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Effects of spent engine oil pollution on the nutrient composition and accumulation of heavy metal in cowpea [*Vigna unguiculata* (L.) Walp]

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Abstract

This study was carried out to determine the nutrient composition and heavy metal accumulation in leaves and seeds of cowpea, grown in spent engine oil polluted soil of Owerri, Imo State, Nigeria. The experiment was arranged in Completely Randomized Design, replicated five times. Five levels (0, 50, 100, 150 and 200ml) of spent engine oil were used. The cowpea seeds and leaves were harvested at the end of 12 weeks after planting (WAP) and the proximate composition and heavy metal were estimated. The result revealed that mean moisture content, protein, ash and fat content of seeds of cowpea grown in spent engine oil polluted soil were significantly (P<0.05) reduced (3.17%, 22.98%, 2.13%, 3.13% respectively), lower than seeds from non-spent oil polluted soils. The mean values of the corresponding parameters in non-polluted soils were as 21.69%, 24.71%, 2.43% and 3.88% for moisture content, protein, fat and ash, respectively. Moreover in seeds, the dry matter, fibre and carbohydrate were significantly increased (P<0.05) (DM, 96.83%, fibre, 2.43%, CHO, 69.14%), respectively in 200 ml polluted soil, compared to the corresponding values 78.21%, 1.87%, 67.08% recorded in control. In leaves, the protein, ash, fibre and moisture content were significantly (P<0.05) reduced as level of spent engine oil pollution increased in the soil, compare to the control. Whereas, carbohydrate, dry matter, were increased significantly P<0.05 as the level of spent engine oil increased, (Dry matter 42%, CHO, 67.41%) compare to the control, which were 26.10% and CHO 58%, respectively. The heavy metals such as Leads, Nickel and Zinc were found to be accumulated more in the leaves than in seed as the level of spent engine oil increased. The indiscriminate disposal of spent engine oil could lead to build up of heavy metals in plant seeds which in turn cause cancer or mutation in humans due to biomagnifications in food chain, hence there is need to avoid planting crops in polluted soils.

Keywords: heavy metals; pollution; proximate Composition; Spent engine oil; *Vigna unguiculata*..

Introduction

Advances in technology and science have caused the environmental changes that have become difficult to evaluate and fully comprehend. Oil spillage has a major impact on the ecosystem into which it is being released, immense destruction of the mangrove and rainforest, destruction of crops, farmland, and aquaculture such as fish, periwinkle and drinking water are manifested. Adekunle *et al* (2003) stated that the Niger Delta region of Nigeria is the hardest hit of environmental destruction arising from oil production. They further stated that people living in the Niger Delta region are faced with health hazards, lack of safe drinking water, to lack of cultivatable land. Pollution of the soil with petroleum derivatives is often observed in municipal soils, around industrial plants and in areas where petroleum and natural gas are obtained (Adam *et al*., 2003, Clark, 2003). Processing and distribution of petroleum hydrocarbon as well as the use of petroleum product are the main cause of soil contamination, Ayotammo *et al*. (2006). Changes in soil properties due to contamination with petroleum derived substances can lead to water and oxygen deficit as well as shortage to available forms of nitrogen and phosphorus Wyskowka *et al.* (2000). Contamination of the soil environment can also limit protective functions, upset metabolic activity, unfavorably affects its function and chemical characteristics, reduce fertility and negatively influence plant production (Gong *et al*., 1996., Wyszokowiski *et al*., 2004). According to Adenipekun and Kassim (2006), engine oil affected moisture content in *Celosia argentea* plant. Some people dump used engine oil anywhere that offers a convenient spot for them to do so. They pour it in wooden areas, in road side ditches, into storm drain, and even into or near creeks or rivers, unware of or unconcerned about environmental damage that results from irresponsible disposal of petroleum products. Disposal of spent engine oil in the big cities in Nigeria has been persistently problematic since many automobile mechanics dispose these oils indiscrimately either in gutters or open lands. This practice adversely affects plants, microbes and aquatic lives (Nwoko *et al.,* 2007; Adenipekin *et al*., 2008), because of the large amount of hydrocarbons and highly toxic polycyclic aromatic hydrocarbons contained in the oils (Nwoko and Fashemi, 2005). Cowpea (*Vigna unguculata*) is an annual legume and it is a worm-season crop, well adapted to many areas of humid tropics and temperate zone. It has different types which are often categorizes as erect, semi-erect, prostrate or climbing. Growth habit ranges from indeterminate to fairly indeterminate. Cowpea is generally tap rooted, it tolerates heat and dry conditions, but is intolerant to frost. Cowpea seeds provide a source of cheap plant protein to humans and livestock. Considering the economic value cowpea plant in the menu of poor people of the world, the present study was aimed at investigating the effects of spent engine oil pollution on proximate composition and extent of accumulation of seeds heavy metals in cowpea.

