Tolerance of Maize (*Zea mays*) Seed Germination to Effect of Four Different Concentrations of Palm Oil Mill Effluent (POME)

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ABSTRACTS

Palm Oil Mill Effluent (POME) is considered the most harmful waste for the environment if discharged untreated. The study was carried out to evaluate the effect of POME on seed germination percentage and germination rate of maize (Zea mays). The seeds were collected from National Root Crop Research Institute (NRCRI) Umudike, Abia state. The experiments were set on sterilized Petri dishes stuffed with cotton wool. Four different concentrations of the POME: 25%, 50%, 75% and 100% were administered to the seeds while distilled water was used as the control of the experiment. The different concentrations POME caused inhibitory effects on the germination percentage and germination rate of the maize which increased with the increase in the concentration of POME. The POME concentrations of 75% and 100% had the highest inhibition percentage values of 16.67% and 10.00% while the POME concentrations of 50%, 25% and control had lowest inhibition values of 40.00%, 43.33% and 46.67%. The POME concentrations of 75% and 100% had the lowest germination rate value of 1.0 and 0.6 while the POME concentrations of 50%, 25% and control had the germination rate value of 2.4, 2.6 and 2.8 respectively. These findings showed that low concentrations of POME had low inhibitory effects on the germination percentage and germination rate of maize while high concentrations of POME showed increased inhibitory effects on the germination percentage and germination rate of maize. The present study suggests that the effluent can be used safely for maize cultivation, only after proper treatment and dilution.

KEYWORDS: *Maize, Concentration, Inhibitory effect, POME, Germination rate.*

INTRODUCTION

Palm oil mill effluent (POME) is the waste water from palm oil industry. It is a colloidal suspension which is 95-96% water, 0.6-0.7% oil and 4-5% total solids including 2-4% suspended solids originating in the mixing of sterilizer condensate, separator sludge and hydrocyclone wastewater. POME contains 4,000 mg dm-3 of oil and grease, which is relatively high compared to the limit of only 50 mg dm-3 set by the Malaysian Department of Environment (MA, *et al.*, 1999, Dewwanthi, 2008). When palm oil is extracted and processed, it also produces effluents

with high organic matter, suspended matter, oil and grease (Sridhar and AdeOluwa, 2009; Rupani *et al*., 2010; Ma, 1999; Ma, 2000). Gaseous emissions are often unreported. These processing wastes if not adequately managed causes adverse environmental impacts including land and aquatic ecosystem contamination, loss of land and resources, negative impacts on soil micro flora and fauna and loss of biodiversity (Sridhar and AdeOluwa, 2009).
The biochemical oxygen demand (BOD) of these waste are usually high (>10,000mg/l) (Nwoko *et al.,* 2010; Yahaya and Lau, 2013). POME consists of water soluble components of palm fruits as well as suspended materials like oil residues, short palm fiber, cell walls, organelles, a variety of carbohydrates ranging from cellulose to simple sugars, a range of nitrogenous compounds from proteins to amino acids, free organic acids and assembly of minor organic and mineral constituents (Ugoji, 1997). Nutrients contents in POME are nitrogen, phosphorus, potassium, magnesium and calcium, which are the vital nutrient elements for plant growth (Habib *et al*., 1997; Muhrizal *et al*., 2006). Due to the non-toxic nature and fertilizing properties, POME can be used as fertilizer or animal feed substitute, in terms of providing sufficient mineral requirements (Yahaya and Lau, 2013).

For every metric ton of palm oil produced, 2.5metric tonnes of effluent (POME) are generated from processing in palm oil in mills. Direct release of this effluent causes freshwater pollution, which can affect downstream biodiversity and people (Clay, 2004). In Malaysia, the total production of crude palm oil in 2008 was 17,734,441tonnes. However, the production of this amount of crude palm oil results in even larger amounts of palm oil mill highly polluting effluent that were mostly discharged directly into environment especially by small and medium palm oil mills operators. Palm oil mills discharged palm oil effluent into environment in its raw form. Studies on the effect of palm oil effluent on soil showed that raw POME is acidic and alters microbiological and physiochemical properties of soil, which ultimately affects soil fertility (Bek-Nielsen *et a*l., 1999).

