EFFECTS OF CASSAVA PROCESSING WASTEWATER ON THE PERFORMANCE OF MAIZE (*Zea mays* L.)

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ABSTRACT

This study was aimed at assessing the effects of cassava processing wastewater on Maize performance. The field experiment was carried out at the Botanical Garden at site III, Delta State University, Abraka. The Maize (Local variety) used for this experiment was gotten from Abraka Main Market, Abraka, Delta State. Cassava effluents were collected from 2 different locations and were used to make a bulk sample. There were 5 levels of treatments in the experiment with 4 replicates each. The parameters measured were height of plant, stem girth, leaf area, number of leaves and number of buds for a period of 7 days. The results showed that the control treatment attained the highest height, stem girth, leaf area and number of leaves at 31.6±1.0, 2.56±0.19, 34.54±1.46 and 5.8±0.44 respectively. However, The 100% sample attained the lowest height at 25.8±0.76, 2.02±0.24, 23.7±1.43, 3.8±0.83. Seeds grown in 100% and 75% concentration showed signs of wilting after 2 days while those of 50% and 25% showed signs of wilting after 4 days. Acidity increased with increasing concentration of effluent. This study thus established that cassava processing wastewater is toxic and hinders the growth of maize plant, hence, recommends proper disposal of cassava wastewater because of its toxicity to maize.

Keywords: Cassava effluent, *Zea mays* L., Performance

INTRODUCTION

Zea mays (Maize) is a crop that belongs to the family of Poacea (Grass family). Maize is one of the staple food consumed by a large amount of people in Nigeria. Maize has been ranked as the third most important cereal crop after rice and wheat (Agbogidi *et al*., 2007). Kernels from maize are used as food for livestock and as an essential raw material for several industrial Processes (Agbogidi *et al*., 2007). Maize plant does not develop or grow in the wild. It develops and survives only through human care (Adiaha *et al*., 2016). It varies from about 1 to 4 meters in height producing narrow and opposite leaves which is about a tenth as wide as they are long.

Maize crop is primarily a warm weather crop which is grown in a range of climatic conditions. It can be cultivated successfully in areas that receive an annual rainfall of about 60cm. which should be evenly distributed throughout its growth stage. This plant is known as “The Queen of cereals” because of its highest genetic yield potential (Dabija *et al*., 2021).

Maize is a C4 plant which has about 50 species which consist of different sizes, shapes (Shapes of grains), colour and texture. The maize plant can be grown by planting the kernels (Seeds) with adequate sunlight, soil nutrient and water. Maize is wind pollinated, whether self or cross pollination and its pollen that are shed can remain viable for about 10-30 minutes (Sam *et al*., 2017). Maize is rich in starch, proteins, lipid, fibre, ash and moisture (Dabija *et al*., 2021). Waste water (Effluents) from *Manihot esculentus* Cranz. (Cassava) when released into the soil can be a pollutant and a source of pollution because it contains a toxic substance called Hydrogen cyanide (Nwakaudu *et al*., 2012; Sam *et al*., 2017). Cassava factories usually discharge cassava effluents far from the factories to reduce pollution of their surroundings.

Manihot esculentus (Cranz) (Cassava) belongs to the family Euphorbiaceae. Cassava is one of the over 3000 types of plants that produce cyanogenic compounds and releases hydrogen cyanide (HCN) upon hydrolysis. This process of HCN production is known as cyanogenesis and it makes cassava a potential toxic food to humans (Igwe and Azorji, 2019). Hydrogen cyanide is formed when Linamarin and Lotaustiallin which have been stored in the vacuole undergoes the process of hydrolysis. A typical composition of the effluent discharged from a cassava processing plant is shown in Table 1.

