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Utilization of Cassava Peel as Substrate for Production of Biofertilizer and Its Effect on the Growth of Millet

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Abstract

The quality of the carrier is critical in influencing microbial load and shelf life of biofertilizers. Cassava peels are abundant and have little economic value, making them ideal for use as biofertilizer carrier materials. The carrier material supported the growth of the test organism, thus suggesting the presence of nutrients and absence of toxicity. During isolation and culturing of bacteria, three (3) grams of soil sample was measured and diluted with 100ml of distilled water, and mixed well to get soil suspension. Ten (10) ml of the soil suspension was poured in the first test tube and shake well, 1ml of the first test tube was transferred into the second test tube containing nine (9) ml of sterile distilled water aseptically to get dilution. One (1)ml of the suspension from the second test-tube was transferred to third test tube also containing 9ml of sterile distilled water aseptically, 1ml of the soil suspension was transferred from the third test tube to the fourth test tube,1ml of the soil suspension was transferred from the fourth test tube was transferred to the fifth test tube,1ml of the soil suspension from the fifth soil suspension was also transferred to the sixth test tube, another 1ml from the sixth soil suspension was also transferred to seventh test tube aseptically. Soil sample from test tube 4, 5, and 6 was inoculated in yeast extract media and was incubated for 24 hours. The result

shows that at 2DAP, 3DAP, 4DAP, 5DAP, AND 6DAP there is statistical significant difference between the treatment and control but at 7DAP, 8DAP, 9DAP AND 10DAP there is no statistical significant difference between the treatment and control but also at 11DAP there is statistical significant difference between the treatment and the control and at 10DAG, 12DAG, 14DAG, 16DAG, 18DAG, AND 20DAG there is no statistical significant difference between the treatment and control but at 22DAG there is statistical significant difference between the treatment and control at 24DAG there is no statistical significant difference between the treatment and the control. And at 26DAG there is statistical significant difference between the treatment and the control but also at 28DAG there is no statistical significant difference between the treatment and the control using fisher's least significant difference test. Biofertilizer is a relevant alternative for disposal of this waste and even enables the act of converting wastes to wealth.

Keywords: Biofertilizer, Cassava, Millet, Growth and Microorganisms

INTRODUCTION

Biologically synthesised fertilizer has been seen as a means of improving soil fertility in addition to it consistency in keeping the soil healthy, unlike the inorganic fertilizer that increases crop growth, accumulating the soil with problems like acidification, nutrient imbalance and trace element deficiencies (Htwe *et al*., 2019) Bio-fertilizer has been described by Ogbo and Odo, 2011 as living or latent cells of efficient strains of microbes. Typically, these dormant cells are discovered or trapped on a carrier substance that, when interacting with other plants in the rhizosphere helps crops absorb nutrients and ultimately increases agricultural productivity. Its eco-friendliness elevate it higher stage than chemical synthesised fertilizer. It uses as soil amendment have also been recognized. International Federation of Organic Agriculture Movements (IFOAM, 2005) agrees with the point that Biofertilizers can be used as tools for organic cropping. Availability in adequate amounts, inexpensive, non-toxic to bacterial/plant utilization, good moisture absorption capacity including amenability to processing/sterilization was outline as factors to consider before choosing a material for bio fertilizer production/creation (IFOAM, 2005). The use of agricultural waste and other materials as carrier materials for the production of biofertilizer has been studied. Cassava peel is one of the many agricultural wastes found in developing countries. The Food and Agricultural Organization (FAO) of the United Nations reports that 230 million tons of cassavas were produced in developing countries. Even though

there have been many studies on the use of waste as animal feed, a significant amount of waste is found in heaps near processing facilities and disposed of in places like waterways, where it contaminates and pollutes water bodies, including surface, subsurface, and atmosphere (Kalu *et al.*, 2009; Onwudike *et al.*, 2016). Since cassava peel is plentiful and essentially worthless in many developing nations, it is necessary to find more profitable and efficient ways to use this waste. The purpose of the study was to analyze the impact of cassava peel on maize (Zea mays L.) production and assess its potential as a nutrient carrier material. In Nigeria and other African nations, cassava (Mani hot sp.) is one of the most staple roots that is eaten in a variety of ways. In Nigeria it is consumed either as food, or processed into garri. The technology of processing cassava roots into garri comprises, peeling, grating, fermenting, de-watering and frying. Basic steps such as soaking, grating and fermentation, increase qualities of cyanogenic glycosides and cassava waste products lost into the wash water used. This wash water cannot be discharged directly into the environment; they need to be treated biologically before discharging (Eze, 2010). The production of organic fertilizer utilising cassava peel as a substrate has attract attention due to its potential value on crop growth. Biofertilizers, such as those produced from beneficial microbes and cassava peel, have been shown to enhance plant growth, nodulation, and nutrient uptake (Nosheen *et al.*, 2021). Additionally, biofertilizers play a crucial role in increasing crop yield and maintaining long-term soil fertility, which is essential for meeting global food demand (Nosheen *et al.*, 2021).

