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ORIGINAL RESEARCH ARTICLE

STUDY ON THE USE OF BANANA AND PINEAPPLE PEEL WASTE AS BIOFERTILIZERS: ENHANCING SOIL FERTILITY, PROMOTING SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL SANITATION

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ABSTRACT

Indiscriminate agricultural waste disposal especially fruits peels can cause environmental pollution with increased public health risk. This study deals with managing banana and pineapple peel waste as organic fertilizers towards promoting sustainable environmental sanitation and agriculture production. Waste of banana and pineapple peels were separately collected in households, dumpsites and markets, the collected fruits peels were cleaned, sun dried for 33 days and grounded into powdered form. Three different formulations of organic fertilizers were made from the sun dried and finely grounded fruit peels of banana and pineapple, namely; formulation A containing 100g of banana peels powder; formulation B containing 100g of pineapple peels powder and formulation C containing 100g of a mixture of banana and pineapple peels powder. Four different containers were used to collect 10kg of soil each, three of which were treated with the three formulations and named sample A, B, C and an additional sample D which is control. After 30 days of treating the soil with the different formulations. The result of laboratory soil analysis showed that; Sample A contains 14% Nitrogen, 37% Phosphorus, 7% Potassium, 40% Calcium and 2% Magnesium. Sample B contains 11% Nitrogen, 39% Phosphorus, 8% Potassium, 39% Calcium and % Magnesium. Sample C contains 17% Nitrogen, 35% Phosphorus, 4% Potassium, 43% Calcium and 1% Magnesium. Sample D (Controlled Soil Sample) contains 1% Nitrogen, 17% Phosphorus, 4% Potassium, 45% Calcium and 33% Magnesium. It was revealed that the fruit peel powder formulations can increase the soil fertility which serves as alternative replacement for chemical fertilizers towards sustainable agriculture and the environment. It is recommended that the farmers and general public should make beneficial use of fruits waste as organic fertilizers and not to be discarded indiscriminately.

1.0 Introduction

Maximum agricultural productivity often requires application of artificial nutrients known as *fertilizer* to augment soil nutrients and increase soil fertility (Savci, 2012). However, achieving this based on inorganic fertilizer (such as NPK and Urea), is found to be detrimental to the ecosystem (Savci, 2012), especially on long term basis (Dubey *et al*., 2012), thus damaging the ecosystem. It often leads to decline in soil organic matter content, soil acidification and soil physical degradation leading to increase soil erosion, and toxification of the physical environment particularly its water resources contents (Morakinyo *et al*., 2013). Inorganic fertilizers are potential water pollution sources of nitrate, potassium, phosphate and various strains of heavy metals such as Arsenic (Ar), Cadmium (Cd), Mercury (Hg), chromium (Cr), Lead (Pb) that are generally harmful to the human health system (Sönmez *et al*., 2007; Morakinyo *et al.,* 2013, Sharma and Singhvi, 2017), Furthermore, inorganic fertilizers are expensive, thus beyond the reach of resource-poor farmers because of high cost and uncertain accessibility and organic inputs, which are often proposed as alternative to inorganic fertilizer composition and high labour requirement (Law-Ogbomo *et al*., 2011). It is therefore imperative

to adopt eco-friendly and sustainable agricultural practices for efficient food production through organic farming.

