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EFFECTIVENESS OF AFRICAN LOCUST BEAN WASTEWATER AS A RESOURCE FOR PRESERVING AGRICULTURAL PRODUCE (GRAIN AS A CASE STUDY)

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ABSTRACT

The use of synthetic chemicals for increasing shelf life of agricultural produces have been widely reported to have hazard effect to human health if not kill. This study investigated the re-use of locust bean effluents as a resource for preserving produces as alternative to synthetic chemicals. Physicochemical properties of Jimba-Oja and NCAM effluent locations were determined, bioassay was also performed on maize weevils to evaluate lethal concentration of effluents within 15 and 25 minutes duration of exposure. Data obtained and observed were subjected to descriptive statistics. Physicochemical parameters of effluents showed that pH was slightly acidic 5.94 - 6.54. Dissolved oxygen ranged from 2.59 - 3.02 mg/L, Biochemical oxygen demand from 0.33 - 0.40 mg/L, Total hardness from 471.82 - 542.34mg/L of NCAM and Jimba-Oja effluent respectively. Concentration of cadmium, copper, nickel, cobalt, iron, Sulphate, phosphate and nitrate ranged from 0.15 - 0.24, 5.19 - 7.31, 0.12 - 0.33, 0.35 - 0.52, 46.94 - 57.18, 3.15 - 3.71, 87.32 - 96.57 and 2.19 - 2.47mg/L respectively. Lead concentration of 0.38mg/L was detected with NCAM effluent only. Toxicity evaluation showed that the mortality rate increased with increased in effluents concentration with respect to exposure time. Mortality rate of 2.2, 17.8 and 31.1% were recorded for Jimba-Oja effluent at concentration of 5, 10 and 15mL within 15 minutes of exposure while 11.1, 33.3 and 55.6% were recorded within 25 minutes. Mortality rate of 6.7, 31.1 and 46.7% were recorded within 15 minute while 17.8, 48.9 and 71.1% were recorded within 25 minute for NCAM effluent of the same effluent concentration. The study concluded that locust bean effluent as wastewater can be re-used as biopesticide.

Keywords: Biocidal test, effluent, African locust bean and maize weevil

INTRODUCTION

In Nigeria, the rapid growth in population has led to increase in the demand for local condiment known as Iru or dawadawa in Nigeria (Ojewumi *et al*., 2016b) which has led to establishment of many processing centres both traditional and mechanical methods of processing adopted. National Centre for Agricultural Mechanization (NCAM) is a potential prototype of *P. biglobosa* processing industry (Amusat *et al*., 2020).

Locust bean effluent, a waste product from African locust bean can be harmful to pest, aquatic life and other animals (Campbell-platt, 1980). The dried fruit pods of *P. biglobosa* contains heavy metals (Henry *et al.*, 2016), they have potential hazardous effect not only on plants and aquatic animals but also on human health (Das *et al*., 1997) depending on the dose and duration of exposure (Yusuff and Sonibare, 2004). The other toxic aspects of the plant identified to contain biocidal properties comprise the bark, pods, fresh seeds and the pulp (Bonkoungou, 1986) and this plant has also been known to contain alkaloids and tannins (Akintobi *et al*., 2016). The effluent from its pod may serve as a good biopesticide.

Controlling stored pests is not an easy task although synthetic chemicals are available for use, however its health implications deserve to be banned because they have residual effects and non-biodegradable in nature. Regular use of pesticide promotes faster evolution of resistant form of pests, turns formerly inoffensive species into pests, harms other non-target species and contaminates food (Busungu and Mushobozy, 1991). There is, thus, an urgent need for control agents, which are less toxic to man and more readily degradable. It had been well reported that extracts from a variety of plants have potent insect pest-control properties, and they have being found to affect the biology of target insects in different modes such as repellents, fumigants, contact toxicants, and insecticides (Sen, 2001).

In addition, plant-based pesticides are renewable in nature and cheaper. Also, some plants have more than one chemical as active ingredients responsible for their biological properties. These may be either for one particular biological effect or they may have diverse ecological effects. The chances of developing quick resistance to different chemicals are highly unlikely (Saxena *et al*., 1989). Based on these information there is possibility of African locust bean effluent to be converted into resource instead of waste for preserving agricultural produces as alternative usage to synthetic chemicals in agricultural sector was the aim of this research.