Additionally, the conversion of cassava waste into biofertilizer using phosphate-solubilizing fungi demonstrates the potential for sustainable agricultural practices (Ogbo, 2010). Cassava peel, as a byproduct of cassava processing, has been explored for various applications, including the production of bioenergy and bioplastics (Fathima *et al.*, 2022; Fadhallah *et al.*, 2023). Studies have also highlighted the potential of cassava peel in the removal of heavy metals from wastewater, indicating its versatility in environmental remediation (Simate & Ndlovu, 2015; Pondja *et al.*, 2017). Moreover, the utilization of cassava peel as a substrate for biogas production and composting has been investigated, showcasing its potential for waste valorization and sustainable agricultural practices (mare *et al.*, 2023; Kortei *et al.*, 2014). In millet planting, the use of organic substrates and biofertilizers, such as cassava peel, aligns with the goal of sustainable agriculture. The application of biofertilizers has been attached to improved soil health and quality, which are essential for promoting crop productivity (Otaiku, 2019). Furthermore, the potential

use of plant extracts to mitigate pathogenic *Fusarium* sp. of millet seedlings underscores the importance of sustainable management strategies for promoting millet growth (Akanmu *et al*., 2013).

Cassava is a perennial shrub of the family Euphorbiaceae, and its starchy roots are the major reason it is grown. In the tropics, it is the fourth most important source of calories and one of the most important food staples.

On a worldwide basis it is ranked as the sixth most important source of calories in the human diet (FAO, 1999). The crop is typically grown as a subsistence crop in a variety of agricultural and food systems by small farmers due to its resilience to poor soil and severe climates. Despite being a perennial crop, cassava storage roots can be harvested anywhere from six and twenty-four months after planting (MAP), depending on the cultivar and the growing environment (El-Sharkawy, 1993).

Biofertilizer is a substance which contains living microorganisms which, when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Biofertilizers supply nutrients through the natural processes of nitrogen fixation, solubilising phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. Biofertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The natural nutrient cycle of the soil is restored and soil organic matter is increased by the microorganisms found in biofertilizers. It is possible to cultivate healthy plants and improve soil health and sustainability by using biofertilizers and since they play vital roles, a preferred scientific term for such beneficial bacteria is "plant-growth promoting rhizobacteria" (PGPR). As a result, by providing organic nutrients through microorganisms and their byproducts, they are very helpful in increasing soil fertility and providing plant nutrient requirements. Therefore, no chemicals that are detrimental to the living soil are included in biofertilizers (IFA, 2008). Bacteria that involved in the formation of biofertilizers such as *Rhizobium, Azotobacter, Azospirilium* and blue green algae have been in use for decades. *Rhizobium* inoculant is used for leguminous crops. *Azotobacter* can be used in crops like wheat, maize, mustard, cotton, potato and other vegetable crops. *Azospirillum* inoculations are recommended mainly for sorghum, millets, maize, sugarcane and wheat. Blue green algae belonging to a general cyanobacteria genus, *Nostoc* or *Anabaena* or *Tolypothrix* or *Aulosira*, fix atmospheric nitrogen and are used as inoculations for paddy

