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# SIMULTANEOUS SACCHARIFICATION AND FERMENTATION (SSF) OF BLENDED ORGANIC FERTILIZER FROM YAM AND SWEET POTATO PEELS

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## ABSTRACT

*This study shows the production of organic fertilizer by utilization of yam and sweet potatoes peels through Simultaneous Saccharification and Fermentation (SSF) Method. Samples are categorized into sun-dried, sundried and autoclaved, Heat-dried, heat-dried and autoclaved; the fermentation process is carried out using alpha amylase and saccharomyces cerevisiae. Investigation of mineral elements (N, Cd, P, Zn, Pb, As, K, Hg.), in the eight varieties of Organic Fertilizer produced shows concentration of Cadmium (Cd) ranges from 0.0015 mg/kg to 0.0033 mg/kg), Nitrogen (N) in Percentage ranges from 2.3450% to 3.8550%; Phosphorus (P) ranges from 2.345 mg/kg to 3.607 mg/kg; Zinc (Zn) ranges from 2.215 mg/kg to 6.335 mg/kg. Lead (Pb) ranges from 0.00 mg/kg to 0.0015 mg/kg, potassium (K) ranges from 3.952 mg/kg to 6.213 mg/kg; Mercury and Arsenic nil. The study shows that Sweet Potato Peel (SDSPP) contains high Cadmium and potassium compare to other organic fertilizer produced. Sundried and Autoclaved Yam Peel (SDAYP) contains high percentage of Nitrogen (N), Heat Dried and Autoclaved Sweet Potato Peel (HDASPP) contains low Nitrogen, Sundried and Autoclaved Sweet Potato Peel (SDASPP) contains low phosphorus, Sundried Yam Peel (SDYP), Sundried and Autoclaved Yam Peels (SDAYP), Heat Dried Sweet Potato Peel HDSPP and Heat Dried Sweet Potato Peel (HDSPP) has zero trace of Lead (Pb) making it free of food intoxication from heavy metals, SDYP contains high phosphorus. These indicate that the samples will make quality organic fertilizer because it contains high Nitrogen, Phosphorus and potassium (NPK) which are essential elements required in plant structures.*

**Keywords:** Yam and Sweet Potatoes Peels, Fermentation, Saccharification, Autoclave, Dried

## INTRODUCTION

The expansion in world population has raised food demand, and the constant use of land for agriculture to meet this demand has caused the soil to lose fertility and provide poorer yields, leading to the use of artificial fertilizer in agriculture to boost food production.

However, the use of synthetic chemical nitrogen and phosphate fertilizers has been substantially responsible for the establishment of a highly productive and intensive agricultural system(Schultz *et al*., 2018).

Soil quality, groundwater quality, biodiversity, and ecosystem function have all been negatively impacted by contemporary agriculture's overuse, imbalanced application, and consistency of chemical fertilizers (Socolow, 1999). Chemical fertilizers are manufactured and transported using fossil fuels, which contribute to nitrogen and carbon dioxide pollution in the atmosphere, threatening terrestrial ecosystems. Moreover, if chemical fertilizers are added to the soil in excess of what is needed by crops, they are stored by plants and frequently result in potential losses (by leaching, volatilization, acidification, and denitrification) because of elevated nitrate and phosphorus concentrations in water bodies that cause eutrophication and hypoxia in lakes and estuaries (Vance, 2001). Consequently, greener, sustainable, and healthy living are needed.

Organic fertilizers, whether applied to plants, soil, or by fertigation (applying irrigation water), can restore natural soil nutrients, promote crop development, and improve soil fertility (Thomas *et al*., 2019). These provide plants with micronutrients such as zinc, copper, iron, boron, and molybdenum, as well as key macronutrients such as nitrogen, phosphorus, potassium, calcium, sulfur, and magnesium (Alley and Vanlauwe, 2009). Chemical fertilizers and pesticides must be minimized in agricultural use without impacting crop output by adopting and using safe, sustainable organic fertilizer inputs. The greatest alternatives to chemical fertilizers are organic fertilizers, which comprise both living and dead organisms as well as organic waste (Thomas *et al*., 2019). More crucially, organic fertilizers may contain efficient microbial strains that aid agricultural plants in absorbing nutrients via rhizosphere interactions. Several bacteria designated as plant growth-promoting rhizobacteria (PGPR) can aid in the development of plants through a variety of known and unidentified methods. Some of the key acknowledged mechanisms demonstrated by PGPR that promote plant growth include the production of plant growth hormones, nutrient uptake enhancement, phosphorus solubilization, atmospheric nitrogen fixation, and nutrient absorption enhancement (Bashan *et al.* 1990). Around 2% (w/w) of nitrogen, phosphorus, and potassium can be found in the soil, along with a variety of microorganisms, earthworms, and dung beetles. Moreover, supplying vital supplements to the plants boosting soil microorganisms activity, the microorganisms oxygen addition of biomolecule particles by soil microbes led to generation of organic make-up substance, that will be utilised as bio fertilizer to adequately oxygenate, cluster, safeguard, and keep the ground watery (Li *et al.,* 2016). Compost is made from a variety of materials, including leaves, bedding from cattle sheds, fruit and vegetable wastes, slurry from biogas plants, industrial wastes, city garbage, sewage sludge, and industrial waste. Compost is produced by a variety of degrading microorganisms, including *Azotobacter, Beijerinkia, Clostridium, Nostoc, Trichoderma viridae, Aspergillus niger A. terreus, Bacillus spp.,* and various Gram-negative bacteria (*Pseudomonas, Serratia, Klebsiella, and Enterobacter*). In addition to having proteolytic activity and antibiosis (by creating antibiotics), which suppresses other parasitic or dangerous microorganisms, it also has cellulolytic or lignolytic activities that breakdown plant cell walls (Boulter *et al.,* 2002). From 2015 to 2022, the organic fertilizer industry was expected to develop at a compound annual growth rate of 13.2%, reaching US$1.105 billion (Timmusk *et al.,* 2017). Additionally, a variety of macro and micronutrients that are crucial for plant growth are provided by organic fertilizers. Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), zinc (Zn), magnesium (Mg), and other trace elements make up the majority of these nutrients. (Toor *et al*., 2021). Depending on the sources and manufacturing procedures, organic fertilizer contains varying amounts of nutrients. In contrast, manure-based fertilizers are great sources of nitrogen, phosphate, and potassium (Sánchez *et al*., 2021). For instance, nitrogen is naturally added to decomposed plant waste.

