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INFLUENCE OF CASSAVA MILL EFFLUENT (CME) DUMPING ON SOIL PHYSICOCHEMICAL PARAMETERS AND SELECTED PLANT NUTRIENTS IN UTURU, ABIA STATE NIGERIA

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Abstract

This study monitored the influence of dumping cassava mill effluents (CME) on soil physicochemical parameters and selected soil plant nutrients. Soil samples were collected from eight (8) CME dumping sites in two seasons (Wet: May – September and Dry: November – March). In each sampling site, soil samples were obtained from discharge spot, 4 and 8 meters from discharge spot along the route of flow of effluents. Top soil samples, (0 – 30cm depth), sub-soil samples (31-60cm depth) and bottom soil samples (61-90cm depth) were collected from each sampling spot using plastic auger while control soil samples were from spots within each sampling site uncontaminated with effluents. The CME soil sample temperature and percentage moisture were significantly ($p<0.05$) higher than those of control soil samples. However, the pH of soil samples from CME dumpsites were alkaline ($7.6 \pm 0.04 – 8.1 \pm 0.30$). Similarly, low cation exchange capacities and exchangeable acidities ($p<0.05$) were obtained for CME dumpsite soil sample relative to control soil samples. This study also established low ($p<0.05$) aluminium ion (Al^{3+}) sulphate ion (So_4^{2-}), sodium ion (Na^{+}) and potassium ion (k^{+}) in the CME infiltrated soils. Although CME soil phosphate did not vary from that of control soil samples, CME dumpsite soil ammonium and nitrate ions were higher ($p<0.05$) than in control soil samples. These results therefore, indicate that the CME infiltrated soils may not be useful for agricultural purposes – unless properly managed.

Introduction

Cassava is extensively cultivated in the tropical and subtropical regions of the world and grows to edible starely tuberous root with more than 200 calories/day of food value (FAO, 2004). Cassava, *Manihot esculenta* (Cratz) FAO, 2004) is the major sources of carbohydrate and the third largest food crop whose tubers are harvested between 7-13 months based on the cultivars planted (Taye, 1994). Cassava processing involves several unit operations such as peeling, washing, grinding, pressing (to remove water), fermentation, sieving and drying. The final product of the above processing method is a fine edible flour (garri) Okaka, 2006). Other processing methods will lead to production of crispchips, tapioca or a slurry delicacy, foofoo. The processing of cassava is associated with discharge of large water (Ogeweole and Donfe, 1992). The production and subsequent consumption of cassava have increased extensively in recent times. This increased utilization of processed cassava product has equally increased the environmental pollution associated with the disposal of the effluents (Nwaugo *et al*., 2008). Among all the products processed from cassava, garri is the most common in Nigeria. Garri production is done in varying scales: in small scale, medium and large scales. In processing of cassava the outer covering of cassava root (peel) is removed (i.e. peeled off). The peel which contains the outer thin brown and a thick leathering paranchymateous inner covering are discarded as waste and allowed to rot. Also discarded are the fibre, cassava juice and the residue water produced after separating starch and fibre during the periods of fermentation and drying respetivley (Cassava Mill Effluent, CME) (Oboh and Akindahunsi, 2005). These wastes have been noted to contain varying concentrations of heavy metals either as simple metal or complexes (Igbozurike *et al*., 2002). Also various forms of cyanide complexes have been noted in cassava leaves and tubers (Oti, 2002).

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Continuous discharge of cassava effluent have been shown to accentuate adverse effects of cassava wastes to the environment and biodiversities (Goodley, 2004). For instance, CME discharged to the environment has been associated to foul smell and production of unattractive sights (FAO and IFAD, 2001). This effluent has also been shown to upset marine ecological equilibrium (Uzoije and Egwuonwu, 2011). Arimoro *et al*. (2008) showed a depletion of dissolved oxygen, depression in pH values, elevation of BOD and nitrate values in the tropical streams of southern Nigeria. With high pH value of cassava mill effluent germination of seed by contaminated soils has been shown to be inhibited (Olorunfemi *et al*., 2007). Varying levels of soil cyanide have been obtained from CME dumpsite soils (Chinyere, 2001,2003 and, 2013, Nwabueze and Odunsi, 2007; Nwaugo *et al*., 2008a).