crop grown both under upland and low-land conditions. Anabaena in association with water fern *Azolla* contributes nitrogen up to 60 kg/ha/season and also enriches soils with organic matter. Other types of bacteria, so-called phosphate-solubilizing bacteria, such as *Pantoeaagglomerans* strain P_5 or *Pseudomonas putida* strain P_{13}, are able to solubilize the insoluble phosphate from organic and inorganic phosphate sources. In fact, due to immobilization of phosphate by mineral ions such as Fe, Al and Ca or organic acids, the rate of available inorganic phosphate (Pi) in soil is well below plant needs. In addition, inorganic phosphate fertilizers are also immobilized in the soil, immediately, so that less than 20% of added fertilizer is absorbed by plants. Therefore, reduction in Pi resources, on one hand, and environmental hazards resulting from both production and applications of chemical Pi fertilizer, while other, have already demanded the usage of phosphate biofertilizers (vessey,2003). Inserting of microorganisms in carrier material enables easy-handling, long-term storage and high effectiveness of bio fertilizers. Among various types of bio fertilizers, bacterial inoculants is one major group which includes *rhizobia*, nitrogen-fixing rhizobacteria, plant growth-promoting rhizobacteria, phosphate-solubilising bacteria, and so on. Essentially, the carrier-based inoculants of these microorganisms can be manufactured using a standard technique and most of the bacteria included in biofertilizer have close relationship with plant roots. *Rhizobium* has symbiotic interaction with legume roots, and rhizobacteria inhabit on root surface or in rhizosphere soil. To achieve the successful inoculation of Rhizobium or rhizobacteria, large community of the bacterial strain must be placed close to the emerging root, so that the majority of nodules are formed by the inoculated rhizobial strain, and that the inoculated rhizobacterial strain occupies the rhizosphere as major member of rhizobacteria. (Singh *et al*., 2011).

Nitrogen-fixing bacteria with a larger number of microorganisms that can convert atmospheric N_2 into organic compounds and finally into forms that can use by plants are among the bacteria that contributes to the development of biofertilizer. Thus, these bacteria fix N_2 from the atmosphere and supply that to plants in usable forms which ultimately increase soil N_2 level and overall soil fertility level. Several microorganisms are used as Nitrogen fixing bacteria which are *Azotobacter, Anabaena, Nostoc, Clostridium* etc. are used as free-living N_2 fixing bacteria; while *Frankia, Rhizobium, and Anabaena azollae* are utilized as symbiotic N_2 fixing bacteria and *Azospirillum* play a role of associative symbiotic N_2 fixing bacteria.

Phosphorus solubilizing biofertilizers are capable to lower soil pH by secreting organic acids and thus dissolve the bound phosphates. Some of these bacteria are: *Bacillus megatherium, Pseudomonas striata, Bacillus circulans, Bacillus subtilis; and* some fungus used for this purpose are: *Aspergillus awamori and Penicillium* sp.

Phosphorus mobilizing biofertilizers Different fungi and mycorrhiza, which activate the movement of P ions and thus metabolic activities, belong to this group and they are utilised as P mobilizing biofertilizers are *Glomus* sp., *Gigaspora* sp*., Boletus* sp., *Laccaria* sp., *Pisolithus* sp., *Rhizoctoniasolani, Pezizellaericae* etc.

Millet (*Pennisetum americanum*) is a versatile cereal cultivated for food, feed and forages (Arora *et al*., 2003) particularly in African and Asian countries (Nambiar *et al*., 2011). It has the capability to survive under drought and high temperature conditions which further increases its potential to be grown in those regions where wheat, maize and other cereal crops fail to persist. Among all the millet varieties, greater than 29million hectare area is occupied by pearl millet; however, its distribution is restricted geographically mainly in Africa (15 million) and Asia (11 million), as being the largest producer (Rathore *et al*., 2016). Millets are in the family of cereals grown globally with differential importance across continents and within regions of the world. They form a diverse group of small grains cultivated in diverse and adverse environments, mostly in the dry, semi-arid to sub-humid drought-prone agro ecosystems. Worldwide, there are nine species of millets with total production of 28.38 million tons, out of which 11.36 million tons (40%) are produced in Africa from six species. Millets need very little water for their production. Millets are high energy, nutritious foods recommended for the health and well-being of infants, lactating mothers, elderly and convalescents. However, the foods produced from them traditionally and industrially, at present, have short keeping qualities due to the presence of high fat content in the millet flours. Their good nutritional values including high levels of quality protein, ash, calcium, iron and zinc, which make millet nutritionally superior than most cereals, are now being enhanced through bio fortification and micronutrient research (Obilana *et al*., 2002).

MATERIALS AND METHODS

Sample Collection

The samples sample was collected from Agric farm in Taraba State University Jalingo and it was taken to biological science Laboratory for immediate evaluation. One variety of millet was used in the experiment and is bought from bye-pass CBN market. Taraba State University Jalingo is located at the northeastern part of Nigeria which lies between latitude 8 0 47'to 9 0 01'N and longitude 11 0 09' to 11 0 30'E.

