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EFFECTS OF STARCH WASTEWATER ON THE PERFORMANCE OF MAIZE (*Zea mays* L.) IN ABRAKA, DELTA STATE, NIGERIA

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ABSTRACT

The study was carried out at the Botanical Garden, site III, Delta State University, Abraka, Delta State to evaluate the effects of starch wastewater on the growth of maize. The maize grains used were obtained from Abraka Market, Abraka, Delta State, and the soil samples were obtained from site III, Delta State University, Abraka. Five levels of treatments (0, 25, 50, 75, and 100%) with 4 replicates each were used. The sample soils were contaminated with starch effluent at different concentrations and laid out in a randomized complete block design and readings were taken for 4 weeks. Parameters measured were germination characteristics (germination percentage, germination rate and days to germination) and seedling growth (plant height, stem girth, number of leaves and leaf area). The results showed that the control plants attained the highest growth levels in all the parameters measured followed by 25%. Significant ($p \leq 0.05$) reductions were observed with increasing concentration of the contaminant in all the growth parameters examined. This paper established that starch waste water does not encourage the growth, hence the performance of maize plant was significantly reduced by the contaminant. It is recommended that starch waste water should not be disposed indiscriminately to reduce impacts on the plant performance.

Keywords: Starch wastewater, performance, maize, Delta State

INTRODUCTION

Maize (*Zea mays* L.) is a crop that belongs to grass family," Poaceae". This plant is globally cultivated being one of the most important cereal crops worldwide (Agbogidi *et al*., 2007). *Z. mays* is pollinated by wind and they usually can carry out both self and cross pollination. Mature pollen which are shed off can remain viable for about 10-30 minutes, however, when the condition is favourable, the seed may remain viable for a longer duration (Brunce *et al*., 2002). Maize is primarily a crop grown is warm weather but can still be grown in several ranges of climatic conditions (Sam *et al*., 2017). Maize can be grown successfully in areas that receives a mean annual rainfall of about 60cm. Maize plant does not develop or grow in the wild, It develops and survives only through human care (Adiaha *et al*., 2016). Maize has a wide range of uses; food, animal feed, industrial and pharmaceutical uses (Agbogidi *et al*., 2007).

Starch can be gotten from cassava and cassava has been found to be amongst significant root crops grown in the tropics and used as a source energy to humans due to the presence of a high amount of carbohydrates and a highly nutritive roots (Akparobi, 2017). A mature cassava root is composed of about 30–35% carbohydrate, 1–2% fibre, 1–2% fat, 1–2% protein and 60 –70% moisture, as well as some quantities of minerals and vitamins (Ekebafe *et al*., 2012). A mature root of cassava may range in its content of starch from about 15 to 33%, depending on the climatic condition and time of harvest (Hasmadi *et al*., 2020). Firouzeh *et al*. (2007) stated that the area of the leaves of *Glycine max* (Soybean) reduced rapidly after exposure to starch effluent. Starch waste water is acidic and rich in minerals, vitamins and other organic compounds which are derived from the degradation of starch in the plant body (Pereira *et al*., 2016).

Starch is widely used in food, pharmaceutical, paper and textile industry in large quantities (Akparobi, 2017). Cassava is used as a bulk source of starch production in various countries (Shubhaneel *et al*., 2018). Starch from (cassava) is obtained during the cassava milling process and it has numerous economic importance. Cassava starch also known as hydrogel (Superabsorbent polymers). They are materials that have the ability to absorb fluids which are about 15 times greater than their own dried weight examples are water, electrolyte solution, blood sweat and urine (Ekebafe *et al*., 2011). The starch waste water contains high amount of volatiles, dissolved chemicals used in modification, impurities from cassava processing, gluten and dextrose and characterized as high strength (Osunbitan, 2012).

There is a significant pressure on plant life through the application of different hazardous pesticides and chemicals from fertilizers and this indeed threatens the ecosystems (Agbogidi, 2021a). Several other pollutants like waste water may also contain deleterious chemicals and free radicals that may pollute the soil and cause stress in plants (Agbogidi, 2021b; Agbogidi, 2021c). Very few data are available in the literature on the effects of starch wastewater on the performance of maize. It is against this background that a study as this has been embarked upon to evaluate the performance of maize as affected by starch wastewater with a view to recommending the same to maize farmers and rural inhabitants of Delta State for sustained land maximisation and without being a threat to the environment.