Ehiagbonare (2009) reported an increased air pollution by CME in Okada environment and obliteration of fungi population in the polluted soil and Olorunfemi (2008) reported decreased chlorophyll and protein content of cereals grown in soils polluted with CME. As a result of the environmental impact of CME, this study is aimed at establishing the influence of CME dumping on selected soil ions and plant nutrients.

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Methodology

Sample collection: A total of eight (8) sampling sites were used for sample collection. In each site, three spots were chosen for the collection of samples thus:

Spot X: was the discharge point of effluents

Spot Y: Was a point four (4) meters away from spot X along the route of flow of discharged effluent.

Spot Z: Was a point eight (8) meters away from spot X along the route of flow of discharged effluents.

At each spot X, Y and Z three samples were collected and designated as X_1, X_2, X_3, Y_1, Y_2, Y_3 and Z_1, Z_2, Z_3.

Samples A ($X_1 + Y_1 + Z_1$) = Top soil samples from 0 to 30cm depth, B(X_2, + Y_2 + Z_2) = subsoils, samples from 31cm to 60cm depth and C ($X_3 + Y_3 + Z_3$) = bottom soil samples from 61cm to 90cm depth respectively. Control samples were collected from spots in each site not infiltrated by effluent and designated D_1, D_2 and D_3 respectively. Samples collected were packed separately in marked cellophane bags tightly tied to avoid contamination and stored in refrigerators of temperature 4-6^{o}c. Samples were sieved (4mm) and sub-samples for the determination of physicochemical parameters were air-dried and sieved (2mm) before analysis. Analyses were done in tow seasons thus: Wet season (May – September) and Dry season (November – March) respectively.

Sample Analyses

Soil temperature was monitored *insitu* at the site of collection of samples using mercury-in-glass thermometer while soil pH was determined using pH meter as described by Bates (1954). Soil moisture was measured using method of APHA (1998). However, soil samples exchangeable acidity, cation exchange capacity. sulphate, phosphate, and nitrate were determined using the methods of Dewis and Freitas (1970). Soil sample ammonium ion was measured using the method of Vogel (1962) while sodium, potassium and aluminium ions in soil samples were determined using Atomic Absorption spectroscopy according to AOAC (2005). All statistical analyses were done using ANOVA and Duncan Multiple Range.

Result and Discussion

The cassava mill effluents dumping led to rises in soil temperatures of dumpsites ($p<0.05$) (fig. 1) over those of control soil samples.

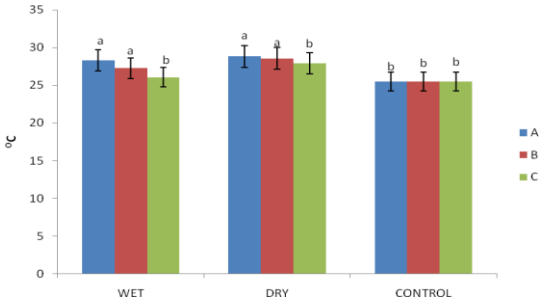

Fig 1: Cassava Mill effluent (CME) infiltrated soil temperature (^{o}C) wet and dry season.

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

Changes in soil temperature strongly affects root growth and nutrient uptake by plants. Shoot development and mineral nutrient accumulation by plants will be consequently hindered (Tagliavini *et al*., 1991, McMichael and Burk, 1998). Similarly the CME dumpsite soil pH increased significantly (alkaline) ($p<0.05$) over those of the control soil samples (fig. 2) in both seasons (wet and dry).

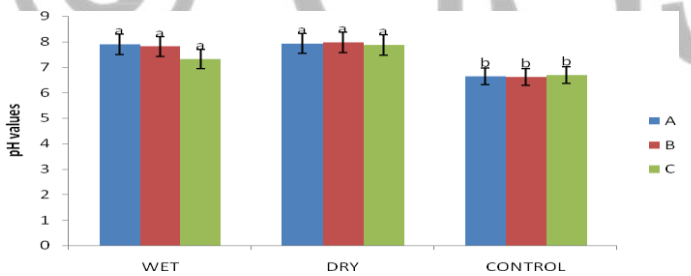

Fig. 2: Cassava Mill effluent (CME) infiltrated soil pH values. Wet and dry season.