## MATERIAL AND METHODS

**Sample Collection**:

The sweet potato peels were obtained from a food vendor near Federal University Wukari, Taraba state. The sweet potato peels were washed with tap water to remove soil and dirt before being sun-dried for 5 days in the open air.

**Milling or Grinding of Sample:**

The well dried samples was milled using a milling machine outside the school premises, the machine was properly cleaned with tap water and given time to dry.

Experimental Group:

Group 1: Yam Peels

SDYP = Sun Dried Yam Peel acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation

(b)HDYP= Heat dried yam peels acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation.

(c)NDAYP= Normal dried & Autoclaved yam peels acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation.

(d) HDAYP= Heat dried & Autoclaved yam peels acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation.

LAGEND: SDYP = Sun Dried Yam Peel, HDYP= Heat dried yam peel, NDAYP= Normal dried & Autoclaved yam peels, HDAYP= Heat dried & Autoclaved yam peels

Group 2: Sweet potato peels.

SDSPP= Sun Dried Sweet potato peels acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation.

(b)HDSPP= Heat dried sweet potato peels acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation.

(c)NDASPP= Normal dried and autoclaved sweet potato peels acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation.

(d)HDASPP= Heat dried & Autoclaved sweet potato peels acted upon by α-Amylase enzyme and *Saccharomyces cerevisae* in Simultaneous saccharification and fermentation.

LAGEND: SDSPP= Sun Dried Sweet potato peels, HDSPP= Heat dried sweet potato peels, NDASPP= Normal dried and autoclaved sweet potato peels, HDASPP= Heat dried & Autoclaved sweet potato peels.

**Experimental Method**

All of the samples, including those that had been heat dried normally, normally dried (by autoclave), and heat dried (by autoclave), underwent solid-state fermentation (SSF). In this technique, samples are inoculated with yeast and an enzyme. Each sample was measured at 150g and placed into its corresponding conical flask. At 30°C, the processes of saccharification and fermentation were carried out simultaneously by adding 0.02% amylase and an inoculum equivalent to 3% (v/v). The samples will additionally receive 0.6g of urea as a nitrogen source. By employing a buffer to alter the pH, the pH will be adjusted at 6.0, and fermentation will continue for 96 hours at 30°C.

**Nutrient analysis**

An Atomic Absorption Spectrophotometer was used to estimate the sample's pH, Electric Conductivity, Sulphate, Chloride, Phosphorous, Total Organic Carbon, Nitrogen, Calcium, Potassium, Iron, Manganese, and Copper.

The pH meter was calibrated using a two-point calibration with buffer solutions ranging from pH 7 to 10 and an electrode slope ranging from 92 to 102%. Fermented waste (20g) from each sample was collected and deposited in 100 ml beakers with 20 ml of deionized water, which was constantly mixed for 30 minutes. The pH was then measured after an extra hour of standing. After being raised in deionized water, the calibrated Electrode and Automatic Temperature Compensation (ATC) were wiped dry with a clean tissue. The pH values of the organic fertilizer samples were then evaluated using pH meter probes.

**Electric Conductivity**:

This means that bio fertilizer (fermented wastes) possess the characteristics of an electrical conductor. This phenomenon is known as electrical conductivity (EC) and is measured in (mS/m). Salinity of fertilizer has been measured by soil scientists using EC.  In the lab, soil salinity is often evaluated by using the conductivity meter or the total soluble salts by evaporating the soil water extract (TSS).

**Dry Ash Procedure for Heavy Metals and other Elemental Analysis.**

**PROCEDURE**

The sample (5.000g) was placed in a "high form" ceramic vessel, which was then placed in an incinerator and the heat was steadily regulated until the temperature reached 550$^{o}$C and the substance turned ash-like or murky is seen in the vessel, the sample collected in the vessel was dissolved in 2 mL of conc. Nitric acid, the ash was released into conical flasks, and dilute to volume with dH20 and shook, standards were ran, and unfamiliar samples using AAS Buck 230 (for Pb, Hg, As, Cu, Mg, Fe, Cr, Cd, Zn, Ca and Mn) and Jenway ME 882 Flame photometer (for Na and K) using air acetylene flame integrated mode and quantify strength of unrecognised from the calibration curve of standards. The AOAC (2015) technique was employed.