MATERIALS AND METHODS

Study location

The study was carried out in a screen house at the Botanical Garden, Site III, Delta State University, Abraka. The study location is found between latitude 5° 45′ and 5° 5 0′ N and longitude 6° and 6° 15′ E. This area is defined by total annual rainfall of about 3.098mm with mean monthly rainfall ranging from 28.8mm. The soil temperature in this area is about 28^0C and soil pH ranging from 4.5-8 (Achuba and Ja-anni, 2018).

Sample collection

Soil samples collection

The fresh soil was collected into a polytene bag at Site III, Delta State University, Abraka.

Source of seeds
A local variety of maize seeds were obtained from the Abraka Market, Delta State.

Source and preparation of starch effluent
The starch effluent was prepared locally by adding water into the ground cassava. The ground cassava was collected from the grinding engine in Abraka Market, Delta State. The effluent was allowed to sit for 24 hours before use.

Field work
The field work was conducted in a screen house located at the botanical garden, Site III, Delta State University, Abraka. Fresh soil with no history of pollution was collected, air dried and sieved and then 2kg was measured in 25 polytene bags. Out of the 25 polytene bags, 5 were the control plants (1 control and 4 replicates), the other 20 were contaminated with different concentrations (25, 50, 75 and 100%). Before planting, the maize seeds were tested for viability using the water floatation test. The soil of the samples were further polluted before planting (3 seeds) using the different concentrations.

Experimental design
A Randomized Complete Block Design (RCBD) was used. The experiment was observed for 4 weeks after planting (WAP).

Collection of data
The parameters collected were germination %, germination rate, days to germination, plant height, plant girth, leaf area and number of leaves.

Germination rate
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

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

Seeds which failed to sprout after the fifth day were regarded as having not germinated following the methods of Agbogidi *et al*. (2007). Days to germinating were taken when the seeds started sprouting. The height of the plant was measured from level of the soil to terminal bud at a week after planting (WAP) using a measuring tape. The stem girth or plant girth was measured weekly using a measuring tape. The number of leaves was determined by mere counting of the leaves while the leaf area was determined with the length and breadth measurements of the longest leaf per plant while correlation factor of 0.75 was used to multiply the value following the procedure of Agbogidi *et al*. (2007).

Leaf colour
The colour of the leaves was examined daily by visual aid from the time of sprouting to four weeks.

Statistical analysis
The parameters were analysed using a one way ANOVA and the significant means were separated using the Duncan's Multiple Range Tests (DMRT) using the procedures of SAS (1996).

Chemical Analysis
The chemical analysis of the contaminant was conducted at Botany Laboratory located at Site II, Delta State University, Abraka. Substances analysed were oxidisable substances, calcium, magnesium, zinc, acidity and alkalinity. It was conducted using the method for test of water as stated in the British Pharmacopoeia (BP, 2019).

pH
The pH of the effluents (25, 50, 75 and 100%) and water was determined using a pocket pH Meter.

RESULTS AND DISCUSSION
Results
The results obtained on germination parameters are presented in Table 1. The maize seeds sown in the control plots performed significantly better (P<0.05) viz: they had 100% germination, all the seeds germinated and sprouted three days after planting. Significant reductions (P<0.05) were recorded in seeds planted in the contaminated soils and germination performance was observed to be dependent on the level of the contaminant. The seeds sown in 100% starch effluent failed to germinate even after 10 days after planting.

Table 1: Germination parameters of maize as affected by starch waste water

Level of contaminant (%)	% germination	Days to germination	Rate of Germination
0	100^{a}	3^{a}	3^{a}
25	75^{b}	3^{a}	3^{a}
50	64.2^{c}	4^{b}	2^{b}
75	20.2^{d}	5^{c}	1^{c}
100	0.0^{e}	0^{d}	0^{d}

*The means in the same row with same letters are not significantly different (P<0.05) using Duncan's Multiple Range Test (DMRT)

The performance of maize seedlings as affected by the contaminant in terms of plant height, stem girth, leaf area and number of leaves are presented in Tables 2, 3, 4 and 5 respectively.

Table 2 shows that the highest heights were attained for the seedlings grown in the control when compared to the 25%. The mean plant height of 50% and 75% were higher unlike the 100% seedlings that didn't sprout at all.