Isolation of Bacteria

Three (3) grams of soil sample was measured and diluted with 100ml of distilled water, and mixed well to get soil suspension. Seven (7) different test tubes were used for the experiment. Ten (10) ml of the soil suspension was poured in the first test tube and shake well. 1ml of the first test tube was transferred into the second test tube containing nine (9) ml of sterile distilled water aseptically to get dilution. 1ml of the suspension from the second test-tube was transferred to third test tube also containing 9ml of sterile distilled water aseptically, 1ml of the soil suspension was transferred from the third test tube to the fourth test tube,1ml of the soil suspension was transferred from the fourth test tube was transferred to the fifth test tube,1ml of the soil suspension from the fifth soil suspension was also transferred to the sixth test tube, another 1ml from the sixth soil suspension was also transferred to seventh test tube aseptically. Soil sample from test tube 4, 5, and 6 was inoculated in yeast extract media and was incubated for 24 hours according to the method of Moe and Namakwa, 2019.

Preparation of Pure Culture

Three (3) g of nutrient agar powder was dissolved in 110mls of sterilized distilled water according to the manufacturer's instruction and the media was sterilized in an autoclave at 121°C for 15 minutes and allowed it to cool and pour into Petri dishes after it solidify the colony from the yeast extract media was inoculated into the nutrient agar media and incubates at 37°C for 24 hours. The *azotobacter* pure growths was obtained and used for mass production in nutrient broth.

Culturing of Bacteria

The bacteria were cultured in mass amount in Nutrient Broth media. Thirteen 13g of nutrient broth media was dissolved in 1000ml of distilled water, and sterilized by using an autoclave at 121°C for 15 was inoculated into the media and incubate for 48hours.

Mixing of the Carrier Material and the Bacteria

The carrier material (cassava peel) were dried and ground and the carrier material was package into polythene bag and sterilized in an autoclave at 121degree Celsius for 15minutes and then mix with the nutrient broth media contain the bacteria at 1/3 of the water holding capacity of the carrier and allowed to dried under standard room temperature in sterile plate and environment to avoid contamination or introduction of other organism into the mixture.

Application Rate of Biofertilizer

Biofertilizer can be inoculated on seeds as well as in the roots of different crop plants under ideal conditions. The can also be applied directly to the soil. There are certain approaches to the application of biofertilizers as described.

Seed Inoculation or Seed Treatment

In this procedure, the organic fertilizers were mixed with 10% solution of jaggary. The slurry is then poured over the seeds biofertilizer seedling root dip. The seedling roots of transplanted crops were treated for half an hour in a solution of biofertilizers before transplantation in the field. The seedlings required for one acre are inoculated using 2-2.5kg biofertilizers. To do this, fill a bucket with enough water, then thoroughly mix the biofertilizer. The roots of seedling were then dipped in this mixture so as to enable the roots to get inoculum. These seedlings were then transplanted. This method has been found very much suitable for crops like tomato, rice, onion, cole crops and flowers.

Main field application

Before used, the inoculum was incubated with the desired amount of well the composed granulated farm yard manure (FYM) for 24 hours. One treatment was used in the experiment which is; the biofertilizer and also control without treatment. The application rates are as follows; bio fertilizer at 1000ml was mixed with soil and put in a polythene bag containing 3kg of the soil sample. The following observation was carryout base on the following parameters were collected after one month and they include: number of

germinated seeds of millet, number of germinated seeds, length of leaves per plant, leaves length per plant and plant height.

Statistical analysis

The above data was subjected to analysis of variance (ANOVA) using genstat software version 16.0 to determine significance difference between means of treatments. The mean of each parameter that was separated using Fisher's protect least significant differences.

RESULTS

Table 1: The effect of biofertilizer on germinated seeds of millet

Days After Germination	2DAG	3DAG	4DAG	5DAG	6DAG	7DAG	8DAG	9DAG	10DAG	11DAG
BIOFERTILIZER	1.60[a]	160[c]	2.00[b]	2.80[c]	2.80[c]	3.60[a]	3.60[a]	3.80[a]	3.60[a]	3.00[b]
CONTROL	3.40[a]	3.80[a]	3.20[a]	4.40A	4.40[a]	4.00[a]	3.80[a]	3.80[a]	3.20[a]	4.00[a]
LSD	1.663	1.631	1.345	2.188	1.929	1.564	2.188	1.756	2.063	1.458

KEYS

DAG = days after germination

LSD = least significant difference

Table 1 represent significant difference test of the effect of biofertilizer on germinated seeds of millet.