Table 1. Effects of spent engine oil pollution on nutrient composition of cowpea seed mean percentage of nutrient composition (%)

Treatment leaves	MC (%)	Dry matter (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	CHO (%)
0 ml	21.69[a]	78.21[e]	24.71[a]	2.43[a]	3.88[a]	1.87[d]	67.08[d]
50 ml	16.15[c]	83.85[c]	23.80[b]	2.41[b]	3.61[b]	1.87[d]	60.31[e]
100 ml	3.00[e]	97.05[a]	23.68[c]	2.31[c]	3.53[c]	2.11[c]	68.36[c]
150 ml	17.00[b]	83.02[d]	23.33[d]	2.27[d]	3.44[d]	2.38[b]	68.61[b]
200 ml	3.17[d]	96.83[b]	22.98[a]	2.13[c]	3.13[e]	2.43[a]	69.14[a]

Means in the same column having the same letter(s) are not significantly different at P<0.05.

Table 2. Effect of spent engine oil pollution on nutrient composition of cowpea leaves (%)

	Percentage Nutrient composition (%)						
Treatment leaves	MC (%)	Dry matter (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	CHO (%)
0 ml	73.91[a]	26.10[e]	9.92[a]	2.33[a]	7.33[a]	5.89[a]	58.91[e]
50 ml	46.53[e]	53.97[a]	8.78[b]	2.01[b]	7.33[a]	5.81[b]	59.20[d]
100 ml	68.50[c]	31.50[c]	8.05[c]	1.68[c]	7.10[b]	5.39[c]	60.06[c]
150 ml	70.45[b]	29.56[d]	4.67[d]	1.68[c]	6.83[c]	5.01[d]	62.41[b]
200 ml	57.49[d]	42.52[d]	4.67[d]	1.35[d]	6.53[d]	5.01[d]	67.41[a]

Means in the same column having the same letter(s) are not significantly different at P<0.05.