Recently, the need for clean environment for healthy habitation has attracted the integration of vegetables and fruits peels waste into farms, as an alternative to synthetic plant growth nutrient, and as part of measures towards efficient nutrient management and recycling of wastes; Although animal manures are also being incorporated into organic farming, however, they sometimes present some sort of public health and environmental water pollution issues in nearby farms if not well managed; it leads to pathogenic bacterial contamination, ammonia pollution and depletion of dissolved oxygen in water bodies which is especially unconducive for aquatic livelihood. However, a wide range of agricultural fruit waste such as banana peel, orange peel, pineapple, egg shell, tea waste, potato peel waste, generated from especially households and fruit vendors were mostly discarded without subjecting to any form of commercial value, and at large environmental expense and quality of life of people (Harir *et al.,* 2015).However, numerous scientific studies showed that various quantities of minerals and natural bioactive phytochemicals are contained in fruits peels, which are essentially needed by plant for optimum growth and development (Rudra *et al*., 2015; Bakry *et al.,* 2016; Khattak and Rahman, 2017; Pathak *et al.,* 2017, Sagar *et al.,* 2018; Vasanthi and Ramadas, 2019), such as calcium, sodium, magnesium, iron, manganese, zinc, potassium and phosphorus which are potential sources of plant nutrient. Hence utilizing these wastes as plant fertilizers undoubtedly may lead to increase in soil plant nutrients and sustainable plant growth and environment. Banana and pineapple peel are some common fruits consumed globally, Hence, with the increasing banana and pineapple fruits production and consumption, banana and pineapple waste are also proportionally increasing, thus waste disposal present a serious environmental challenge, as the rich nutrients packed in these wastes make them vulnerable to microbial spoilage. The objectives of this research are to demonstrate the efficacy of the use of peels of Banana and pineapple on soil fertility for maximum agricultural production.

2. Methodology

2.1. *Collection and Preparation of soil*

Clay soil samples were collected in a barren land and were filled in four different containers (made up of rubber), and named sample A, B, C and D (control), each weighing 2kg, the soil was sampled, air-dried in an oven and collected in a sterile polythene bags and sent to Laboratory for analysis of macro elements (Nitrogen, Phosphorous and Potassium), micro elements (Calcium and Magnesium), and tested for Electrical conductivity and pH, as initial nutrient content of the soil sample before treatment

2.2. *Extraction of fruit peel waste*

Waste of banana and pineapple peels waste were separately collected in households, dumpsites and markets, the collected fruits peels were rinsed adequately in running tap water of debris, sand and foreign materials, the cleaned peels were cut into small pieces (1-5cm) and sun dried for 33 days, which were then ground into powdered form, sieved and stored at room temperature, each of pineapple and banana extract were prepared Separately and an additional preparation containing a mixture of pineapple and banana. Figures 1 and 2 show the banana peel and Pineapple peel powders.

Figure 1: Grounded Banana Peel Powder

Figure 2: Grounded Pineapple Peel Powder

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2.3. Formulation of different fruit peels fertiliser

Three formulations, 4g of each of fruit peel powders prepared were diluted in 400ml of water and applied to soils, and mixed properly for uniform distribution, controls and two replications maintained for each of powders, for 32 days.

2.4. Physiochemical analysis of treated Soil Samples

After treatment, the three different samples were tested at the Department of Geology Laboratory, University of Maiduguri. The samples are Sample A (Banana Peel Powder with Soil Sample), Sample B (Pineapple Peel Powder with Soil Sample) and Sample C (Banana Peel Powder and Pineapple Peel Powder with Soil Sample). Parameters measured were pH, Electronic Conductivity (EC), Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca) and Magnesium (Mg) in order to discover their increase level and availability in the soil sample.

3. Results and Discussion

3.1 Chemical Properties of Different Fertilizer Formulations Soil Samples and control.

The result of the soil analysis of the various soil sample treated and the control were shown below in Table 1 and Figure 3.

Table 1: Chemical properties of the various samples mixed and treated with the soil sample

			Composition of Micro-nutrient percentage (%)			Composition of Macro-Nutrients percentage (%)	
Samples	PH	EC(µs/cm)	N	P	K	Ca	Mg
Soil Sample A (Banana Peel Formulation)	8.1	380	10.21	26.7	5.10	28.90	0.98
Soil Sample B (Pineapple Peel Formulation)	8.0	330	8.91	30.98	6.0	31.0	2.01
Soil Sample C (Banana + Pineapple Peel Formulation)	7.9	370	15.32	32.90	3.96	39.67	15.32
Soil Sample D (Control)	6.2	430	0.105	1.75	0.395	4.6	3.3

Note: Results are in percentage with exception of pH and EC.

