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The Effect of Fresh and Aged *Cassava* Processing Effluent on the Physio - Chemical Properties of Soil

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Fresh *Cassava* processing effluent was obtained from a *Cassava* processing mill in Ekpoma, Edo State. One half of the fresh effluent was used to pollute top soil while the second half was aged for 7 days before use. The relative effects of the fresh and aged *Cassava* effluents on the physio - chemical properties of soil were determined. The effects of pollution varied with the soil/effluent contact period and the nature of the effluent. The result showed increase in the levels of pH, organic carbon, phosphorus, sodium, potassium; and decrease in calcium, magnesium and nitrogen in the soil after treatment with the effluents. There were no marked differences in the particle size distribution nature of the soil and the level of the exchangeable acidity after treatment with the effluents. The results showed that the disposal on the top soil of fresh and aged *Cassava* processing effluent could have diverse effects on the nutrient availability in the soil.

Key words: *Cassava*, particle size, Dicotyledon plant, *Euphorbiaceae.*

Introduction

Cassava (*Manihot esculenta* Crantz) is a dicotyledon plant belonging to the family Euphorbiaceae. Its tuberous roots are valuable source of cheap calorie,especially in developing countries where calorie deficiency and malnutrition are wide spread. *Cassava* is well - cultivated in all the tropical regions of the world (Nestel 1973).

Two main types of *Cassava* are cultivated in Nigeria; namely, the “sweet” variety, which has low content of cyanogenic glycosides, and the “bitter” variety, which has high cyanide content. The utilization of *Cassava* roots for both human and animal nutrition appears to be limited by the presence of the cyanogenic glycosides. As a result a number of traditional methods (Rosling 1988) have been used to process *Cassava* tubes in order to reduce toxicity and improve palatability.

Garri, the form in which *Cassava* is most widely consumed in Nigeria, is derived from the roots by peeling away the back of the *Cassava* tuber, grating the tuber, dewatering and fermentation of the grated pulp and then roasting of the resultant mash. Garri is probably the most important single traditional stable food in West Africa, and it is estimated that about 70% of the total *Cassava* grown in Nigeria are channeled into garri production (Olayide *et al* 1972). The annual output of garri in Nigeria has been estimated as 1.5 - 2 million metric tones, amounting to a monetary turnover of N150 - 200 million (Ngoddy and Kaplinsky 1968). The large volume of wastewater generated in the processing of *Cassava* is often discharged untreated into the environment. In this study, the relative effects of fresh and aged *Cassava* processing effluents on the physio-chemical properties to top soil are examined.

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Experimental

Collection of soil sample and Cassava effluent. The soil sample used for this study was collected from a fallow land in Ekpoma. Composite topsoil (0 - 15cm) sample was collected, air - dried, crushed, mixed, sieved through 2mm sieve and stored in a plastic container. The soil sample was characterized in terms of pH, organic carbon, exchangeable bases and acidity, nitrogen, phosphorus and particle size distribution.

Fresh *Cassava* processing effluent was collected at a *Cassava* processing mill in Ekpoma. One half of the *Cassava* effluent was aged (allowed to stand) for 7 days before use. The fresh and aged samples of the effluents were characterized in terms of pH, organic carbon, nitrogen, phosphorus, exchangeable bases and cyanide content.

Treatment of the soil sample with Cassava effluent. Three hundred g of the soil samples were separately weighed into ten plastic containers. Five of the weighed soil specimens were mixed thoroughly with 100ml of fresh effluent and air - dried for 5,10,15,20, and 25 days respectively. The samples were designated F_5, F_{10},F_{15},F_{20} and F_{25}. Remaining five samples were treated in the same manner with aged *Cassava* effluent. The samples were designated A_5, A_{10}, A_{15}, A_{20}, and A_{25}. The fol-