Table 1: Proximate components of Cassava processing effluent

Component	% Composition
Water	60.40
Protein	1.40
Carbohydrate	34.41
Fat	0.30
Mineral	1.443
Hydrogen Cyanide	0.007
Lotaustralin/ Linamarin	1.98

Some researches that have been carried out on the effect of cassava effluent have shown that there are always some physio-chemical changes in the soil properties when cassava effluents are released on it. Ebhoaya *et al*. (2004) showed that there was increase in soil acidity, potassium, sodium, phosphorous, and organic carbon and also a decrease in calcium, nitrogen and magnesium when soil was polluted with cassava effluents. Olorunfemi *et al*. (2008) also researched on the effect of cassava processing effluent on seedling height, biomass and chlorophyll content of some cereals and it indicated that cassava effluent inhibits seed germination and seedling growth; continuous application of the effluent resulted to the death of the plant. On the study of the herbicidal effects of cassava effluent on the growth performance of *Chromolaena odorata* - a common weed, Ogundola and Liasu (2006) showed that cassava effluent can be used as weed controller at early stage. Cassava processing effluent has serious environmental impacts because it causes acidification due to the hydrolysis of cassava cyanogenic glucoside, linamarin and lotaustralin (methyl linamarin) producing hydrogen cyanide as discussed above. This in turn becomes toxic to household animals, fisheries and other organisms. This waste water from cassava processing factories released directly into the environment before proper treatment causes pollutions, sometimes discharged beyond the factory wall into roadside ditches or fields and allowed to flow freely sometimes they settle in shallow depressions. Eventually, this will percolate into the subsoil or flow into streams. This causes serious environmental pollution and a foul odour leading to contamination of surface and underground water and soil. Sikalengo (2016) noted that the soil pH recommended for maize production is 7.0 to 7.5. Since the availability of a lot of essential nutrients as well as activities of microbes are affected by soil pH, it becomes necessary to maintain pH at the optimum range. However, this contradicts the pH of cassava effluents which is between 4-6 showing acidity. Over the years, plants have undergone several types and levels of disturbance and stress which was as a result of pollutants and other heavy metals present in the soil and water for irrigation (Agbogidi, 2021b; Agbogidi, 2021c). To prevent unwanted stress in plants which may lead to death of the crop plant, there will be a need to examine the performance of maize plant in a contaminated soil containing cassava waste water. Thus, this study was set out to evaluate the effect of cassava processing waste water on the performance of Maize.

MATERIALS AND METHODS

Study Location

The experiment was conducted at a 20ft × 15ft screen house located at the Botanical Garden, Site III, Delta State University, Abraka. It is located between latitude 5° 45′ and 5° 5 0′ N and longitude 6° and 6° 15′ E. It is in the rainforest region with annual rainfall of 3000 mm and temperature of between 28 ^{0}C and 33 ^{0}C (Achuba and Ja-anni, 2018). The area is characterized by total annual rainfall of 3.098mm with mean monthly rainfall ranging from 28.8mm in December to 628.9mm in September. The soil temperature in this area is 28^{0}C at 100m depth and soil pH ranging from 4.5-8.0 with a mean monthly sunshine of 4.8h.

Sample collection

Soil samples collection

8kg of soil was collected into a polythene bag at the Botanical Garden at Site III, Delta State University, Abraka with no history of pollution.

Source of seeds

The Maize (Local variety) was obtained at the Abraka Main market in Abraka, Delta state.

Source of cassava effluent

The waste water from cassava was obtained from two different locations. The first Location was at Jehovah Street, Abraka, Delta State while the second Location was at a cassava mill at Ekrejeta, Abraka, Delta State. After Effluents have been collected from the two locations, they were mixed together to form a bulk sample.

Field experiment

The field experiment took place in a screen house 20ft long and 15ft wide at the Botanical Garden, Site III, Delta State University, Abraka. Fine soil was collected in 25 polythene bags. 1 polythene bag was labeled as "Control" with 4 replicates while there were 4 samples which were irrigated with 100, 75, 50 and 25 percent of cassava effluents respectively (Each with 4 replicates). The viability of the maize seeds was conducted using the floatation test stated by Agbogidi *et al.* (2007), after which a trial experiment was conducted where the different concentration of the effluents (25, 50, 75 and 100%) were used to pollute the soil samples immediately after the seeds were planted. The seeds of the sample plants grown in 100% cassava waste water failed to germinate after 3 weeks. The second experiment was conducted starting with a two-week treatment with pure water before irrigating with cassava effluents. The experiment was monitored for 7 days after the two weeks treatment with pure water.