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

This observation is in accordance with those of Ogboghodo *et al*. (2003 and 2006). Most crops grow at a pH of 6.4 to 7.0 (Hajek *et al*., 1990) and soil pH is one of the principal factors affecting nutrient availability to plants. Therefore, the availability of the plant nutrients in soils is affected by the impacted soil pH

(alkaline) changes. At pH values higher than 7.5 toxic levels of the major plant nutrients (nitrogen, potassium and phosphorus) may become present in the soil (Okwute and Isu, 2007a). The percentage moisture content of the CME impacted soil samples is as presented in fig. 3.

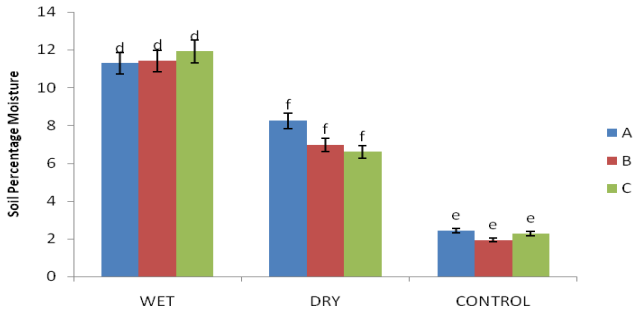

Fig. 3. Cassava Mill effluent (CME) infiltrated soil percentage moisture. Wet and dry season.

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

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Excess soil moisture of the CME impacted soil ($p<0.05$) over those of control soil samples is capable of limiting soil oxygen available to plants and microbes thus altering microbial activities. However, the cation exchange capacities (CEC) and exchangeable acidities (EA) of the CME soil were not altered ($p>0.05$) compared to control soil samples (figs. 4 and 5).

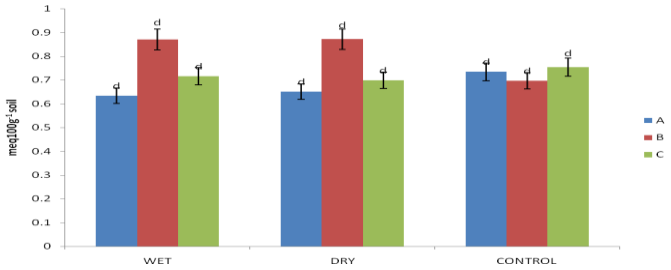

Fig. 4: Cassava Mill effluent (CME) infiltrated soil cation exchange capacity (meq100g^{-1} soil). Wet and dry season

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

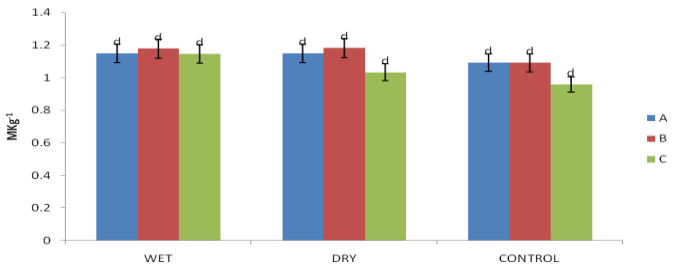

Fig. 5: Cassava Mill effluent (CME) infiltrated soil exchangeable acidity (MKg^{-1}). Wet and dry season

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

Similarly there was no seasonal (wet and dry) influence on CEC and EA. Soil aluminium and sodium ion concentrations were equally not affected by CME dumping (figs. 6 and 9)

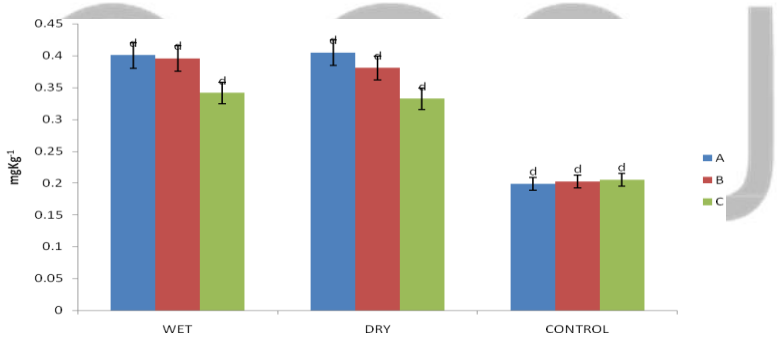

Fig. 6: Cassava Mill effluent (CME) infiltrated soil aluminum ion ($mgKg^{-1}$). Wet and dry season.