**Colorimetric determination of Fe using Orthophenanthronline method**:

An unknown sample (10 ml) was pipetted into a 100 ml flask along with 2 ml of 10% hydroxylamine, 20 ml of 10% Na-citrate solution, and 2 ml of orthophenanthroline reagent. After mixing and waiting 24 hours for the color to develop, the sample was measured for percentage (%) transmittance at 500 nm. The standard curve's percent transmittance for solutions containing 0.5, 1.0, 1.5, 2.0, and 2.50 ppm standard Fe was read using the same approach. The curve was used to calculate the concentration of the unknown.

**Colorimetric Determination of Phosphorus Using Vanadomolybdate (Yellow) Method**

Ammonium molybdate 4-hydrate $(NH_4)_6 Mo_7 O_2$ of 20g, $4H_2O$ was dissolved in 400 ml warm water ($50^0$ C) and cool, 1.0g ammonium vanadate ($NH_4 VO_3$) was dissolved in 300 ml boiling distilled water, cooled and 140 ml conc. nitric acid was added gradually with stirring. Then the molybdate solution is added gradually to the acid vanadate solution with stirring and diluted to a litre with water.

**NITROGEN DETERMINATION**

DIGESTION PROCEDURE:

The sample was ground into small particles, and 2 grams of the dried sample were added to a kjeldahl flask along with catalyst tablets or 4 grams of a mixture of Na2 So4 and Cuso4 along with 25 to 30 ml of concentrated sulfuric acid. The mixture was gently heated at first until frothing stopped, then more vigorously until a nearly clear solution emerged. It wasn't up to par to let the digest to cool and transfer it quantitatively into a 250 ml volumetric flask.

DISTILLATION

For around ten minutes, the distillation equipment was steam-heated. While this is going on, the volume of the digest was adjusted to the right level, and the flask was thoroughly shaken before the 25ml of sample digest and 25ml of a solution containing 40 percent sodium hydroxide were combined. The combination was installed on the distillation unit, heated, and water was continuously pumped through it. The freed ammonia was then collected in a conical flask at the condenser end of the Markham distillation unit together with 10ml of a boric acid-indicator mixture. The distillation was permitted to continue for a further five minutes after the mixture of boric acid and indicator turned green. At the conclusion of the experiment, the conical flask was removed, and the liquid inside was titrated with O.OIN hydrochloric acid until the boric acid-indicator mixture's original color was achieved.

CALCULATION

$$\text{Percentage } \mathbf{N} = \frac{0.\ 00014 * \text{Titre value} * 100 * 100\%}{\text{Sample weight gotten} * \text{Vol. Distilled}}$$

**Applicability of the Organic Fertilizer in Vegetable Plantation**:

To assess the efficiency of the bio fertilizer, the various seed samples (maize and beans) were treated with organic fertilizers for two weeks of growth. Another sample of beans and maize was also planted at the same time, but without any fertilizer; this sample will be used as the control. To assess the efficacy of the bio fertilizer, various seed samples (maize and beans) were fertilized with organic fertilizers when they were 2 weeks old.

**Experimental Design**

Two empty Pot culture boxes with a combined capacity of 100g each were filled with 50g of sand. Five maize seeds were placed in one box, and comparable quantities of bean seeds were placed in another box. Both soils received a mixture of 5g of p1 fertilizer and 5ml of water. The same logic was adopted for the other tuber fertilizer. The efficiency of the organic fertilizer was periodically assessed after the plants had grown for two weeks by measuring their growth every three days for three weeks.

**Statistical Analysis**

Statistical Package for Social Sciences (SPSS) version 20 was used. Results were presented in Mean ± Standard Deviation.

## RESULT AND DISCUSSION

**Growth Determination (Field Work);**

Each plant's growth index (height, width, and length of leaves) was measured at random every month. Three days after two weeks of plant (maize and cowpea) growth, fertilizer was applied, and three days later, the growth index was measured.

**Figure 1:** Plant growth observed after 3 weeks of growth; images captured at the field.

**Table 1:** Chemical composition of samples (mg/kg)

| Sample | N (%) | Hg | Cd | P | Zn | Pb | As | K |
|---|---|---|---|---|---|---|---|---|
| SDYP | 3.2600±0.014$^{c}$ | 0.00±0.00 | 0.0015±0.00$^{a}$ | 3.607±0.00$^{a}$ | 2.325±0.01$^{b}$ | 0.00±0.00 | 0.00±0.00 | 4.565±0.15$^{d}$ |
| SDAYP | 3.8550±0.01$^{a}$ | 0.00±0.00 | 0.0016±0.00$^{a}$ | 3.397±0.01$^{a}$ | 4.215±0.01$^{b}$ | 0.00±0.00 | 0.00±0.00 | 4.812±0.00$^{a}$ |
| HDYP | 3.3200±0.014$^{c}$ | 0.00±0.00 | 0.0014±0.00$^{a}$ | 3.287±0.00$^{a}$ | 3.950±0.00$^{a}$ | 0.0015±0.00$^{a}$ | 0.00±0.00 | 4.963±0.01$^{b}$ |
| HDAYP | 3.4500±0.00$^{a}$ | 0.00±0.00 | 0.0015±0.00$^{a}$ | 3.315±0.00$^{a}$ | 3.775±0.01$^{b}$ | 0.0011±0.00$^{a}$ | 0.00±0.00 | 6.112±0.01$^{b}$ |
| SDSPP | 2.9800±0.014$^{c}$ | 0.00±0.00 | 0.0033±0.00$^{a}$ | 2.345±0.01$^{b}$ | 3.160±0.01$^{b}$ | 0.0012±0.00$^{a}$ | 0.00±0.00 | 6.213±0.00$^{a}$ |
| SDASPP | 2.8150±0.01$^{a}$ | 0.00±0.00 | 0.0021±0.00$^{a}$ | 2.525±0.01$^{b}$ | 2.655±0.00$^{a}$ | 0.0012±0.00$^{a}$ | 0.00±0.00 | 3.952±0.00$^{a}$ |
| HDSPP | 3.4500±0.00$^{a}$ | 0.00±0.00 | 0.0025±0.00$^{a}$ | 2.437±0.00$^{a}$ | 6.335±0.02$^{ab}$ | 0.00±0.00 | 0.00±0.00 | 4.00±0.01$^{b}$ |
| HDASPP | 2.3450±0.01$^{a}$ | 0.00±0.00 | 0.0024±0.00$^{a}$ | 2.618±0.01$^{b}$ | 2.215±0.01$^{b}$ | 0.00±0.00 | 0.00±0.00 | 5.692±0.01$^{b}$ |