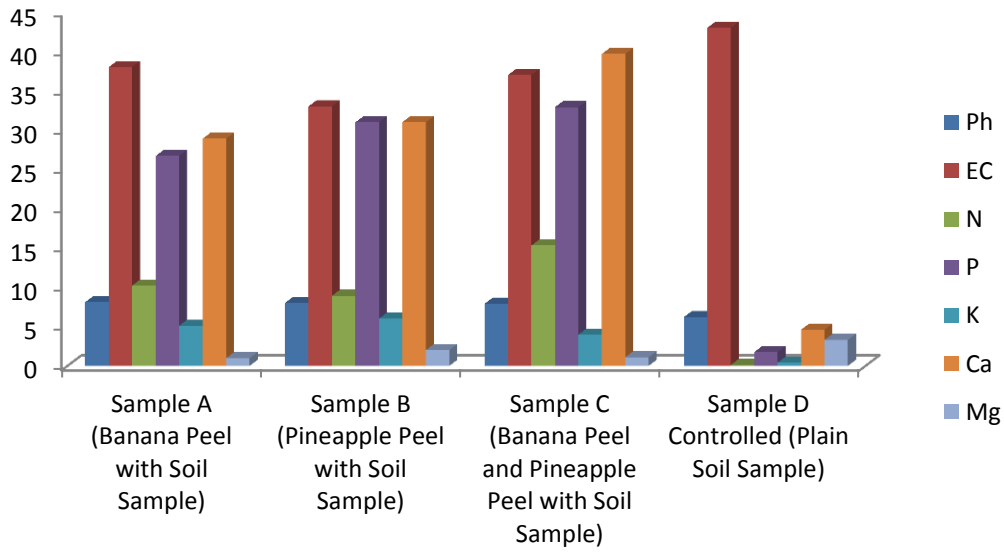

Figure 3: Bar Chart showing the amount of each parameter in the various samples

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3.2 Nitrogen (N)

As shown above in Figure 1 and Table 1, the treated samples have appreciable level of nitrogen content with Sample C (Banana and Pineapple Peel with Soil Sample) being the highest (15.32%) followed by sample A (10.21%) and Sample B (8.91%). However, Sample D (control) has the lowest Nitrogen content (0.105%) which differed significantly, this is similar to studies by Mamouni *et al.*, (2016) in which phytochemicals analysis wastes of potatoes peel and shrimp shells showed high nitrogen presence in them, averaging 16.2 and 49.8 kg/ton respectively, hence, signifying that fruit peels wastes are an important source of Nitrogen for plant growth. Nitrogen plays a vital role is protein development and various critical plant functions such as Photosynthetic and Enzymatic reactions (Hamid *et al.*, 2019; Khairnar and Nair, 2019), if the soil is deficient in Nitrogen, the plants become stunted and pale. However, excess nitrogen can also be detrimental to plants.

3.3 Phosphorus (P)

The result shows that Sample C (Banana and Pineapple Peel with Soil Sample) has the highest amount of Phosphorus with 32.90% followed by Sample B (30.98%) and Sample A(26.7%), and Sample D (controlled) has the lowest amount of Phosphorus with 1.75% which differed significantly with the treated samples. The results are again similar to findings by Mamouni *et al.*, (2016), where almond hulls were found to be a good source of phosphorus with an average of 2.4 kg /ton, which can be beneficial for plant growth. Phosphorus provides plants with a means of using the energy harnessed by photosynthesis to drive its metabolism. It can stimulate root development, increase stalk and stem strength and improve flower and seed production (Hamid *et al.*, 2019). A deficiency of this nutrient can lead to impaired vegetative growth, weak root systems, poor fruit and seed quality, and low yield. However, Plants require fairly large quantities of phosphorus, but the levels of phosphorus available to plant roots at any given time are usually quite low.