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

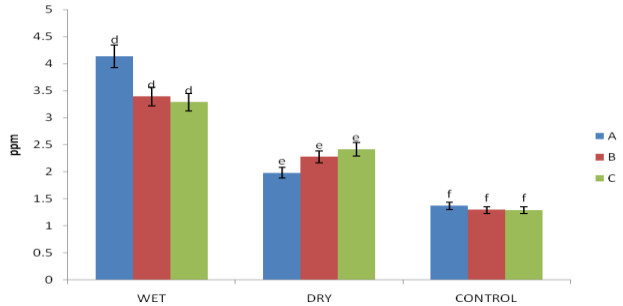

Fig. 7: Cassava Mill effluent (CME) infiltrated soil ammonium ion (ppm). Wet and dry season

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

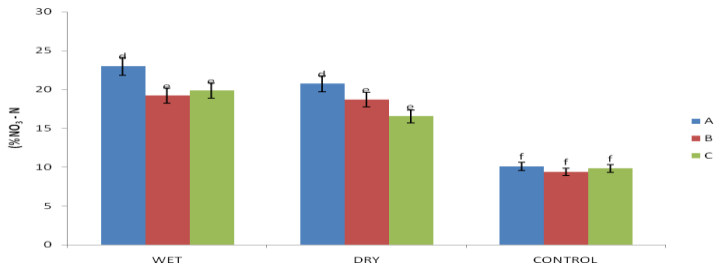

Fig. 8: Cassava Mill effluent (CME) infiltrated soil nitrate ion (% NO_3 - N). Wet and dry season

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

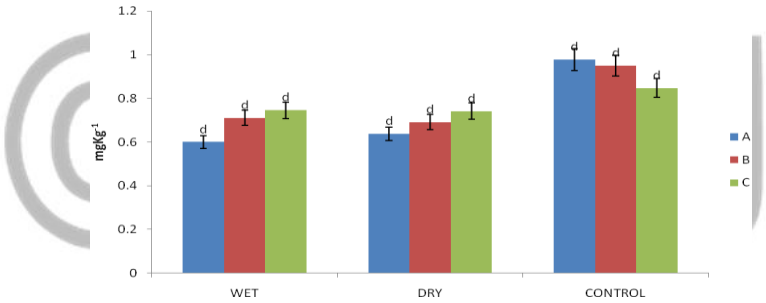

Fig. 9: Cassava Mill effluent (CME) infiltrated soil sodium ion ($mgKg^{-1}$). Wet and dry season.

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

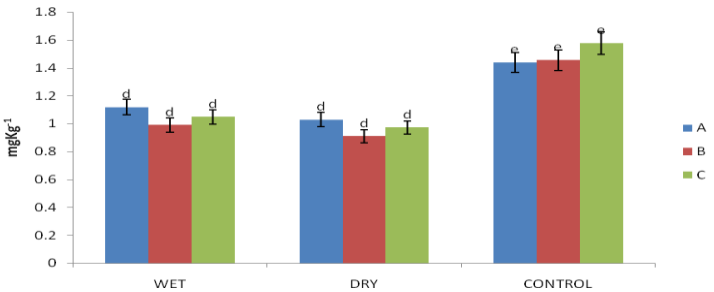

Fig. 10: Cassava Mill effluent (CME) infiltrated soil potassium ion (mg/Kg). Wet and dry season.

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

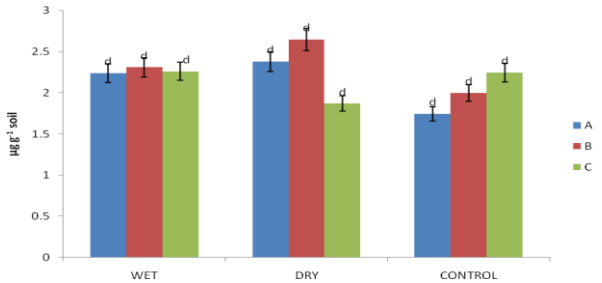

Fig 11: Cassava Mill effluent (CME) infiltrated soil phosphate ion (µg g^{-1} soil). Wet dry season