Table 2: Plant height (cm) of maize as affected by starch wastewater

Weeks	Concentrations of starch wastewater (%)				
	0	25	50	75	100
1	18.54±1.29	16.00±1.00	15.78±1.36	14.64±1.70	0.0±0.0
2	24.48±1.40	22.68±1.60	21.20±1.36	20.94±1.75	0.0±0.0
3	32.48±2.28	25.80±1.25	23.04±0.70	21.62±1.80	0.0±0.0
4	36.86±2.27	29.12±1.40	26.54±1.19	25.34±1.87	0.0±0.0

* Each value is the mean of 5 replicates ± Standard deviation.

Table 3 showed that there was a slow increase in the stem girth of the maize plants (25, 50 and 75%) with time when compared to 0% which showed a rapid appreciation. The stem girth was significantly different at P<0.05 from week one to week four.

Table 3: Stem girth (cm) of maize plants as affected by starch wastewater

Weeks	Concentrations of starch wastewater (%)				
	0	25	50	75	100
1	1.66±0.13	1.28±0.10	1.12±0.30	1.08±0.13	0.0±0.0
2	1.92±0.93	1.46±0.18	1.44±0.42	1.30±0.10	0.0±0.0
3	2.20±0.16	1.54±0.23	1.50±0.50	1.38±0.14	0.0±0.0
4	2.64±0.23	1.64±0.33	1.62±0.47	1.40±0.18	0.0±0.0

* Each value is the mean of 5 replicates ± Standard deviation.

From the results in Table 4, the mean values of 0% were the highest at 17.02±0.89, 27.26±1.26, 43.40±2.43, 50.30±2.50 when compared with 75% which attained the lowest mean in leaf area. No growth was recorded at 100% level of contamination. The leaf area of maize plants was significantly different at P<0.05.

Table 4: Leaf area (cm^2) of maize plants as affected by starch wastewater

Weeks	Concentrations of starch wastewater (%)				
	0	25	50	75	100.0
1	17.02±0.89	15.6±1.57	14.66±1.78	12.42±0.94	0.0±0.0
2	27.26±1.26	24.06±1.35	23.00±1.36	22.95±1.22	0.0±0.0
3	43.40±2.43	33.18±1.79	31.36±1.72	25.68±1.96	0.0±0.0
4	50.30±2.50	38.08±3.24	34.28±1.10	30.52±1.66	0.0±0.0

* Each value is the mean of 5 replicates ± Standard deviation.

From the results in Table 5, there was a significant difference (P<0.05) in the number of leaves between the seedlings grown in the contaminated soils and the control. The values obtained are concentration dependent.

Table 5: Number of Leaves of maize plant as affected by starch wastewater

Weeks	Concentrations of starch wastewater (%)				
	0	25	50	75	100
1	3.40±0.54	3.60±0.54	2.00±0.00	2.20±0.44	0.0±0.0
2	4.60±0.54	4.20±0.83	3.60±0.54	3.20±0.44	0.0±0.0
3	5.60±0.54	4.80±0.83	4.00±0.70	3.80±0.83	0.0±0.0
4	7.00±0.70	4.80±0.83	4.00±0.70	3.80±0.83	0.0±0.0

* Each value is the mean of 5 replicates ± Standard deviation.

Table 6: Chemical parameters of water and starch waste water Effluent

Parameters	0	25	50	75	100
pH	7.00	4.01	3.88	3.78	3.75
Acidity	Neutral	Acidic	Acidic	Acidic	Acidic
Alkalinity	-	-	-	-	-
Ca & Mg	-	+	+	+	+
Chlorides	-	-	-	-	-
Zinc(Zn)	-	+	+	+	+
Oxidisable substances	-	+	+	+	+
Sulphates	+	+	+	+	+
Sodium	-	+	+	+	+
Total Dissolved Solids (TDS)					1674mg/L

* +Key **Present**
* - Key **Absent**

Discussion

Findings from the study indicated that starch wastewater significantly reduced the performance of maize including the germination characteristics and growth. The high acidity observed in the contaminated soils could have affected the performance of the maize plants. This agrees with the findings of Pereira *at al*. (2016). Similarly, the high amount of oxidisable substances, sodium and zinc could have also impacted the performance of the test plant.

CONCLUSION

This study examined the effects of starch waste water on the growth of maize. This study established that starch waste water does not encourage the growth of maize plant and thus may not encourage the growth of other plants in the environment. The effluent significantly reduced the germination parameters as well as the growth of maize seedlings. It is recommended that starch waste water should be carefully disposed in areas where it would not affect the distribution and growth of plants.