Results

Results of the study showed that there was significant difference in the moisture content in the seeds and leaves of cowpea plants grown in the polluted soil, and those grown in the non-polluted soil. From the Tables 1, seeds of cowpeas grown in 200ml spent oil polluted soil recorded the lowest moisture content (3.17) which was significantly different (P<0.05) from that of the control (with 0ml oil pollution) which recorded a mean moisture content of 21.69. Similarly, leaves of cowpea plants grown in 200ml spent oil polluted soils recorded the lowest mean moisture content (57.49) which was significantly different (P<0.05) from that of the control experiment (73.91) (Table 2). The dry matter content was found be higher in the seeds of cowpea plants grown in 100ml spent oil polluted soil with mean value of 97.05. This was significantly different from the dry matter recorded from cowpea plants in the other treatments (Table 1). On the other hand, cowpea plants grown in 50ml spent oil polluted soils recorded the highest dry matter (53.97) which was significantly different from the other treatments (Table 2). However, plants in the control experiments recorded the heart dry matter (Table 2). In the Table 1, protein, fat and ash content seeds of cowpeas grown in the control experiment (0ml of spent oil) recorded the highest values (24.71, 2.43 and 3.88, respectively). The values were significantly different from that of the other treatments. However, seeds of cowpea plants grown in the 200ml spent oil polluted soils produced the lowest values of protein (22.98), fat (2.13) and ash (3.13) (Table 1). Similarly, leaves of cowpea grown in the control experiment recorded the highest values of protein (9.92) and ash (7.33) which were significantly different (P<0.05) from the other treatments. However, cowpea that grew in 200ml spent oil polluted soils produced the least protein the least protein (4.67) and ash (6.53) in their leaves (Table 2). Seeds of cowpea plants grown in the 200ml spent oil polluted soil recorded the highest mean fibre (2.43) which was significantly different (P<0.0) from the other treatments (Table 1). Seeds of cowpea in the control experiment produced the least fibre (1.87) (Table 2). On the other hand, cowpeas grown in the control experiment produced the highest fibre in the leaves (5.89) which was significantly different from the other treatments (Table 2). Table 1 and 2, indicated that seeds and leaves of cowpeas grown in the 200ml spent oil polluted soils record the highest carbohydrate (69.14 and 67.41, respectively). These values were significantly different (P<0.05) from the other treatments. However, plants in the control experiments recorded the lowest carbohydrate in the seeds and leaves as shown in the table 1 and 2, respectively. The heavy metals accumulation in the seeds and leaves as presented in the Tables 3 and 4 showed that there were significantly difference among the various treatments. Zinc, Nickel, and Lead were observed to be increasing in accumulation in the seeds and leaves of cowpea as the quantity of the spent engine oil increases. Consequently, cowpea plants grown in the 200ml spent oil polluted soils accumulated higher Zinc, Nickel and Lead in their seeds and leaves (Tables 3 and 4, respectively).

Discussion

The moisture content was higher in the seeds and leaves of cowpea plants that grew in the control experiment (0ml of spent engine oil). On the contrary, moisture content decreased in seeds and leaves of cowpeas that grew in the spent oil polluted environment. The observed decrease in the moisture content of seeds and leaves of cowpea may have been attributed to water stress which may have been induced by the presence of the spent engine oil in the soil, thus impairing water conduction along the xylem tissue; leading to physiological drought. This observation is similar to that of Adenipekun and Kassim (2006) who reported that engine oil affected moisture content in *Celosia argentea.* Protein, ash and fat contents in the seeds and leaves were observed to be higher in the cowpea plants grow in the control experiment (0ml spent engine oil). In contrast, percentage of protein, ash and fat was decreasing in the seed and leaves of the treated cowpeas, as the concentration of the spent oil increased. This could be as a result of a hydrophobic layer over the roots forward by the spent engine oil, which may have limited water and nutrients absorption necessary for synthesis of protein, ash and fat in both seed and leaves of cowpea. This observation is in line with the findings of Ogbuehi *et al.* (2010) and Agbogidi *et al.* (2007) who reported that reduction in protein, crude fibre and at contents of cassava and maize respectively was due to impairment of photosynthetic activities through cell injury and disruption of

Tables 3. Effect of Spent Engine Oil Pollution on Heavy Metal Accumulation in Cowpea Seeds

	Mean values of Heavy Metals (ppm dry matter)		
Treatment	Zinc (ppm)	Nickel (ppm)	Lead (ppm)
Control	0.0^{d}	0.00^{c}	0.01^{c}
50ml	0.32^{c}	0.01^{b}	0.01^{c}
100ml	0.32^{c}	0.01^{b}	0.02^{b}
150ml	0.36^{0}	0.02^{a}	0.03^{a}
200ml	0.38^{a}	0.02^{a}	0.03^{a}

Means in the same column having the same letter(s) are not significantly different at P<0.05.