Table 1
Characteristics of the fresh and aged *Cassava* effluents

Parameters tested	Fresh *Cassava* effluent	Aged *Cassava* effluent
pH	6.30	6.00
Carbon(%)	0.46	0.52
Nitrogen(%)	0.27	0.36
Phosphorus(ppm)	192.00	168.20
Sodium (meq / 100 soil)	1.90	0.54
Potassium ″	2.70	1.45
Calcium ″	0.68	0.92
Magnesium ″	0.85	0.87
Cyanide (meq / 1)	2.56	1.98

lowing determinations were carried out using the various soil samples.

pH of soil sample in water. Twenty g of the soil sample was weighed into a 50ml beaker; 20ml of distilled water was added, stirred and allowed to stand for 30 min. The pH of the mixture was then determined using a Bechman pH meter.

Soil organic carbon. The organic carbon contents of the soil samples were determined by Walkely Black method (Black 1965).

Exchangeable bases (calcium magnesium, potassium and sodium). Calcium and magnesium in the soil samples were determined using the EDTA complexometric method (Jackson 1958), while the potassium and sodium were determined by the flame photometry (Jackson 1958).

Exchangeable acidity (hydrogen and aluminium). The exchangeable acidity of the soil samples was determined by titration of the KCl extract of the sample with 0.01M NaOH (Jackson 1958). The exchangeable acidity in the soil samples were expressed in meq/100 of soil.

Phosphorus. The phosphorus contents of the soil samples were determined using the Bray PI method (Bray and Kurtz 1945).

Total nitrogen. The total nitrogen content of the soil samples was determined using the Macro - Kjeldhal digestion - distillation method (Bremner 1960).

Physical properties of the soil sample by mechanical analysis (Davidson 1953). Fifty g of air-dried soil was weighed into a shaking bottle. 50ml of distilled water was added, mixed with a stirring rod and allowed to set for 30 min. The soil suspension was then stirred with a mechanical stirrer for 30 min.

Table 2
Physio - chemical characteristics of the untreated soil sample

Parameters tested	Composition
pH	6.60
Carbon(%)	0.38
Nitrogen(%)	0.46
Phosphorus(ppm)	5.30
Sodium (meq / 100 soil)	0.06
Potassium ″	0.10
Calcium ″	7.92
Magnesium ″	0.88
Hydrogen ″	0.20
Aluminium ″	9.26
ECEC	9.26
Clay (%)	2.30
Silt (%)	4.40
Sand (%)	93.30

The suspension was transferred to the mechanical analysis glass cylinder and made up to mark with distilled water. The cylinder was shaken by inverting it several times until all the soil went in suspension. The cylinder was placed on a flat surface and the time was noted. A hydrometer was slowly slided into the suspension and the first reading on the hydrometer was recorded after 60 sec to obtain the percentage sand in the soil. The second reading of the hydrometer was taken after 2 h to obtain the percentage clay. The difference in the hydrometer readings gives the percentage silt.

Characterisation of Cassava processing effluents. The fresh aged *Cassava* processing effluents were characterised to determine their composition. The pH, the carbon, nitrogen and phosphorus contents and the exchangeable bases were determined.

The cyanide contents of the effluents were determined by titrating 25ml of the *Cassava* effluent with 0.1N silver nitrate using diphenyl carbazine as indicator (Vogel 1978).

Results and Discussion

The results obtained from the analysis of the fresh and aged *Cassava* effluents and the various soil samples are shown in Table 1 to 4. The *Cassava* effluents were found to be rich in phosphorus, potassium and sodium. The fresh effluent contained 192 ppm phosphorus, 2.70 meq /l potassium and 1.90 meq /l potassium and 0.54 meq / l sodium as compared to the untreated soil which contained 5.30 ppm phosphorus, 0.10 meq potassium and 0.06 meq sodium per 100 g soil.