REFERENCES

Achuba, F. I. and Ja-anni, M. O. (2018).Effect of abattoir waste water on metabolic and antioxidant profiles of cowpea seedlings grown in crude oil contaminated soil. *International Journal of Recycling of Organic Waste in Agriculture*, **7**:59–66.

Adiaha, M.S., Agba, O.A., Attoe, E.E., Ojikpong, T.O., Kekong, M.A., Obio, A. and Undie, U.L. (2016). Effect of maize (Zea mays L.) on human and development and the future of man-maize survival: a review. *World Scientific News*, **59**:52-62.

Agbogidi, O.M. (2021a). Conservation of natural resources. University Printing Press, Delta State University, Abraka. 118p.

Agbogidi, O.M. (2021b). Introduction to ecology and environment (2nd Edition). Sanctuary Ulta Modern Prints, Ibadan.324p.

Agbogidi, O.M. (2021c). Plant responses to the environment. Jef Ventures Publishers, Warri, Delta State. 148p.

Agbogidi, O.M., Eruotor, P.G., Akparobi, S.O and Nnaji, G.U. (2007). Heavy metal content of Maize (*Zea mays* L.) grown in soil contaminated with Crude Oil. *International Journal of Botany*, **3**:385-389.

Akparobi, S.O. (2017). Cassava: a goldmine for sub-Saharan Africa. The 55th in the series of inaugural lectures, Delta State University, Abraka, presented 19th January, 2019. 97p.

British pharmacopoeia Commission. (2019). Purified water specification. Vol. III. London: pp.1263-1264.

Brunce, B.W., Gregory, O.C. and Baker, T.C (2002). Molecular and physiological approaches to maize improvement for drought tolerance. Journal of Experimental Botany, **53**: 13-25.

Ekebafe, L.O., Ogbeifun, D.E. and Okieimen, F.E. (2011).Effect of native cassava starch poly (Sodium Acrylate-co-Acrilamide) Hrdrogel on the growth performance of Maize (Zea mays) Seedlings.*American journal of Polymer Science*, **1**(1): 6-11.

Ekebafe, L.O., Ogbeifun, D.E. and Okieimen, F.E. (2012).Effect of cassava starc hydrogel on the water requirement of Maize (*Zea mays*) seedlings and selected properties of sandy loam soil. *International Journal of Basic and Applied Sciences*, **1**(2): 132-139.

Gopolan, C., Rama-Sastri, B.V. and Balasubramanian, S. (2007). Nutritive value of Indian food. Published by National Institute of Nutrition (NIN), pp. 13-15.

Hasmadi,M., Noorfarahzilah, M., Noraidah, H., Zainol, M. K., & Jahurul, M. H. A. (2020). Functional properties of composite flour: a review. *Food Research*, **4**(6), 1820–1831.

Karl, J.R. and Arnoid, J.G.(2013). Rice parameters describing crop performance of four rice cultivar. *Journal of Agronomy*, **93**(6): 1354-1361.

Osunbitan, J.A. (2012). Short term effect of cassava processing wastewater on some chemical properties of loamy sand soil in Nigeria. *Journal of soil science and Environmental Management*, **3**(6): 164-171.

Pereira, J.M., Aquino, A.C., Oliveira, D.C., Rocha, G., Francisco, A., Barreto, P.L. and Amante, E.R. (2016). Characteristics of cassava starch fermentation wastewater based on structural degradation of starch granules. *Food Technology*, **46**(4): 732-738.

Sam, S.M., Esenowo, G.J. and Udosen, I.R. (2017). Biochemical characterization of cassava processing waste water and its effect on the growth of Maize seedlings. *Nigerian Journal of Basic and Applied Science*, **25**(2): 12-20.

SAS (1996). Statistical analysis system. SAS user's Guide: Statistics SAS Institute Inc, Cary, U.S.A.

Shubhaneel, N., Apurba, D. and Kumar, C. P. (2018).Corn starch industry wastewater pollution and treatment processes-a review.*Journal of Biodiversity and Environmental Science*, **12**(3): 283-293.

Yazdani, F., Allahdadi, I. and Akbari, G.A. (2007). Impact of superabsorbent polymer on yield and growth analysis of Soybean (*Glycine max* L.) under drought stress condition. *Pakistan Journal of Biological Sciences*, **10**: 4190-4196.