LAGEND: SDYP = Sun Dried Yam Peel, HDYP= Heat dried yam peel, NDAYP= Normal dried & Autoclaved yam peels, HDAYP= Heat dried & Autoclaved yam peels, SDSPP= Sun Dried Sweet potato peels, HDSPP= Heat dried sweet potato peels, NDASPP= Normal dried and autoclaved sweet potato peels, HDASPP= Heat dried & Autoclaved sweet potato peels

*Result is presented as mean ± standard deviation. Attached superscript indicates the level of significance. Mean values with the same superscript indicate there is no level of significance between them within an evaluated parameter and treatment group. While mean values with the different superscript indicate there is significant difference between the individual values within the groups of the treatment parameter ($p>0.05$).*

**Table 2:** Measurement of maize and cowpea growth index (cm) 3 days after fertilizer application

| Organic fertilizer description | Height of maize (from the base) (cm) | Width of maize leaf (from the base) (cm) | Height of beans (from the base) (cm) | Width of beams leaf (from the base) (cm) |
|---|---|---|---|---|
| SDASPP | 26.00±1.41 | 2.25±0.35 | 6.00±1.41 | 2.50±0.71 |
| SDYP | 24.00±1.41 | 2.25±0.35 | 5.50±1.41 | 2.50±0.71 |
| SDAYP | 21.00±1.41 | 3.25±0.35 | 6.00±1.41 | 2.50±0.71 |
| HDYP | 24.00±1.41 | 3.25±0.35 | 6.00±1.41 | 3.00±1.41 |
| HDAYP | 23.50±2.12 | 2.50±0.71 | 5.50±1.41 | 3.00±1.41 |
| SDSPP | 21.00±1.41 | 2.50±0.71 | 6.00±1.41 | 2.50±0.71 |
| HDSPP | 19.00±1.41 | 2.50±0.71 | 5.00±1.41 | 2.50±0.71 |
| HDASPP | 22.00±1.41 | 3.25±0.35 | 5.00±1.41 | 3.00±1.41 |
| Urea | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 |

*Result is presented as mean ± standard deviation.*

LAGEND: SDYP = Sun Dried Yam Peel, HDYP= Heat dried yam peel, NDAYP= Normal dried & Autoclaved yam peels, HDAYP= Heat dried & Autoclaved yam peels, SDSPP= Sun Dried Sweet potato peels, HDSPP= Heat dried sweet potato peels, NDASPP= Normal dried and autoclaved sweet potato peels, HDASPP= Heat dried & Autoclaved sweet potato peels.

**Table: 3** Measurement of maize and cowpea growth index (cm) 6 days after fertilizer application

| Organic fertilizer description | Height of maize (from the base) (cm) | Width of maize leaf (small and big) (cm) | Height of beans (from the base) (cm) | Width of beams leaf (small and big) (cm) |
|---|---|---|---|---|
| SDASPP | 22.00±1.41 | 1.25±0.35 | 5.00±1.41 | 1.50±0.71 |
| SDYP | 21.00±1.41 | 1.25±0.35 | 4.50±1.41 | 1.50±0.71 |
| SDAYP | 19.00±1.41 | 2.25±0.35 | 5.00±1.41 | 1.50±0.71 |
| HDYP | 21.00±1.41 | 2.25±0.35 | 5.00±1.41 | 2.00±1.41 |
| HDAYP | 21.00±1.41 | 1.50±0.71 | 4.50±1.41 | 2.00±1.41 |
| SDSPP | 20.00±1.41 | 1.50±0.71 | 5.00±1.41 | 1.50±0.71 |
| HDSPP | 19.00±1.41 | 1.50±0.71 | 4.00±1.41 | 1.50±0.71 |
| HDASPP | 21.00±1.41 | 2.25±0.35 | 4.00±1.41 | 2.00±1.41 |
| Urea | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 |

*Result is presented as mean ± standard deviation.*

LAGEND: SDYP = Sun Dried Yam Peel, HDYP= Heat dried yam peel, NDAYP= Normal dried & Autoclaved yam peels, HDAYP= Heat dried & Autoclaved yam peels, SDSPP= Sun Dried Sweet potato peels, HDSPP= Heat dried sweet potato peels, NDASPP= Normal dried and autoclaved sweet potato peels, HDASPP= Heat dried & Autoclaved sweet potato peels