Table 3
Physio - chemical characteristics of soil samples treated with fresh *Cassava* effluent

Parameters tested	F_5	F_{10}	F_{15}	F_{20}	F_{25}
pH	7.30	7.70	7.90	8.00	8.00
Carbon (%)	0.96	0.90	0.77	0.70	0.65
Nitrogen (%)	0.27	0.22	0.19	0.14	0.12
Phosphorus (ppm)	60.40	66.70	70.60	71.90	70.80
Sodium (meq/100 soil)	0.27	0.21	0.15	0.13	0.11
Potassium ″	0.57	0.54	0.53	0.49	0.47
Calcium ″	7.12	7.20	7.28	7.52	7.76
Magnesium ″	2.64	2.56	1.60	0.88	0.16
Hydrogen ″	0.20	0.20	0.20	0.30	0.20
Aluminium ″	0.00	0.00	0.00	0.00	0.00
ECEC	10.80	10.61	9.76	9.32	8.70
Clay (%)	2.30	1.80	2.30	2.30	2.30
Silt (%)	3.40	2.90	3.40	3.40	3.40
Sand (%)	94.30	95.30	94.30	94.30	94.30

Table 4
Physio - chemical characteristics of soil samples treated with aged *Cassava* effluent

Parameters tested	F_5	F_{10}	F_{15}	F_{20}	F_{25}
pH	7.40	7.80	8.20	8.20	8.30
Carbon (%)	1.18	1.12	1.09	0.90	0.76
Nitrogen (%)	0.44	0.42	0.38	0.27	0.26
Phosphorus (ppm)	42.40	43.50	51.50	51.50	52.00
Sodium (meq/100 soil)	0.09	0.08	0.09	0.10	0.11
Potassium ″	0.20	0.20	0.22	0.25	0.29
Calcium ″	8.82	8.88	8.40	8.08	7.20
Magnesium ″	2.55	1.58	0.96	0.64	0.40
Hydrogen ″	0.20	0.20	0.20	0.20	0.10
Aluminium ″	0.00	0.00	0.00	0.00	0.00
ECEC	11.86	10.94	9.87	9.27	9.27
Clay (%)	2.30	1.80	2.30	2.30	2.30
Silt (%)	3.40	2.90	3.40	3.40	3.40
Sand (%)	94.30	95.30	94.30	94.30	94.30

The results in Table 3 and 4 show that there was no marked difference in the particle size distribution nature of the soil, before and after treatment with the effluents. The untreated soil sample was found to contain 93.30% sand, 4.40% silt and 2.30% clay. Treatment with fresh *Cassava* effluent increased the sand content to 95.30% and reduced the silt content to 2.90% after the soil/effluent contact period of 10 days. Pollution did not show any appreciable effect on the clay content of the sample. Similar results were obtained when aged *Cassava* effluent was used instead of the fresh effluent.

The pH of the untreated soil, the fresh and aged effluents were 6.60, 6.30 and 6.00, respectively. The pH levels of the soil samples treated with aged effluents ranged from 7.30 to 8.00 while those of samples treated with aged effluents ranged from 7.40 to 8.30 as the contact period increased from 5 to 25 days. The results show that *Cassava* processing effluents (fresh or aged) increase the pH of the soil making it alkaline. However, the increase in pH was more pronounced when the aged effluents were used. Soil alkalinity is mainly caused by the presence of OH^- and HCO_3^- anions. These anions are generally produced by the hydrolysis of carbonates in the soil, particularly sodium carbonate. The increase in the pH of the soil samples following treatment with *Cassava* effluents could be due to the fermentation of the effluents during which CO_2 is released. The increase in pH of the soil from 6.60 to 8.30 could have a negative effect on the growth of plants, as it is known that plants survive in a pH range of 5.70 to 7.80 (Egharevba and Mayah 2001).

The organic carbon content of the soil increases form 0.38% for the untreated soil to 0.96% when the soil was treated with fresh effluent for a period of 5 days. Further increases in the contact period reduced the organic carbon content to 0.65 (25 days contact period). When the aged effluent was used, the percentage of carbon contents was generally higher than the fresh effluent. The organic carbon increased to 1.18% at the contact period of 5 days and decreased to 0.76 at the contact period of 25 days. The general increase in the levels of organic carbon of the soil can be attributed to the contribution from the effluents.