Experimental design

A Randomized complete block design (RCBD) was used

Collection of Data

Germination characteristics

Grain sprouting began 3-4 days after planting and when seedlings were 5 days old, germination counts were taken per treatment. The percentage germination was calculated as number of seedlings that sprouted over the number of seeds planted times 100 using the procedure of Agbogidi *et al*. (2007)

$$\frac{\text{No of seedlings}}{\text{No of seeds planted}} \times 100$$

Height of the plant

The heights of the plants were measured daily using a measuring tape. The height was measured from the tip of the leaf to the soil level.

Stem girth

Stem girth was measured daily by wrapping a measuring tape around the maize plant.

Leaf area

This was done by measuring the length and width of the leaf and then multiplying by the correlation factor of maize which is 0.75 i.e length × breadth × 0.75 following the procedure of Agbogidi *et al.* (2007).

Number of leaves

The number of the leaves was counted by visual counting and this was done daily for 7 days.

Chemical analysis

The chemical analysis was conducted at the Department of Botany Laboratory located at Site II, Delta state University, Abraka using the methods stated in the British pharmacopoeia (2019) for the analysis of water.

pH

The pH of the effluents (25, 50, 70 and 100%) and water was determined using a pocket pH Meter.

Acidity and Alkalinity

Reagents: Methyl red indicator, Bromothymol blue indicator

Apparatus: Conical flask, Beaker, Measuring cylinder

Procedure:

- 10ml of freshly boiled effluent was measured into a borosilicate flask, 0.05ml of methyl red solution R was added. The solution which was produced was not coloured red.
- 10ml of the effluent was measured into a conical flask. 0.1ml of bromothymol blue solution R1 was added. The solution was not coloured blue

Statistical analysis

The data collected were analyzed using a one way analysis of variance (ANOVA). While the significant means were separated with DMRT using SAS (1996)

RESULTS AND DISCUSSION

The results obtained during the field experiment were analyzed and are presented in Table 2-9

Table 2 shows the germination characteristics (% germination, days to germination and rate of germination). 100% germination was recorded for maize seeds grown in the uncontaminated soils and those subjected to 25% cassava effluent treatment. Significant reductions ($P<0.05$) were observed in maize seeds grown in 50, 75 and 100%. It took 3 days for maize seeds sown in the uncontaminated soils to germinate while those sown in other treatments germinated at 4 days after planting. In the same vein, all the seeds (4) planted germinated at 0% and 25% while 3 germinated at 5% and 2 each sprouted at 75 and 100% effluent respectively (Table 2).

Table 2: Germination parameters of maize before addition of cassava processing wastewater

Level of contaminant	% germination	Days to germination	Rate of Germination
0	100[a]	3[a]	4[a]
25	100[b]	4[a]	4[a]
50	75[b]	4[b]	3[b]
75	50.[d]	4[c]	2[c]
100	50[e]	4[d]	2[d]

Table 3 shows that 100% and 75% remained constant showing no sign of an increase in height until day 4 when wilting occurred and this is in variance with 0.00% which showed an increase in height for 7 days. Seedlings in 25%, 50% showed a slight increase in height.

The control (0%) and 25% attained the highest means for the period of 7 days. The result of the plant height has shown that a significant difference (P<0.05) occurred in seedling grown in control polypots when compared to those subjected to other levels of treatment.

Table 3: Plant height (cm) of maize as affected by cassava wastewater

	Concentrations of cassava wastewater (%)				
Days	**0**	**25**	**50**	**75**	**100**
1	27.00±0.73	26.00±1.10	25.40±0.70	25.70±1.90	25.80±0.80
2	27.80±1.10	26.10±1.10	25.50±0.65	25.70±1.90	25.80±0.80
3	28.00±1.00	26.40±0.95	25.70±0.54	25.72±1.20	25.80±0.80
4	28.30±1.00	26.80±1.00	25.70±0.56	0.00±0.00	0.00±0.00
5	29.10±1.00	27.10±0.96	0.00±0.00	0.00±0.00	0.00±0.00
6	29.80±0.97	27.10±0.87	0.00±0.00	0.00±0.00	0.00±0.00
7	31.60±1.00	27.10±0.87	0.00±0.00	0.00±0.00	0.00±0.00