**Table 4:** Measurement of maize and cowpea growth index (cm) 9 days after fertilizer application

| Organic fertilizer description | Height of maize (from the base) (cm) | Width of maize leaf (small and big) (cm) | Height of beans (from the base) (cm) | Width of beams leaf (small and big) (cm) |
|---|---|---|---|---|
| SDASPP | 30.00±1.41 | 5.25±0.35 | 9.00±1.41 | 4.50±0.71 |
| SDYP | 28.00±1.41 | 5.250±0.35 | 8.50±1.41 | 4.50±0.71 |
| SDAYP | 26.00±1.41 | 5.250±0.35 | 9.50±0.71 | 4.50±0.71 |
| HDYP | 28.00±1.41 | 6.250±0.35 | 9.00±1.41 | 5.00±1.41 |
| HDAYP | 27.00±1.41 | 5.500±0.71 | 8.50±1.41 | 5.00±1.41 |
| SDSPP | 25.00±1.41 | 5.500±0.71 | 8.50±2.12 | 4.50±0.71 |
| HDSPP | 23.00±1.41 | 5.500±0.71 | 8.00±1.41 | 4.50±0.71 |
| HDASPP | 26.00±1.41 | 6.250±0.35 | 8.00±1.41 | 5.00±1.41 |
| Urea | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 |

*Result is presented as mean ± standard deviation.*

LAGEND: SDYP = Sun Dried Yam Peel, HDYP= Heat dried yam peel, NDAYP= Normal dried & Autoclaved yam peels, HDAYP= Heat dried & Autoclaved yam peels, SDSPP= Sun Dried Sweet potato peels, HDSPP= Heat dried sweet potato peels, NDASPP= Normal dried and autoclaved sweet potato peels, HDASPP= Heat dried & Autoclaved sweet potato peels

**Table 5:** Measurement of maize and cowpea growth index (cm) 12 days after fertilizer application

| Organic fertilizer description | Height of maize (from the base) (cm) | Width of maize leaf (small and big) (cm) | Height of beans (from the base) (cm) | Width of beams leaf (small and big) (cm) |
|---|---|---|---|---|
| SDASPP | 30.00±1.41 | 5.25±0.35 | 9.00±1.41 | 4.50±0.71 |
| SDYP | 28.00±1.41 | 5.250±0.35 | 8.50±1.41 | 4.50±0.71 |
| SDAYP | 26.00±1.41 | 5.250±0.35 | 9.50±0.71 | 4.50±0.71 |
| HDYP | 28.00±1.41 | 6.250±0.35 | 9.00±1.41 | 5.00±1.41 |
| HDAYP | 27.00±1.41 | 5.500±0.71 | 8.50±1.41 | 5.00±1.41 |
| SDSPP | 25.00±1.41 | 5.500±0.71 | 8.50±2.12 | 4.50±0.71 |
| HDSPP | 23.00±1.41 | 5.500±0.71 | 8.00±1.41 | 4.50±0.71 |
| HDASPP | 26.00±1.41 | 6.250±0.35 | 8.00±1.41 | 5.00±1.41 |
| Urea | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 | 0.00±0.00 |

*Result is presented as mean ± standard deviation.*

LAGEND: SDYP = Sun Dried Yam Peel, HDYP= Heat dried yam peel, SDAYP= sun dried & Autoclaved yam peels, HDAYP= Heat dried & Autoclaved yam peels, SDSPP= Sun Dried Sweet potato peels, HDSPP= Heat dried sweet potato peels, NDASPP= Normal dried and autoclaved sweet potato peels, HDASPP= Heat dried & Autoclaved sweet potato peels

**Discussion**

The quality of the biofertilizers may be impacted by the decomposer known as synthetic microbiome, which is generated from local microorganisms. The amount of microorganisms present and their ability to decompose organic materials will determine the chemical properties of biofertilizer, even when there is a variation in access to a synthetic microbiome. The biofertilizer's N element analysis, which is rather high across all treatments, demonstrates how fiercely competitive these bacteria are. A research by Simarmata et al., 2016 found that the decomposer consortium that adds to composted straw can lessen pathogens in the straw, expedite the composting process, and improve the compost's quality.

From the result obtain in table 1 indicates that all the eight (8) of organic fertilizer produced didn’t contain mercury (Hg) and arsenic (As) which are both toxic to human and plant as reported by Rana *et al*., (2018). All the variety of organic fertilizer contained nitrogen which high significant value is found SDAYP (3.8550±0.01). Nitrogen is one of the essential nutrients required byplant.it is a key component of amino acid, which are the main plant building blocks of protein and enzyme. Base on the result obtained for nitrogen analysis of SDASPP, SDYP, SDAYP, HDYP, HDAYP, SDSPP, HDSPP, HDASPP have high value compared to Sudharmaidevi *et al*., (2017). According to Sondang *et al*., (2015), reported that an indigenous microbe solution included nutrients N 1.220%, P 0.216%, K 0.889%, C org 5.452%, C/N 4.469, and pH 4.15. Phosphate Solubilizing Bacteria (BPF) can not only dissolve phosphate but also boost nitrogen nutrition availability. According to several researchers' findings, Bacteria Solvents Phosphate (BSP) such as Pseudomonas spp. (Mehnaz *et al*., 2001), *Enterobacteriaceae* (Lin *et al.,* 2012), and *Bacillus* live freely in the root zone and are capable of N2 fixation in plant tissues.