MATERIALS AND METHODS

Samples collection

The African locust bean effluents used for this study labeled as sample L_1 and L_2. Sample L_1 was obtained at National Centre for Agricultural Mechanization processing centre, the effluent was collected from post cooking before de-hulling of the seed. Sample L_2 was obtained from Jimba -Oja African locust bean processing location is among the major processing centre of African locust bean located in Ilorin, Kwara State, North central of Nigeria (Amusat *et al*., 2020). The two locations were chosen for the research to be broad and stand the test of time.

Sample analysis

Selected physicochemical properties of the effluent were evaluated either *in situ* or *ex situ*. The parameters evaluated *in situ* are: temperature, colour and pH. Electronically combined pH meter (Combo HI 98130, Hanna, USA) was used for *in situ* evaluation of the effluent at the point of sample collection which was first diluted and neutralize with distilled water and then dipping its probe into the effluent to take readings.

Laboratory analysis were carried out at Department of chemistry, university of Ilorin. The physicochemical parameters that were determined using APHA (1995) are: biochemical oxygen demand, dissolved oxygen, total hardness, sulphate, phosphate and nitrate. The heavy metals concentrations of lead, cadmium, copper, nickel, cobalt and iron in the effluent samples were also analysed using atomic Absorption Spectrophotometer after digestion with 12 ml of conc. *HNO* and 4 ml of conc. HCl (3:1) in accordance to aqua regia method. Each of these parameters were done in three replicate for the two effluent locations and subjected to descriptive statistics to obtain mean level.

Biocidal evaluation of effluent on maize weevil

Adult maize weevil (*Sitophilus zeamais* was collected and isolated from already infested maize in NCAM vicinity. The maize used to culture the weevil was thoroughly cleaned to ensure the absence of insects, mites or agent of deterioration. The treated maize seeds were introduced into plastic containers that have been previously washed, sterilized and dried. Maize weevil was introduced into the plastic containers containing maize seeds. The plastic containers were covered with a fastened tight net to prevent weevil from escaping. The weevil was allowed to acclimatize to the laboratory environmental conditions for period of seven days before the commencement of experiment.

Mortality Evaluation

Varying concentrations of the African locust bean effluents in three replicate (5, 10 and 15 mL) were measured into a mini sprayer.

Five (5) kg each of uninfected maize was introduced into each sterile plastic container. Fifteen active adult maize weevils were also introduced on the top of the maize inside the containers and were labeled for proper identification. The items in the plastic containers were sprayed with varied concentrations of treatments. The containers were loosely covered to allow ventilation. Observations on the weevils' response to the effluent samples were monitored, monitoring how the weevils reacted with respect to effluents concentration. Weevil mortality was assessed after 15 and 25 minutes of exposure to the effluents concentration.

RESULTS AND DISCUSION

The sample L_1 and L_2 was black and dark brown in appearance respectively with objectionable odours. The variation in the physicochemical parameters of the two Africa locust bean effluent types collected from each of the processing center under the study shown (Table 1), that there were considerable difference in physicochemical properties of effluents, temperature (^{o}C): 24.82 and 25.26, pH: 5.94 and 6.54, dissolved oxygen (mg/L): 3.02 and 2.59, biochemical oxygen demand (mg/L): 0.40 and 0.33, total hardness(mg/L):542.34 and 471.82 for sample L_1 and L_2 respectively. The difference in parameters suggests to the nature and the source of *P. biglobosa*. It might have also depended on the type of water used, temperature of boiling, boiling time and length of fermentation during processing procedures.

Table 1: Physicochemical properties of the locust bean effluents

Parameters	Jimba-Oja effluent	NCAM effluent
Temperature (^{o}C)	24.82	25.26
Colour	Black	Dark brown
Odour	Objectionable	Objectionable
pH	5.94	6.54
Dissolved oxygen (mg/L)	3.02	2.59
Biochemical oxygen demand (BOD) (mg/L)	0.40	0.33
Total hardness(mg/L)	542.34	471.82

The slight variation was also observed in the mineral compositions of the two effluents, cadmium: 0.15 and 0.24, copper: 5.19 and 7.31, nickel: 0.12 and 0.33, cobalt: 0.35 and 0.52, iron: 46.94 and 57.18, sulphate: 3.15 and 3.71, phosphate: 87.32 and 96.57, nitrate: 2.19 and 2.47mg/L for sample L_1 and L_2 respectively (Table 2). Higher values in mineral composition were recorded with sample L_1 than the sample L_2 which was prepared traditionally. These differences could be attributed to boiling time and the nature and the source of *P. biglobosa*.