Table 4 shows that there was an appreciation in the stem girth of the control plant (0%) while there was a slight increase in the stem girth of 25% and also a slight increase in stem girth of 50%, 75% and 100% until day 3 and 4 when the seedlings began to wilt. The result had no significant difference (P>0.05) between the control and the samples on the first to fifth day. After the fifth day, there was a significant difference at P<0.05, as for the 75% and 100% cassava effluent, death occurred as from the 4th day.

Table 4: Stem girth (cm) of maize as affected by cassava wastewater

	Concentrations of cassava wastewater (%)				
Days	**0**	**25**	**50**	**75**	**100**
1	2.04±0.20	1.92±0.16	1.86±0.24	1.94±0.20	2.00±0.27
2	2.08±0.22	1.94±0.10	1.96±0.20	1.96±0.16	2.02±0.24
3	2.18±0.23	2.00±0.10	2.04±0.16	1.96±0.16	2.02±0.24
4	2.24±0.19	2.08±0.08	2.10±0.12	0.00±0.00	0.00±0.00
5	2.40±0.15	2.12±0.10	0.00±0.00	0.00±0.00	0.00±0.00
6	2.42±0.17	2.12±0.10	0.00±0.00	0.00±0.00	0.00±0.00
7	2.56±0.19	2.12±0.10	0.00±0.00	0.00±0.00	0.00±0.00

There was an increase in the leaf area of the 0%. However, there was a slow increase in the stem girth of 25%, 50%, 75% and 100%. Significant difference were observed in the leaf area of the control at P<0.05 when compared with values obtained from other treatments (Table 5).

Table 5: Leaf area (cm^2) of maize plant as affected by cassava wastewater

	Concentrations of cassava wastewater (%)				
Days	**0**	**25**	**50**	**75**	**100**
1	25.50±0.57	23.96±1.98	23.40±2.18	24.96±0.86	22.90±1.56
2	25.62±0.59	25.16±2.20	23.40±2.14	23.10±0.89	22.90±1.60
3	25.96±0.64	25.30±2.18	23.00±1.87	22.16±0.93	23.02±1.60
4	26.72±0.63	25.68±2.24	24.12±1.90	0.00±0.00	0.00±0.00
5	27.74±0.59	26.00±2.18	0.00±0.00	0.00±0.00	0.00±0.00
6	30.08±0.70	26.26±2.29	0.00±0.00	0.00±0.00	0.00±0.00
7	34.54±1.46	26.26±2.29	0.00±0.00	0.00±0.00	0.00±0.00

The results in Table 6 showed that there was no significant difference from the control during the period of the first day to the fourth day. From the fifth day to seventh day, the results showed that there was a significant difference from the control as the control produced more leaves when compared with values from other treatment

Table 6: Number of Leaves of maize plant as affected by cassava wastewater

	Concentrations of cassava wastewater (%)				
Days	**0**	**25**	**50**	**75**	**100**
1	4.40±0.54	3.80±0.83	3.40±0.54	3.80±0.44	3.80±0.83
2	4.40±0.54	3.80±0.83	3.40±0.54	3.80±0.44	3.80±0.83
3	4.60±0.54	3.80±0.83	3.40±0.54	3.80±0.44	3.80±0.83
4	5.00±0.70	4.20±0.83	3.40±0.54	0.00±0.00	0.00±0.00
5	5.20±0.44	4.40±0.54	0.00±0.00	0.00±0.00	0.00±0.00
6	5.40±0.54	4.40±0.54	0.00±0.00	0.00±0.00	0.00±0.00
7	5.80±0.44	4.40±0.54	0.00±0.00	0.00±0.00	0.00±0.00

The results in Table 7 showed that there was no significant difference from the control during the period of the first day to the fourth day. From the fifth day to seventh day, the results showed that there was a significant difference from the control as the control produced more buds than all the samples.