Again cadmium which is toxic to plant growth is significantly found in high amount in SDSPP (0.0033±0.00mg/kg) and lowest value seen in HDYP (0.0014±0.00mg/kg). These could be due farm site where the sample is cultivated or how the sample is transported. Lead is found in trace amount in the HDYP, HDAYP, SDSPP, and SDASPP, this could be due to farm site where they are sample are collected or during various transportation.

Phosphorus which is a vital nutrient that aids in the transformation of carbohydrates and sugars as well as the flow of nutrients throughout the plants. Phosphorus is significantly found in all the 8 variety of organic fertilizer produced with high level seen in SDAYP (3.397±0.0mg/kg) and lowest value seen SDSPP (2.345±0.01mg/kg). Also, potassium is a vital macronutrient for plant development which significantly present in all the variety of organic fertilizer which highest value is seen in HDAYP (6.112±0.01) and SDSPP (6.213±0.00). Plants' P and K levels rise when the number of common microorganisms in biofertilizer increases; this is due to the presence of more bacteria at higher levels. According to Karpagam and Nagalakshmi (2014), certain microbial species may mineralize and dissolve phosphate. Dissolving phosphate activity is determined by bacteria' capacity to release metabolites such as organic acids, which can liberate bound P cations. Kumawat *et al*., (2017) microorganisms can be utilized as biofertilizers since they can dissolve micronutrients like zinc (Zn) and silicate (Si) in addition to phosphate. Using FZB 24 Bacillus subtilis increased cotton growth and output by 30% when compared to NPK fertilizer, according to Yao et al. (2006)

SDASPP, SDYP, SDAYP, HDYP, HDAYP, SDSPP, HDSPP, HDASPP have high value of phosphorus and potassium compared to Phibunwatthanawong and Riddech (2019). The macronutrients nitrogen (N), phosphorus (P), and potassium (K) are essential to plants. An imbalance in the overall nutrients of the soil will result from the lack of one of these components. Plants' ability to absorb N, P, and K nutrients depends on the availability of these nutrients in the soil (Weih *et al*., 2018). Wong et al., (2015) discovered that phytohormones generated by biofertilizers boosted plant development via the process of N fixing and P dissolving by bacteria before becoming accessible to plants.

Zinc is significantly high in HDSP (6.335±0.02) and low in HDASPP (2.215±0.01). Due to its involvement in numerous basal processes, including energy expenditure and physiological activities, catalytic activity, and charges regulation, zinc is a crucial micronutrient that crops need (alsafran *et al*., 2022.)

Table 2 shows the growth rate of maize and beans after 3 days of application. These indicated that the height of maize and beans significantly increase after 3 days of application which significant changes is seen SDASPP. These could be due to average value of macro and micro nutrient (i.e NPK and Zn) are present in SDASPP. Also, SDAYP, HDYP and SDSPP have a significant increase in width of bean after 3 days of application but urea which a synthetic inorganic fertilizer has no effect on both the height and width of maize and bean. The values of height of plant are high but widths of leaf are low compared to Phibunwatthanawong and Riddech (2019) and similarly as Araújo *et al*., (2007) and Ibeawuchi *et al*., (2007).

There was a significant decrease in the both height and width of maize and beans after 6 days of application of all the 8 variety of organic fertilizer produced (table 3). These might be due to unfavourable climate such as low rainfall or high sunlight. But still the height value of plant increases which are the results are consistent with the findings of Mahdi *et al.* (2010); Sivamurugan *et al.* (2018).

Table 4 and 5 indicate a significant increase in 9 and 12 days respectively, after application of all the organic fertilizer produced.

SDASPP, SDYP, HDYP, SDAYP and HDASPP significantly increases the height and width of both maize and beans at 9 and 12 days but has more significant effect in width of maize leaf than that of beans leaf. Lima *et al.* (2012), in an experiment carried out in the field, obtained increased plant height, stem diameter, and dry matter yield of maize after many days of bovine biofertilizer application. The values of height of plant are high but widths of leaf are low. These shows that all the 8 variety of organic fertilizer produced have more significant value on with of cereal plant than that leguminous plant. But urea which is a inorganic fertilizer has no significant effect on height and width of both maize and bean. This is because has no significant effect on both height and width of plant but rather more efficient on fruit production of plant (i.e. it aids yield of plant).

The current method is the use of organic fertilizer that has been contaminated with native bacteria. The goal of the inoculation of bacteria is to take use of their capacity as biofertilizers (Qasim *et al*., 2014) and decomposers (Pan *et al*., 2012). Using natural bacteria helps maintain the natural balance of the ecosystem, create environmentally beneficial products, and improve the nutrients in the soil and plants. Bacteria that can dissolve phosphorus, bind nitrogen, and provide macronutrients are among the indigenous microorganisms (Sondang *et al*., 2015). They may also break down organic debris (Sondang & Anty, 2017).

## CONCLUSION

Nitrogen, Phosphorus and Potassium concentration is significantly high in this samples, growth of plant tissues, such as cells, membranes, and chlorophyll, depends on these three elements (NPK), which are fundamental components of all amino acids in plant structures. NPK is required by crops in large amounts. In fact, these nutrients are very vital that all market-available fertilizers list the quantity of these nutrients (NPK) that they are made-up; for instant 15-15-15, 27-13-13 or numerous compartment of these amounts called ratios which represents the nutrient content. Speaking of which, it was noted that the concentration of the chemical fertilizer was observed to be higher due to the amount (5g) that was applied to the test samples. The increase in the number, the higher the strength of the nutrients.