The rapid rise of palm oil production has made it the most important oil in the world in the last few decade (Yahaya and Lau, 2013). Ogboi *et al* (2010) observed in South Central Nigeria that all the Palm Oil Processing Waste (POME) are being disposed of indiscriminately on the ground. It therefore becomes necessary to look at the impact of this waste on the soil and crop performance. There are a number of studies on the impact of industrial or domestic effluents on soil properties and crop response (Sharma, *et al.,* 2007; Singh and Agrawal, 2010). There is paucity of study on the effects of POME on the germination of the seeds of maize and thus dearth of information. This current study is aim at determining the effect of Palm Oil Mill Effluent on seed germination percentage of maize.

MATERIALS AND METHODS

Study site

The study was carried out in the laboratory of Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike is located at longitude 07°32" to 07°34"E and latitude 05°28 to 05°29"N; elevation of 122m above sea level.

Plant material

The seeds of maize (Zea mays) used for this study were collected from the National Root Crop Research Institute (NRCRI), Umudike, Abia State.

The palm oil mill effluent (POME)

The palm oil mill effluent (POME) was collected in pre-cleaned 10 litre container from the point of discharge in a local palm oil mill at Ubakala, Umuahia South L.G.A, Abia State. The effluent temperature was measured and stored at 4^{o} C to avoid changes in their physiochemical characteristics.

Preparation of Petri dishes

The sterile Petri dishes were stuffed with cotton wool prior to seed planting.

Experimental design and treatments

The experiment was designed in a Completely Randomized Design (CRD) with three replicates. Four different concentrations of POME were used as POME treatments. They were 25%, 50% 75% and 100%. Distilled water was used as the control (0%).

Determination of physiochemical analysis of the POME

The POME samples were taken to laboratory and the following parameters were analyzed. They include: pH, electrical conductivity (EC), total dissolved solid (mg/L), chemical oxygen demand (mg/L), biochemical oxygen demand (mg/L), total Kjeldal nitrogen (mg/L).

Planting

The seeds of maize were subjected to viability test using floating technique which involves putting the seeds into a beaker filled with distilled water. The beaker was allowed to stand for a minute. The seeds floating on top of the water were discarded while those at the bottom were used for the study (Osuagwu and Nwofia, 2014). The 10 seeds were sown in each Petri dishes with cotton wool moistened with the four different concentrations of POME: 25%, 50% 75% and 100%. (Nwokeocha and Ezumah, 2014). Distilled water was used for Petri-dishes that served as the control. The seeds were allowed for five days to germinate with once a day wetting of the dishes to avoid drying up (Nwokeocha and Ezumah, 2014). The numbers of germinated seeds in each treatment were counted on the fifth day.

Germination percent was calculated using the formula:

Germination % = $\frac{Number\ of\ seeds\ germinated}{Number\ of\ seeds\ planted}\ x\ \frac{100}{1}$ (Nwokocha and Ezumah, 2014).

While the germination rate was calculated using the formular:

$$\text{Germination rate} = \frac{Number\ of\ seeds\ germinated}{Number\ of\ days\ of\ germination}$$

Statistical analysis

The data collected were subjected to statistical analysis. The difference between the number planted and the number that germinated under different treatments was tested and compared using paired t –test (Ogbeibu, 2005).

RESULTS

The physiochemical analysis of the POME are presented in Table 1 while the number of seeds planted, number of germinations, germination percentage, germination rate are presented in Table 2. The result showed that the POME was acidic in nature (5.8 – 6.0) with a mean of 5.9 (Table 1). It also showed that as the concentration of POME increased from control to 100%, the germination percentage in maize decreased from 40.00%, 43.33% and 46.67%,16.67% and10.00%. (Table 2). Also, as the concentration of POME increased from control to 100%, the germination rate decreased from 2.8, 2.6, 2.4, 1.0 and 0.6. The maximum inhibition was recorded at 100% concentration while the minimum was recorded at control. Paired t-test analysis showed that there was significant difference ($p<0.05$) between the number of seeds planted and the number that germinated (since t Stat > t Critical two-tail) in both seeds. This difference is attributed to the inhibitory effect of the POME.

Table 1: Physiochemical Analysis of Palm Oil Mill Effluent.

Parameters	**Mean**
Ph	5.9
Electrical conductivity (EC)	6.59
Total Suspended Solid (mg/L)	1871.12
Total Dissolved Solid (mg/L)	446.12
Chemical Oxygen Demand (mg/L)	157.684
Biochemical Oxygen Demand (mg/L)	360.444
Total Kjeldahl Nitrogen (mg/L)	17.29

Table 2: Effects of POME on the germination percentage and rate of germination of maize.