Table 7: Number of Buds of maize plant as affected by cassava wastewater

	Concentrations of cassava wastewater (%)				
Days	**0**	**25**	**50**	**75**	**100**
1	4.40±0.54	3.80±0.83	3.40±0.54	3.80±0.44	3.80±0.83

2	4.40±0.54	3.80±0.83	3.40±0.54	3.80±0.44	3.80±0.83
3	4.60±0.54	3.80±0.83	3.40±0.54	3.80±0.44	3.80±0.83
4	5.00±0.70	4.20±0.83	3.40±0.54	0.00±0.00	0.00±0.00
5	5.20±0.44	4.40±0.54	0.00±0.00	0.00±0.00	0.00±0.00
6	5.40±0.54	4.40±0.54	0.00±0.00	0.00±0.00	0.00±0.00
7	5.80±0.44	4.40±0.54	0.00±0.00	0.00±0.00	0.00±0.00

Table 8: Chemical parameters found in Portable water and Cassava Effluent

Parameters	**Portable water**	**Cassava Effluent (25%)**	**Cassava Effluent (50%)**	**Cassava Effluent (75%)**	**Cassava Effluent (100%)**
pH	7.5	3.54	3.26	3.26	3.17
Acidity	Neutral	Acidic	Highly acidic	Highly acidic	Highly acidic
Alkalinity	-	-	-	-	-
Ca & Mg	-	+	+	+	+
Chlorides	-	+	+	+	+
Zinc(Zn)	-	+	+	+	+
Oxidisable substances	-	+	+	+	+
Sulphates	+	+	+	+	+
Sodium	-	+	+	+	+
Total Dissolved Solids (TDS)					667mg/L

* **+** Key **Present**

* **-** Key **Absent**

Table 9: Cassava wastewater chemical parameters at different levels of concentration compared to WHO's Standard

Parameters	**Cassava Effluent (25%)**	**Cassava Effluent (50%)**	**Cassava Effluent (75%)**	**Cassava Effluent (100%)**	**WHO Standard**
pH	3.54	3.26	3.26	3.17	6-9
Ca & Mg	186	201	221	221	100
Zinc(Zn)	3.80	4.20	5.00	4.80	2.00
Total Dissolved Solids (TDS)	509mg/L	667mg/L	667mg/L	667mg/L	450-2000

DISCUSSION

The observed reduced parameters in the maize seedlings grown in the contaminated soils could be attributed to the reduced pH and presence of heavy metals which could have altered the soil physicochemical parameters and subsequently negatively affected growth. These agrees with the study of Olorunfemi *et al*. (2008) on cereals. The leaves started showing signs of chlorosis after continuous irrigation with cassava waste water and this was in line with the findings of Igwe and Azorji, (2019). The leaf area of the sample plants showed significant reductions ($P<0.05$) across all concentrations. Heavy metals like Zinc (Zn); Sulphates, Magnesium (Mg), Calcium (Ca) and Chlorides were detected in the cassava effluent aligning with the findings of Osunbitan (2012) while found absent in portable water and this might have also affected the germination rate of the plants. Oghenejoboh (2015) outlined that the high total dissolved solids (TDS) may be as a result of salt formation during cassava fermentation and the decay of the cassava effluent

The general reduction in the parameters measured suggested that hydrogen cyanide contained in cassava effluent has a deleterious effect on the plant (Ogundola and Liasu, 2006). All samples began to wilt due to the acidity of the soil and the presence of other toxic chemicals which were found in the waste water. This is in line with Ogundola and Liasu (2006) who stated that cassava waste water caused the wilting of *Chromolaena odorata* and can be therefore used as a weed controller. As stated by Ogundola and Liasu (2006) high concentration of cyanide becomes very toxic to soil micro-organisms and thus inhibiting the growth of plants in such soils

CONCLUSION

This study assessed the effects of cassava processing waste water on the performance of Maize. This study established that cassava processing waste water is toxic and hinders the growth of maize plant and can therefore threaten biodiversity, man and its precious environment. It is therefore recommended that cassava processing waste water be properly disposed. This should spur the proper treatment of cassava processing waste water before disposal on agricultural soils.

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