Chemical fertilizer use during crop production is associated with a number of issues, including crop intoxication, animal consumption-related intoxication, and environmental risks. However, it's important to recognize some additional advantages of using organic fertilizers in farming, as they not only offer a less expensive source of manure but also an environmentally friendly method of crop production by lowering the likelihood that inorganic salts from chemical fertilizers, which cause high salinity of freshwater bodies and kill aquatic life in the process, will leach or wash into rivers.

Utilizing organic fertilizers also boosts the beneficial microbial activity of the soil. These microorganisms disintegrate organic matter to produce substances that plants can readily absorb. Additionally, it replenishes soil structure, aggregation, and nutrient cycling while assisting in the prevention of plant diseases.

## REFERENCE

[1] Alley, M. M., & Vanlauwe, B. (**2009**). *The role of fertilizers in integrated plant nutrient management*. International fertilizer industry Association.Al Jabri, H., Saleem, M. H., Rizwan, M., Hussain, I., Usman, K., & Alsafran, M. (2022). Zinc oxide nanoparticles and their biosynthesis: overview. Life, 12(4), 594.International Fertilizer Industry Association, Paris, p 59

[2] Araújo, J. B. S., Carvalho, G. J. D., Guimarães, R. J., & Carvalho, J. G. D. (**2007**). Composto orgânico e biofertilizante na nutrição do cafeeiro em formação no sistema orgânico: teores foliares.

[3] Bashan Y, Harrison SK, Whitmoyer RE (**1990**) Enhanced growth of wheat and soybean plant inoculated with *Azospirillum brasilense* is not necessarily due to general enhancement of mineral uptake. Appl Environ Microbiol 56:769–775 457

[4] Boulter, J. I., Trevors, J. T., & Boland, G. J. (**2002**). Microbial studies of compost: bacterial identification, and their potential for turfgrass pathogen suppression. *World Journal of Microbiology and Biotechnology*, *18*, 661-671.

[5] Heckman, J. R., Weil, R., & Magdoff, F. (**2009**). Practical steps to soil fertility for organic agriculture. *Organic farming: the ecological system*, *54*, 137-172.

[6] Ibeawuchi, I. I., Opara, F. A., Tom, C. T., & Obiefuna, J. C. (**2007**). Graded replacement of inorganic fertilizer with organic manure for sustainable maize production in Owerri Imo State, Nigeria. *Life Science Journal*, *4*(2), 82-87.

[7] Kadir, A. A., Azhari, N. W., & Jamaludin, S. N. (**2016**). An overview of organic waste in

composting. In MATEC Web of Conferences (Vol. 47, p. 05025). EDP Sciences.

[8] Karpagam, K. & Nagalakshmi, P.K. (**2014**). Isolation and Characterization of Phosphate Solubilizing Microbes from Agricultural Soil, *International Journal of Current Microbiology and Applied Sciences*. 3(3): 601–614.

[9] Kumawat, N., Kumar, R., Kumar, S. & Meena, V.S. (**2017**). Nutrient Solubilizing Microbes (NSMs): Its Role in Sustainable Crops Production. Chapter from BookAgriculturally Important Microbes for Sustainable Agriculture. 25–61.

[10] Kumawat, N., Kumar, R., Kumar, S. & Meena, V.S. (**2017**). Nutrient Solubilizing Microbes (NSMs): Its Role in Sustainable Crops Production. Chapter from Book Agriculturally Important Microbes for Sustainable Agriculture. 25–61.

[11] Li, Z., Zu, C., Wang, C., Yang, J., Yu, H., & Wu, H. (**2016**). Different responses of rhizosphere and non-rhizosphere soil microbial communities to consecutive Piper nigrum L. monoculture. Scientific reports, 6(1), 35825.

[12] Lima JGA, Viana TVA, Sousa GG, Wanderley JAC, Pinheiro Neto LG, Azevedo BM (**2012**) Crescimento inicial do milho fertirrigado com biofertilizante. Agropecuária Científica do Semiárido 8(1):39-44.

[13] Lin, L., Z. Li, C. Hu, X. Zhang, S. Chang, L. Yang, Y. Li & Q. An. (**2012**). Plant Growth-Promoting Nitrogen-Fixing Enterobacteria Are in Association with Sugarcane Plants Growing in Guangxi, China. *Microbes and EnvironmentsMicrobes and Environments*, *27* (4), 391–398. https://doi.org/10.1264/jsme2.me11275

[14] Mehnaz, S., M. S. Mirza, J. Haurat, R. Bally, P. Normand, A. Bano & K. A. Malik. (**2001**). Isolation and 16S rRNA Sequence Analysis of The Beneficial Bacteria From The Rhizosphere of Rice. *Canadian Journal of Microbiology*, *47* (2), 110– 117. https://doi.org/10.1139/w00-132

[15] Pan, I., B. Dam, & S. K. Sen. (**2012**). Composting of Common Organic Wastes Using Microbial Inoculants. *3 Biotech*, *2* (2), 127–134. https://doi.org/10.1007/s13205- 011-0033-5.

[16] Phibunwatthanawong, T., & Riddech, N. (**2019**). Liquid organic fertilizer production for growing vegetables under hydroponic condition. *International Journal of Recycling of Organic Waste in Agriculture*, *8*, 369-380.