Table 2: Mineral composition of the locust bean effluents

Parameters (mg/L)	Jimba-Oja effluent	NCAM effluent
Lead	ND	0.38
Cadmium	0.15	0.24
Copper	5.19	7.31
Nickel	0.12	0.33
Cobalt	0.35	0.52
Iron	46.94	57.18
Sulphate	3.15	3.71
Phosphate	87.32	96.57
Nitrate	2.19	2.47

ND = Not Detected

Toxicity Evaluation

The weevil mortality test of the two effluent1 locations, sample L_1 and L_2 on maize weevil indicated that the two effluents exhibited adverse effect on maize weevil. The direct proportionality increase in weevil mortality with increase in the concentrations of the effluents with respect to duration of exposure were recorded. Mortality rate of 2.2, 17.8 and 31.1% were recorded for sample L_1 at concentration of 5, 10 and 15mL within 15 minutes of exposure while 11.1, 33.3 and 55.6% were recorded within 25 minutes. Mortality rate of 6.7, 31.1 and 46.7% were recorded within 15 minute at 5, 10 and 15mL concentration of sample L_2 while 17.8, 48.9 and 71.1% were recorded within 25 minute of the same effluent concentration (Table 3, 4, 5 and 6). This could be attributed to the presences of heavy metals (lead, cadmium, cobalt, copper and nickel) as this directly affects the central nervous system of the organism. It has been reported that the powder of locust bean oil can serve as a good biopesticide for the control of dried fish beetles (Odeyemi *et al.*, 2000).

A wide variety of plants or plant products are known to be potentially toxic because they contains allelochemicals like glycosides, tannin, cyanides, alkaloids, phytic acid, hemagglutinins and saponins upon hydrolysis (Aletor, 1995). Harmful substances present in African locust bean pods are saponins, tannins, alkaloids and cardiac glycosides (Akintobi *et al*., 2016; Odeyemi *et al*., 2000). These toxicants might have been released into the effluent during the process and caused the death of the weevils through exposure and inhalation. The presence of nitrate and sulphate in effluent which can form acidic products could cause shortness of breath and might have resulted also in the death of the weevils (Odeyemi *et al*., 2000). Phosphate is the foundation of many insecticides and profile of toxic effects its presence in effluent could also responsible for the weevil death.

The variation in weevil mortality between the two effluent locations might be as result of temperature of boiling, boiling time and hence, overall processes involved in locust bean.

Table 3: Number of mortality at 15 minutes of exposure for Jimba-Oja effluent

Conc. of effluent (mL)	1(Freq.)	Pct.	11(Freq.)	Pct.	111(Freq.)	Pct.	Total mortalities	% mortality
	Replicate							
5	1	6.7	0	0	0	0	1	2.2
10	3	20.0	3	20.0	2	13.3	8	17.8
15	4	26.7	5	33.3	5	33.3	14	31.1

Table 4: Number of mortality at 25 minutes of exposure for Jimba-Oja effluent

Conc. of effluent (mL)	1(Freq.)	Pct.	11(Freq.)	Pct.	111(Freq.)	Pct.	Total mortalities	% mortality
	Replicate							
5	1	6.7	2	13.3	2	13.3	5	11.1
10	4	26.7	6	40.0	5	33.3	15	33.3
15	8	53.3	10	66.7	7	46.7	25	55.6

Table 5: Number of mortality at 15 minutes of exposure for NCAM effluent

Conc. of effluent (mL)	1(Freq.)	Pct.	11(Freq.)	Pct.	111(Freq.)	Pct.	Total mortalities	% mortality
	Replicate							
5	2	13.3	0	0	1	6.7	3	6.7
10	5	33.3	4	26.7	5	13.3	14	31.1
15	8	53.3	6	40.0	7	46.7	21	46.7

Table 6: Number of mortality at 25 minutes of exposure for NCAM effluent

Conc. of effluent (mL)	1(Freq.)	Pct.	11(Freq.)	Pct.	111(Freq.)	Pct.	Total mortalities	% mortality
	Replicate							
5	2	13.3	2	13.3	4	26.7	8	17.8
10	6	40.0	8	53.3	8	53.3	22	48.9
15	12	80.0	9	60.0	11	73.3	32	71.1

CONCLUSION AND RECOMMENDATION

This investigation established that African Locust bean effluent as wastewater can be re-used as biopesticide (resource). This could be attributed to the presence of some heavy metals cadmium, cobalt, nickel, lead, and copper which are basic natural components of the earth crust and mineral composition such as nitrate, phosphate and sulphate in effluents.

The re-use of Africa locust bean effluent as biopesticide is a plant-based pesticides that are renewable in nature, cheaper and easily accessed by locals. However, lethal concentration of effluents varied with respect to duration of exposure, further research is required to determine the actual lethal dose and duration of exposure.

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