3.4 Potassium (K)

The result shows that Sample B (Pineapple Peel with Soil Sample) has the highest amount of Potassium (6%) followed by sample A and Sample C, while Sample D (control) has the lowest amount of Potassium with 0.395% which differed significantly, indicating that fruits peels are vital sources of potassium element for plant growth (Hussein et al. 2019), especially the Banana peels (Bakry *et al.*, 2016). Potassium rivals nitrogen as the nutrient absorbed in greatest amounts by plants. Like nitrogen, crops take up a relatively large proportion of plant available potassium each growing season. Potassium enhances enzyme actions, aids in photosynthesis and food formation. It builds cellulose and helps translocation of sugars and starches. Potassium also plays role in the size, shape, color, taste, shelf life, fiber and other quality-related measurements of crops. Additionally, Potassium can increase root growth and improves drought tolerance (Hamid *et al.*, 2019) Plants deficient in potassium are unable to utilize nitrogen and water efficiently and are more susceptible to disease.

3.5 Calcium (Ca)

The result shows that Sample C (Banana and Pineapple Peel with Soil Sample) has the highest amount of Calcium with 39.67% and Sample D (controlled) has the lowest amount of Calcium with 4% which differed significantly. Calcium is essential for proper functioning of plant cell walls and membranes, also activating several enzymatic systems, thus significant to the proper development of plants (El Habbasha and Faten, 2015).

3.6 Magnesium (Mg)

The result shows that Sample C (Banana and Pineapple Peel with Soil Sample) has the highest amount of Magnesium with 15.32% and Sample A (Banana Peel with Soil Sample) has the lowest amount of Magnesium with 0.98% which differed significantly. Magnesium acts together with phosphorus to drive plant metabolism and is part of chlorophyll; a vital substance for photosynthesis (Cowan, 2002; Shaul, 2002).

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3.7 Soil pH

This result shows that Sample A (Banana Peel with Soil Sample) has the highest pH value with 8.1 which corresponds with the findings by Khairnar and Nair, 2019, whereas Sample D (Controlled) has the lowest pH value with 6.2 which differed significantly. However, the pH values of the different soil samples; sample A, sample B and sample C were above 7 which signify the samples are base/alkaline. Depending on the chemical characteristics, different fruits peels exhibit different pH level (Khairnar and Nair, 2019), most plants grow best in soil with a pH between 6 and 7.The results shows that fruits waste can be used to regulate soil pH for enhanced agricultural productivity (Panwar, 2015). Soil pH is an indicator of the soil's acidity which is a primary factor controlling nutrient availability, microbial processes, and plant growth (Allen, 2013). When soil pH is maintained at the proper level, plant nutrient availability is optimized, solubility of toxic elements is minimized, and beneficial soil organisms are most active, the alkalinity of the treated samples was due to the fact that banana and pineapple were both alkaline fruits, hence can be essential in regulating soil PH for optimum growth and development as different plants perform best at a particular PH (Adrija and Navni, 2018).

3.8 Soil Electrical Conductivity (EC)

This result shows that Sample D (Controlled) has the highest amount with 430µs/cm and Sample B (Pineapple Peel with Soil Sample) has the lowest amount with 330µs/cm which differed significantly. The High EC in the untreated sample (sample D) is an indication that fertilizer application is essential for altering soil EC and replenishing soil nutrients for maximum production. The Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics. Electrical conductivity (EC) is the most common measure of soil salinity and is indicative of the ability of an aqueous solution to carry an electric current. Plants are detrimentally affected, both physically and chemically (Mun), by excess salts in some soils and by high levels of exchangeable sodium in others. Excess salts hinder plant growth by affecting the soil-water balance (Sheldon *et al*., 2004). Soils containing excess salts occur naturally in arid and semiarid climate.

4. Conclusion

Comparative study on the utilization of Banana and Pineapple fruit peel as organic fertilizer was carried out to know soil fertility, towards promoting both sustainable agricultural and environmental sanitation. From the study, it is found that Banana and Pineapple peel waste are substantially rich in soil micro and macro nutrients to enhance soil fertility and increase plant yield, thus sanitizing the environment and reducing the negative impacts of inorganic fertilizers. It is therefore recommended that public and farmers should make beneficial use of fruits waste as organic fertilizers and not discarded indiscriminately causing pollution of the environment.

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