersed. The exchangeable sodium percentage of the untreated soils varied from 7.19 to 12.13% with a mean of 9.42% while that of the treated soils varied from 3.45 to 10.23% with a mean of 5.58% (Tables 2 and 3). The critical level of sodium required in soils is 15%[13] above which the soil may be deflocculated and associated with problems of soil crusting. However, none of the treated or untreated soils showed values greater than the critical levels.

Exchangeable potassium levels of the untreated soils varied from 0.11 to 0.37cmol/kg with a mean of 0.19cmol/g while that of the treated soils varied from 5.14 to 7.56cmol/kg with a mean of 5.89cmol/kg (Tables 2 and 3). Exchangeable potassium content of the treated soils was markedly higher than the untreated soils. At about pH 5.5, exchangeable potassium becomes increasingly unavailable due to increased binding to cation exchange sites. However, the average values of potassium in the treated soils showed an increase of over 3000% indicating that the increase may not be due to pH influenced availability of potassium but may be due to external inputs from corn cob. Corn cob is relatively high in potassium. The critical level of exchangeable potassium in soils is 0.2cmol/kg[14]. The results showed that 33.33% of the untreated soils had their exchangeable potassium above the critical level while all of the treated soils had their exchangeable potassium above the critical level.

Exchangeable calcium and magnesium levels of untreated soils varied from 3.04 to 6.24cmol/kg and 0.56 to 3.25cmol/kg with means of 4.39 and 1.26 respectively (Table 2) while that of the treated soils varied from 1.20 to 4.80cmol/kg and 0.40 to 5.80cmol/kg with means of 3.24 and 1.91cmol/kg respectively (Table 3). There was marked difference between the exchangeable calcium and magnesium contents of untreated and treated soils: exchangeable calcium contents of the treated soils decreased while the level of magnesium in the treated soils increased over the untreated soils. The decrease in calcium level (about 35%) was attributed to a reaction with phosphates whose products are then bound to exchange sites. Magnesium suffers the consequence of an enhanced binding of calcium to sites as its binding to exchange sites is thereby reduced.

Exchangeable hydrogen content of the untreated soils varied from 0.30 to 0.90cmol/kg with a mean of 0.55cmol/kg while that of the treated soils varied from 0.20 to 0.80cmol/kg with a mean of 0.42cmol/kg. On average, the exchangeable hydrogen of the treated samples was lower than that of the untreated soils. This decrease was ascribed to the acidic pH of the treated soils which affects the release of bound hydrogen.

The cation exchange capacity presented in Tables 2 and 3 was the sum of exchangeable acids and bases. The cation exchange capacity of the untreated soils varied from 5.77 to 8.48cmol/kg with a mean of 7.05cmol/kg while the cation exchange capacity of the treated soils varied from 9.42 to 15.00cmol/kg with a mean of 12.12cmol/kg. The cation exchange capacity of the treated soils was higher than the untreated soils by about 72% on average. Although the decrease in hydrogen saturation would have led to a decrease in cation exchange capacity, the marked increase in potassium level ascribed to input from corn cob may largely be responsible for the increase in cation exchange capacity. The critical value of the soil fertility status with regard to cation exchange capacity is 4.0cmol/kg[15]. The results showed that cation exchange capacity of the soils was markedly enhanced by the treatment.

The percentage base saturation, which is another parameter for evaluating soil fertility is the contribution of exchangeable bases to the overall exchange capacity. From the data of Tables 2 and 3 the percentage base saturation of the untreated soils varied from 87.93 to 95.28% with a mean of 92.09% while that of the treated soils varied from 92.03 to 98.67% with a mean of 96.50%. There was no marked difference between the percentage base saturation of untreated and treated soils (Tables 2 and 3).

Also based on the data tabulated (Tables 2 and 3), the soil buffering capacity of the untreated soils varied from 6.78 t0 20.20 with a mean of 12. 94 while that of the treated soils varied from 11.55 to 74.00 with a mean of 35.35. The soil buffering capacity of the treated soils was higher than that of the untreated soils.

Exchangeable aluminium was undetected in both the treated and untreated soil samples while the percentage of clay, silt and sand were unchanged by the treatment.

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