Treatments	**Total number of seeds planted**	**Number of days of germination**	**Number of seeds germinated**	**Germination percentage**	**Germination rate**
Control (0%)	30	5	14	46.67%	2.8
25%	30	5	13	43.33%	2.6
50%	30	5	12	40.00%	2.4
75%	30	5	5	16.67%	1.0
100%	30	5	3	10.00%	0.6

DISCUSSION

The Palm oil mill effluent (POME) was acidic in nature (5.8 – 6.0) with a mean of 5.9 (Table 1). These values are higher than those of Nwoko *et al*. (2010) and Rajeev *et al* (2013) that have mean values of 4.50 and 3.91 respectively. Typically, POME waste water is low in pH because of the organic acids produced in the fermentation process ranging about 4.5 as it contains organic acids in complex forms that are suitable to be used as carbon sources (Parveen *et al*., 2010). Decrease in pH can be ascribed to acidic nature of POME having high available free ions (Singh *et al.*, 2010).

The germination percentage were 46.67% in control, 43.33% in 25%, 40.00% in 50%, 16.67% in 75% and 10.00% in 100%. The maximum inhibition was recorded at 100% concentration while the minimum was recorded at control. The germination rate were 2.8 in control, 2.6 in 25%, 2.4 in 50%, 1.0 in 75% and 0.6 in 100%. The maximum inhibition was recorded at 100% concentration while the minimum was recorded at control. The effect of POME on the germination percentage and germination rate of maize followed the same trend. Paired t-test analysis showed that there was significant difference ($p<0.05$) between the number of seeds planted and the number that germinated (since t Stat > t Critical two-tail). This difference is attributed to the inhibitory effect of the POME.

POME also had high levels of biochemical oxygen demand (360.444mg/l), chemical oxygen demand (157.684mg/L), total suspended solid (1871.12mg/L) and electrical conductivity (6.97) (Table 1). Yahaya and Lau (2013) gave lower values of BOD (25,000mg/L), COD (5,000mg/L), and TSS (18,000mg/L). The effluent was dark brown in color due to high suspended and dissolved solids as observed by Parveen *et al*. (2010) and Rajeev *et al*. (2013). The raw or partially treated POME has an extremely high content of degradable organic matter (Parveen *et al.*, 2010). Palm oil mill effluent (POME) creates environmental problems due to discharge of effluents consisting of higher pH, EC, BOD, COD, TDS, total N, phosphate and sulphate content (Habib *et al.*, 1997; Muhrizal *et al.*, 2006). High EC of POME alters the chelating properties of receiving water system, creating favourable conditions for metal availability to flora and fauna (Nanda *et al.*, 1999). The pH of POME decreased at different ratios; however EC increased. The increase in EC and decrease in pH can be ascribed to acidic nature of POME having high available free ions (Singh *et al.*, 2010).Total dissolved as well as suspended solids of different ratios of POME increased with increasing ratios.

The reduction in the amount of water absorption by seeds took place due to changes in the osmotic relationship of the seed and water, resulting into the retardation of seed germination due to enhanced salinity (Rajeev *et al.*, 2013). The inhibitory effect shown by 100% concentration of POME may be due to high osmotic pressure at high dose, salts making imbibition more difficult and retarded germination (Nagda *et al.*, 2006). The salt concentration outside of the seed is known to act as limiting factor and it might be responsible for delay in germination (Adraino *et al.*, 1997). The other prospect of reduction in germination percentage at higher concentration of effluent may be due to existence of excess amount of ammonia in effluent, causing depletion of the tricarboxylic acid cycle which reduces the respiration rate and subsequently germination (Kirkby, 1967). According to Saxena *et al.* (1968), the low amount of oxygen in dissolved form due to the presence of higher concentration of solid in the effluent, reduces the energy supply through anaerobic respiration resulting in restriction of the growth and development of the seedling.

The effluent is non-toxic, as no chemicals are added to the extraction process (Khalid and Mustafa, 2009; Ma *et al*., 1993). POME has a high nutrient content, and large oil palm plantations prefer to use it directly as fertilizer. The POME is first treated to reduce the organic load. The sediments left after treatment, which have a higher nutrient value than the slurry, are either recycled to the field or sold to the public. (MA *et al.*, 1996, Modise *et al*., 2006).

CONCLUSIONS

Since the higher concentration of effluent is toxic to the plant growth, it is recommended that only after treatment and dilution, POME can be used for irrigation purposes. Tolerance of maize seed germination to POME was both negative as well as positive. From this study it can also be concluded that not only toxic metals but higher nutrients can also be toxic and inhibits the seed germination and plant growth.

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