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

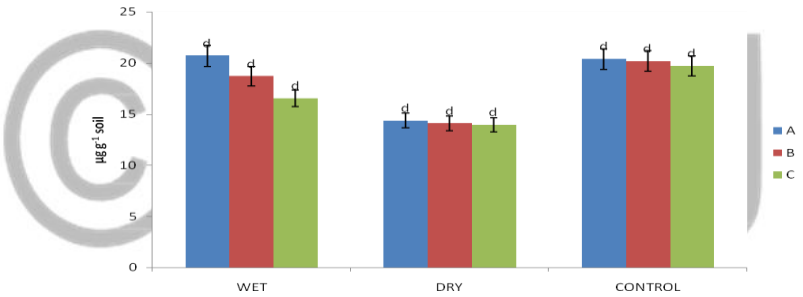

Fig. 12: Cassava Mill effluent (CME) infiltrated soil sulphate ion (µgKg^{-1}). Wet and dry season

Results are mean of triplicate determinations ± standard deviation (SD)
A = Top soil samples (0 - 30cm depth)
B = Subsoil samples (30 – 60cm depth)
C = Bottom soil samples (60 – 90cm depth)
Bars bearing the same letters are not significantly different (P>0.05)

The low percentage nitrogen observed for the CME impacted soil (fig 7) arose probably from the low protein content of cassava fibers and the alkaline environment of CME soils. This will encourage ammonification and nitrification leading to reduction of the soil nitrogen. Cookson and Lepiece (1996) reported increased urease activities in soils with low nitrogen but high NH_3 content.

This may explain the high (alkaline) pH of the CME soil samples. Soil samples percentage nitrogen from clayey CME impacted soils were higher ($p<0.05$) than those of loamy and sandy soils (table 1)

TABLE 1: PERCENTAGE NITROGEN (%) FOR 3 SELECTED SITES (CME)

Sample	WET SEASON			← Site →	DRY SEASON		
	1	2	3		1	2	3
A_1 (0-30cm) Deep	0.30±0.02^{ab}	0.32±0.00^{ab}	0.29±0.04^{ab}		0.16±0.04^{a}	0.19±0.01^{ab}	0.15±0.02^{a}
A_3 (60-90cm) Deep	0.08±0.01^{ab}	0.10±0.00^{ab}	0.08±0.06^{ab}		0.05±0.00^{b}	0.08±0.00^{ab}	0.04±0.00(??)
C_1 (0-30cm) Deep	0.26±0.03^{ab}	0.25±0.01^{ab}	0.20±0.02^{ab}		0.15±0.03^{a}	0.17±0.00^{ab}	0.14±0.01^{a}
C_3 (60-90cm) Deep	0.13±0.02^{ab}	0.16±0.06^{ab}	0.10±0.01^{ab}		0.04±0.01(??)	0.06±0.00^{ab}	0.03±0.00^{b}
D_1 (0-30cm) Deep	0.31±0.01^{ab}	0.34±0.03^{ab}	0.30±0.00^{ab}		0.13±0.00^{a}	0.15±0.01^{ab}	0.13±0.02^{a}
D_3 (60-90cm) Deep	0.11±0.04^{ab}	0.14±0.00^{ab}	0.09±0.01^{ab}		0.06±0.01^{b}	0.07±0.01^{ab}	UND

Soil Texture of Site: Site 1 = Loamy Figures are mean of triplicate determination ±
Site 2 = Clayey Standard deviation
Site 3 = Sandy UND = Undetected
?? = Query result
D_1D_2 = Control
$\mathbf{A}_1$ = Discharge point of effluent
C1 = 8 meters from A1 along effluent flow route
D = Control
Samples with same letters are not significantly different (P.0.05) for each season compared with control

Sadej and Przekwas (2008) noted that organic nitrogen is usually bound to clay and humus particles known as soil colloids forming stable complexes. Significantly high ($p<0.05$) ammonium ions concentrations were obtained from CME impacted soils during the wet season compared with the control soil samples. Ammonium ion values decreased with depth and distance of sample collection from the discharge point in the wet season and is associated with the level of CME assault. Urea hydrolysis leads to the conversion of urea-N to

ammonia and subsequently the ammonia reacts with proton to produce ammonium ions. This process leads to sharp increase in pH (beyond 7) and ammonium ions around the granule. In such an alkaline condition more ammonia is produced and increasing volatilization losses mean lower urea-N use efficiency (Zengping *et al*., 1991, Gioacchin *et al*., 2002). Also the CME soil samples had higher ($p<0.05$) nitrate levels than control samples. This indicated that higher nitrification reactions were going on in the CME infiltrated soil samples. This also attest to more biodegration of organic wastes in the soil samples. There were no changes between CME infiltrated soil sulphate and non-CME impacted soil.