[17] Qasim, M., Younis, A., Zahir, Z.A, Riaz, A., Raza, H. & Tariq, U. (**2014**). Microbial Inoculation Increase the Nutrient Uptake Efficiency for Quality Production Gladiolus grandiflorus. *J.Agri.Sci*. 51(4): 875–880.

[18] Rana, M. N., Tangpong, J., & Rahman, M. M. (**2018**). Toxicodynamics of lead, cadmium, mercury and arsenic-induced kidney toxicity and treatment strategy: a mini review. *Toxicology reports*, *5*, 704-713.

[19] Sánchez, Ó. J., Ospina, D. A., & Montoya, S. (**2017**). Compost supplementation with nutrients and microorganisms in composting process. *Waste management*, *69*, 136-153.

[20] Schultz, E., DeSutter, T., Sharma, L., Endres, G., Ashley, R., Bu, H., ... & Franzen, D. (**2018**). Response of sunflower to nitrogen and phosphorus in North Dakota. *Agronomy Journal*, *110*(2), 685-695.

[21] Simarmata, T., Hersanti, T. Turmuktini, B. N. Fitriatin, M. R. Setiawati & Purwanto. (**2016**). Application of Bioameliorant and Biofertilizers to Increase the Soil Health and Rice Productivity. *Hayati Journal of Biosciences*, 23 (4), 181–184. https://doi.org/10.1016/j.hjb.2017.01.001

[22] Socolow, R. H. (**1999**). Nitrogen management and the future of food: lessons from the management of energy and carbon. *Proceedings of the National Academy of Sciences*, *96*(11), 6001-6008.

[23] Sondang, Y. & Anty, K. (2017). Penggunaan Kompos sebagai Substitusi Pupuk Anorganik dalam Upaya Meningkatkan Produksi Jagung. *Prosiding Seminar Nasional: Inovasi Teknologi dalam Mewujudkan Kemandirian Pangan Nasional Berkelanjutan*, Politeknik Pertanian Negeri Payakumbuh 4 Oktober **2017**. ISBN 978-602-51262-0-8, 37–42.

[24] Sondang, Y., Alfina, R., & Anty, K. (2015). Karakteristik Mikroorganisme Lokal (MOL) dari Berbagai Sumber Bahan Organik. *Prosiding Seminar Nasional: Ketahanan Pangan dan Pertanian Berkelanjutan, Tantangan dan Peluang Implementasi Teknologi dalam Perspektif Nasional*, Politeknik Pertanian Negeri Payakumbuh 07 Oktober **2015**. Buku 2. ISBN: 978-979-98691-7-3, 104–109.

[25] Sondang, Y., Alfina, R., & Anty, K. (**2015**). Karakteristik Mikroorganisme Lokal (MOL) dari Berbagai Sumber Bahan Organik. *Prosiding Seminar Nasional: Ketahanan Pangan dan Pertanian Berkelanjutan, Tantangan dan Peluang Implementasi Teknologi dalam Perspektif Nasional*, Politeknik Pertanian Negeri Payakumbuh 07 Oktober 2015. Buku 2. ISBN: 978-979-98691-7-3, 104–109.

[26] Sudharmaidevi, C. R., Thampatti, K. C. M., & Saifudeen, N. (**2017**). Rapid production of organic fertilizer from degradable waste by thermochemical processing. *International Journal of Recycling of Organic Waste in Agriculture*, *6*, 1-11.

[27] Thomas, L., & Singh, I. (**2019**). Microbial biofertilizers: types and applications. *Biofertilizers for sustainable agriculture and environment*, 1-19.

[28] Timmusk, S., Behers, L., Muthoni, J., Muraya, A., & Aronsson, A. C. (**2017**). Perspectives and challenges of microbial application for crop improvement. Frontiers in plant science, 8, 49.

[29] Toor, M. D., Adnan, M., Rehman, F. U., Tahir, R., Saeed, M. S., Khan, A. U., & Pareek, V. (**2021**). Nutrients and their importance in agriculture crop production; A review. *Ind. J. Pure App. Biosci*, *9*(1), 1-6.

[30] Vance, C. P. (**2001**). Symbiotic nitrogen fixation and phosphorus acquisition. Plant nutrition in a world of declining renewable resources. *Plant physiology*, *127*(2), 390-397.

[31] Weih, M., Hamner, K. & Pourazari, F. (**2018**). Analyzing Plant Nutrient Uptake and Utilization Efficiencies Comparison Between Crops and approaches. *Plant Soil.* 430: 7–21.

[32] Wong, W.S., Tan, SN., Ge L., Chen, X. & Yong, J.W.H. (**2015**). The Importance of Phytohormones and Microbes in Biofertilizer *in book* Microbial Phytohormones a Key Role in Mitigating the Salt Induced Damaged in Plant, 105-158.

[33] Yao, A., H. Bochow, S. Karimov, U. Boturov, S. Sanginboy, & A. Sharipov. (**2006**). Effect of FZB 24® Bacillus subtilis As A Biofertilizer On Cotton Yields In Field Tests. *Archives of Phytopathology and Plant Protection*, *39* (4), 323–328.

[34] Yao, A., H. Bochow, S. Karimov, U. Boturov, S. Sanginboy, & A. Sharipov. (**2006**). Effect of FZB 24® Bacillus subtilis As A Biofertilizer On Cotton Yields In Field Tests. *Archives of Phytopathology and Plant Protection*, *39* (4), 323–328.