Tables 4. Effect of Spent Engine Oil Pollution on Heavy Metal accumulation in Cowpea Leaf

	Mean values of Heavy Metals (ppm dry matter)		
Treatment	Zinc (ppm)	Nickel (ppm)	Lead(ppm)
Control	0.28^{e}	0.02^{b}	0.01^{c}
50ml	0.28^{c}	0.02^{b}	0.02
100ml	0.36^{b}	0.02^{b}	0.02^{b}
150ml	0.36^{b}	0.04^{a}	0.03^{a}
200ml	0.42^{a}	0.04^{a}	0.04^{c}

Means in the same column with the same letter are not significantly different at P<0.05.

cell membrane caused by properties of crude oil. The fibre content in both seed and leaves of cowpea respond differently to spent oil application. While it significantly reduced the value in the leaves, in the seed, it significantly increased it. This could be as a result of physiological changes as food is been assimilate and translocated to seed for storage purpose during harvesting period. However, from this study it showed that fibre content of seed was not affected by increase concentration of spent oil level in the soil. The dry matter and carbohydrate content of the cowpea seeds and leaves were found to increase in both seed and leaves as spent oil concentration increased. The results for heavy metal accumulation in the seeds and leaves of cowpea showed that Zinc, Nickel and Lead accumulated more in the seeds and leaves of polluted cowpea more than in the control plants. However, the result revealed that cowpea heavy metals accumulated in the seeds and leaves as pollution levels increased. It was also observed that the Zinc accumulated more in both seed and leaves of cowpea than Nickel and Lead. The higher accumulation of Zinc in the leaves and seeds of cowpea could be as a result of the more solubility and mobility of Zinc than Nickel and Lead even under pollution environment. This agrees with the findings of Baker *et al* (1994), Dushenkove *et al.* (1997), Ogbuehi and Akonye (2008), Ogbuehi *et al.* (2010) who reported separately that some plant have the ability to phytoextract heavy metals from crude oil polluted soils.

Materials and methods

Study Location

The study was carried out as pot experiment in the green house the Teaching and Research Farm of Faculty of Agriculture, Imo State University, Owerri, Imo State, Nigeria.

Source of Experimental Materials

Seeds of cowpea were obtained from Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria. Topsoil obtained from the University Farm site then was sieved with a 2 mm mesh to remove debris. The spent engine oil used was obtained from auto-mechanic workshop along Okigwe Road, Owerri, Imo State, Nigeria.

Experimental Methods and Design

A sample of 15kg of soil was filled into black polythene bags measuring 14 x 14cm perforated 3-5 holes at the base. The bags were arranged in a completely randomized design consisting five treatments replicated five times. The soil was then treated with the different levels, 0ml, 50ml, 100ml, 150ml and 200ml of used engine oil. The engine oil was thoroughly mixed with trowel to achieve uniformity. The treated soil was allowed to stay for a week, to allow to mix oil very well with the soil and to enable the volatile compounds present to escape into the atmosphere. The seeds were planted at the rate of five seeds per bag. At 12 weeks, the seeds and leaves were harvested for proximate composition and heavy metal analysis. Proximate analysis of cowpea seeds/leaves were carried out to determine, moisture content, crude protein, fat, fibre and carbohydrate by using the Association of Official Analytical Chemist (AOAC, 1990), method. Also the heavy metals were analyzed by the AAS method. Data collected were subjected to the analysis of variance and treatment means were separated with the List Significant Difference (LSD) test at 5% level of probability (Onuh and Igwemma, 2001).

Conclusion

The result of this study indicated that spent oil pollution negatively affected the proximate composition of seeds and leaves of cowpea. Also Nickel, Zinc and Lead were found in the seeds and leaves of the polluted cowpeas. This indicated that cowpea as a plant absorbed these heavy metals from polluted environment. Humans and other animals that feed on the seeds and leaves of cowpea grown in spent oil polluted environment stand a risk of gradual accumulation of heavy metals in the body system. It is therefore pertinent to prevent the dumping and indiscriminate disposal of spent engine oil in the arable land meant for agriculture.

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