In conclusion this study established that changes in soil pH, temperature and moisture caused by dumping of CME led to pollution problems experienced in CME dumpsites. Increased amonification in CME dumpsite soils led to high alkaline pH of such soils which discouraged plant growth. Similarly increased soil percentage moisture may have affected soil aeration and microbial activities. However, soil phosphate and sulphate ions were not altered while potassium ion was high in the CME impacted soils. Efforts should therefore be made to check these pollution problems posed by CME dumping. This will help in harnessing CME for profitable uses.

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References

Akubugwo, I. E; Ofoegbu, C. J. and Ukwuoma, C. U. (2007). Physicochemical studies on Uburu salt lake, Ebonyi State Nigeria. *Pakistan Journal of Biological Sciences (7)*: 3170 – 3174.

AOAC (2005). Official Methods of Analysis. 18th edn. Association of Official Analytical Chemists, Washington DC. 116 – 187.

APHA (1998). Standard methods for the examination of water and waste water 18th edn. Washington (American Public Health Association). 89 – 141.

Chinyere, G. C; (2001). Effect of effluents from cassava processing plants on soil cyanide levels; A case study of Okigwe in Imo state and Ovim Ahaba Imenyi in Abia State, Nigeria. *Journal of Health and Visual Sciences 3*(3) 88 – 93.

Chineyere G. C.(2003) Effect of effluents from cassava processing plants on soil cyande levels, A case study of Afikpo South L.G.A Ebonyi State and Umunneochi L.G.A Abia State Nigeria. Journal of Health and Visual Sciences (5) 1:56-63

Chineyere G. C., Akubugwo, E.I. and Ugbogu E.A. (2013). Effects of altering palm oil and cassava mill effluents pH before dumping on dumpsite soils physicochemical parameter and selected enzyme activities. *Journal of Biodiversity and Environmental Science* 3(4).

Cookson P. and G.L. Lepiece (1996). Urease enzyme activity of soils of the Batinah region sultanate of Oman. *Journal of Environment*. 32:225-238.

Bates, R. G. (1954). Electrometric pH determinations. John Willey and Sons Inc; New York.

Dewis, J.; and Fretias, F. (1970). Physical and Chemical methods of soil and water analysis. *Soil Bulletin 10*. FAD ROME. Pp 1 – 275.

Ehiagbonare, J.E. Adjarhore, R.Y; and Enabulele, S.A. (2009) Effect of cassava effluent on Okada natural water. *African Journal of Biotechnology,* 8 (12): 281-2818.

F.A.O and I.F.A.D, (2001) Stategtic environment assessment of the impact of cassava productions and processing on the environment and biodiversity.

Proceedings of the validations forum on the Global cassava Development strategy. 45-55.

F.A.O. (2004). Cassava industrial revolution in Nigeria. *Codex Alimentarius Commission XIL*, Supplementary 4. Rome.

Gioacchini, P; Nastric, A; and Marzadori C (2002). Influence of Urease and nitrification inhibitors on N losses from soils fertilized with urea. *Biology and Fertility* of *Soils*. 6:126-135.

Hajek, B.F; Karlen, D.L; Lowery, B; Power, J.F; Schumaker, T.E; Skidmore, E.L. and Sojka, T. (1990). Erosion and soil properties *In*: W.E. Larson., G.R, Foster, D.F. Allamaras and G.M. Smith (eds) *Research Issues In Soil Erosion Productivity* PP. 23-40

Goodley, J. (2004). A compendium DHI-water and Environment. 4th Edn. FAO, Canada.

Igbozuruike, C.W.I., Opara-Nadi A.O. and Okorie I.K. (2009). Concentrations of heavy metals in soil and cassava plant on sewage sludge dump. Proceedings of the 16h International Plant Nutrition Colloquium, July 8, *International Plant Nutrition Colloquium* pp. 152-160.