The nitrogen contents of the soil samples were depleted when the fresh and fermented effluents were used to pollute the soil samples. However, the negative effect produced by the fresh effluent was more than the fermented effluent.

The nitrogen content decreased from 0.46 % to 0.12 and 0.26% after treating for 25 days with fresh and aged effluents respectively. Adequate nitrogen in the soil is important for the optimum growth of plants since all the vital processes in plants are associated with the presence of nitrogen. It has been reported that nitrogen functions effectively in the structure of proteins, vitamins, hormones and chlorophyll (Dvayi and Ekong 1981). Fresh *Cassava* effluent would in particular render the soil infertile. The decrease in the level of nitrogen in the soil after treatment with the effluents can be attributed to volatilization of the gaseous nutrient from the surface of the soil as well as denitrification (Ulysses 1982). Of the nutrients that plants normally require nitrogen is the most easily lost as ammonia particularly in soil that is poorly drained at a pH of about 7 (Ulysses 1982). The pH of the soil sample treated with fresh and aged effluents varied from 7.30 - 8.00 and 7.40

- 8.30 respectively when the soil / effluent contact period varied from 5 to 25 days. At a pH of about 7, some nitrogen could have been lost as ammonia. In the process of denitrification, nitrogen can be converted by anaerobic bacteria present in the effluents to gaseous nitrogen, which is lost to the atmosphere.

The phosphorus content of the soil was markedly increased from 5.30 ppm for the unpolluted soil to 71.90 ppm and 52.00 ppm when the soil samples were treated with fresh and aged effluents for 25 days respectively. This was justified because the analysis of the *Cassava* effluents revealed a high phosphorus content of 192.00 ppm and 168.20 ppm for the fresh and aged effluents respectively. Phosphorus is a highly predominant mineral in *Cassava* tuber. It is important in the plant system for carbohydrate breakdown for energy release, cell division and stimulation of early root growth and development. It also enhances early maturation of seeds and fruits (Jones 1982). This study has shown that polluting the soil with *Cassava* effluent could enrich the soil with phosphorus.

The results obtained for the exchangeable bases show that the levels of sodium and potassium generally increases when the soil is treated with the fresh and aged effluents. The level of calcium in the soil was reduced when treated with fresh effluent, but it increased from 7.92 to 8.88 meq / 100g soil when treated with aged effluent at a contact period of 10 days. The levels of magnesium decreased from 0.88 meq per 100g soil to 0.16 meq and 0.40 meq per 100g soil at a contact period of 25 days respectively, when the soil samples were treated with fresh and aged *Cassava* effluents. The decrease in the levels of calcium and magnesium can be attributed to their precipitation as insoluble phosphates (Egharevba and Mayah 2001).

The exchangeable bases are important plant nutrient elements in the soil. Treatment of soil with fresh or aged effluent did not produce any marked effect on the available hydrogen and aluminium in the soil sample.

The Effective Cation Exchange Capacities (ECEC) of the soil samples increased from 9.26 meq /100g soil for the untreated soil to 10.80 and 11.86 meq/100g soil respectively, when the soil samples were treated with fresh and aged effluents for 5 days. The values decreased to 8.70 and 9.27 after 25 days of treatment with fresh and aged effluent.

This study shows that polluting the top - soil with fresh and fermented *Cassava* effluents lead to a diverse effect on the physio - chemical properties of the soil. The increase in pH and the depletion of nitrogen and calcium when fresh *Cassava* effluent was used to pollute the soil could have a negative effect on the fertility of the soil. The deteriorating effect of pollution on the nitrogen content of the soil was less pronounced when the aged effluents were used. Also, the calcium contents of the soil was enhanced when the aged effluent was used to pollute the soil. It can therefore, be recommended that effluents from *Cassava* processing mills should be stored in a tank for a suitable period of time before it is discharged into the environment.

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