McMichael, B.L. and Burke, J. J(1998). Soil temperature and root growth *Horticulture Science* 33:97-951

Nwaugo V. O, Chima G.N. Ekot, C.A and Umeham, S.N. (2008a). Effect of cassava effluents on the physiochemical parameters and microbial flora of Nkissa River, Egbema Rivers State. *International Journal Biotechnology and Allied Sciences*. (1):346-353.

Nwaugo, V.O, Etok, C.A., Chima, C.N. and Ogbonna, C.E. (2008b) Impact of Cassava Mill Effluent (CME) on soil physiochemical and microbial community structure and functions. *Nigerian Journal of Microbiology* 22(1): 1681-1688.

Nwabueze, T.U. and Odunsi, F.O. (2007) Optimization of process conditions from cassava (manihot esculent a) lafun production. *African Journal of Biotechnology*. 6(5):603-611.

Oboh, G; and Akindahunsi A.A (2003). Chemical changes in cassava peels fermented with mixed cultcure of Aspergillus Niger and two species of

lactobacillus *integrated Bio-System, Applied Tropical Agriculture*. 8:63-68.

Ogboghodo, A. L; Oluwafemi, A. D; and Ekeh, M; (2006). Effects of polluting soil with cassava mill effluent on the bacteria and fungi populations of a soil cultivated with maize. *Environmental Monitoring and Assessment. 116*: 419 – 425.

Ogboghodo, I.A; Oluwafemi, A. P. and Unuigbe, C. A. (2003). Effects of polluting soil with Cassava (*Manihot esculenta*) Mill Effluent on Maize Growth and Some Soil Properties. *Nigerian Journal of Applied Science*., 21:62-67.

Okaka J.C. (2005). Processing of Starchy foods. In: Handling, storage and processing of plant foods. *OCJ Academic Publisher Enugu* pp. 251-255.

Okwute, L. O; and Isu, N. R; (2007a). The Environmental impact assessment of palm oil mill effluent (POME) on some physico-chemical parameters and total aerobic bioload of soil at a dump site in Anyigba, Kogi, state Nigeria. *African Journal of Agricultural Research 2(12)*: 658 – 662.

Olorunfemi, D.I; Obiaigwe, H. and Okieimen, F. (2007) Effect of Cassava Effluent on Germination of some cereals. *Research Journal of Environmental Science*. 1:166-172.

Olurunfemi, D. I; Emoefe, E. O; and Okieimen, F. E; (2008). Effect of cassava processing effluent on seedling, height, biomass and chlorophyll content of cereals. *Research Journal of Environmental Sciences.* 2(3): 221 – 227.

Oti, E.E. (2002). Acute toxicity of Cassava Mill effluent to the African catfish fingerlings. *Journal of Aquatic Science.* 17:31-34.

Oyewole, O.B. and Odunka, S.A. (1992). Characterization and distribution of lactic bacteria in cassava formentation during fufu production. *J. Appl. Bacteriol.* 68:148-152.

Sadej, W. and Przekwas, K.(2008). Fluctuations of nitrogen levels in soil profile under conditions of a long-term fertilization experiment. *Plant Soil and Environment.* 5 (5): 197-203.

Tagliavini, M., Hogue, E.J. and Neilson, G.H. (1991). Influence of phosphorus nutrition and root zone temperature on growth and mineral uptake of peach seedlings. *Journal of Plant Nutrition*. 14:1267-1276.

Taye, M. (1994). Cassava in South and Southwestern Ethiopia. *Cassava Newsletter* 18:6-9.

Uzoije A.P.and Eghuonwu N.(2011). Quality Assessment of the Cassava Mill-Affluent Polluted Eutric- Tropofluvent. *soil Research Journal of Environmental Science*. 5:312-343.

Vogel, A. I; (1962). A textbook of quantitative inorganic analysis including: Elementary instrumental analysis 3rd edn. Longmans, Green and company Limited. Pp 210 – 250.

Zhengping, W; Van, Cleomput, O; Liantie, L; and Baert, L. (1991). Effect of urease inhibitors on urea hydrolysis and ammonia volatilization. *Biology and Fertility of soils.* 11:43-47.

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