Table 2. Effect of bio fertilizer on length of the plants (millet)

TREATMENT	10DAG	12DAG	14DAG	16DAG	18DAG	20DAG	22DAG	24DAG	26DAG	28DAG
BIOFERTILIZER	7.96[a]	7.74[a]	8.82[a]	10.86[a]	10.14[a]	10.68[a]	14.44[a]	13.86[a]	14.18[a]	13.84[a]
CONTROL	7.80[a]	9.00[a]	8.70[a]	8.16[a]	9.44[a]	9.38[a]	11.90[b]	12.32[a]	11.58[b]	12.52[a]
LSD	4.453	4.462	3.773	3.738	3.158	3.923	2.374	2.512	2.757	4.196

KEYS

DAG = days after germination

LSD = least significant difference

Table 2 shows the least significant difference using fishers protected significant difference test to determine the effect of bio-fertilizer on the length of the plant (millet).

Table 3 Effect of biofertilizer on length of the leaves of the plant (millet)

TREATMENT	10DAG	12DAG	14DAG	16DAG	18DAG	20DAG	22DAG	24DAG	26D
BIOFERTILIZER	9.9[a]	9.68[a]	9.76[a]	10.66[a]	10.86[a]	10.24[a]	10.64[b]	9.72[a]	10.1[a]
CONTROL	8.3[a]	7.80[a]	7.54[a]	8.92[a]	8.32[b]	9.52[a]	11.42[a]	10.24[a]	9.7[a]
LSD	5.77	4.083	4.448	3.008	2.244	3.335	1.787	4.550	4.87

KEYS

DAG = days after germination

LSD = least significant difference

Tables 3 shows the least significant difference using fishers protected significant difference test to determine the effect of bio-fertilizer on the length of the plant (millet).

DISCUSSION

Production of biofertilizer has been seen as a means of improving soil fertility in addition to it consistency in keeping the soil healthy, unlike the inorganic fertilizer that increases crop growth, leaving the soil with problems like acidification, nutrient imbalance and trace element deficiencies (Htwe *et al.* 2019). The comparison table showing the least significant difference between the treatment and control, using fisher's protected least significant difference test to determine the effect of bio fertilizer on germinated seeds of millet (Yomeni *et al.,* 2010).

Effect of treatment (biofertilizer) and control on germinated seeds of millet showed that at 2DAG, 3DAG, 4DAG, 5DAG, AND 6DAG there is statistical significant difference between the treatment (biofertilizer) and control (without treatment), but at 7DAG, 8DAG, 9DAG AND 10DAG there is no statistical significant difference between the treatment and control. Also at 11DAG there is statistical significant difference between the treatment and control. From table 1, it showed the effect of treated millet with biofertilizer

and untreated (without treatment) millet, whereby the treated plant germinated faster than the untreated millet plant. And the reason can be because *Azotobacter* sp. can produce antifungal compounds to fight against many plant pathogens. They also increase germination and vigor in young plants leading to improved crop stands. This result is in agreement with Ajiduku *et al*., 2024, Ano and Ikwelle (2000) and Mokwunye, (1978). Soils of the experimental site and indeed most Nigerian soils are highly weathered and have low activity 5clays (Ano, 1990) and therefore require application of soil amendment for high crop yield to be obtained (Agbor *et al*., 2014).

Effect of biofertilizer on length of the plant (millet) showed that at 10DAG, 12DAG, 14DAG, 16DAG, 18DAG, AND 20DAG there is no statistical significant difference between the treatment (bio fertilizer) and control (without treatment) but at 22DAG there is statistical significant difference between the treatment (bio fertilizer) and control (without treatment) and at 24DAG there is no statistical significant difference between the treatment (bio fertilizer) and the control (without bio fertilizer). And at 26DAG there is statistical significant difference between the treatment (bio fertilizer) and the control (without bio fertilizer) but also at 28DAG there is no statistical significant difference between the treatment (bio fertilizer) and the control (without difference). From the result in Table 2, it showed the effect of treated millet with bio fertilizer and untreated (without treatment) millet, whereby both treated and untreated plant give better result in length of the plant early after germination, but toward the end of the research, plant treated with bio fertilizer give best result and this can be because the nutrient release rate is too slow to meet crop requirements in a short time, as such bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilising phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances this supported the study by (Criollo *et al*., 2011, Agbor *et al*., 2014).

Effect of biofertilizer on length of the leaves of the plant (millet) showed that at 10DAG, 12DAG, 14DAG,16DAG there is no statistical significant difference between the treatment and the control, and at 18DAG there is statistical significant difference between the treatment and the control and at 20DAG there is no statistical significant difference between the treatment and the control and also at 22DAG there is statistical significant difference between the treatment and the control and also at 24DAG and 26DAG there is no statistical significant difference between the treatment and the control but also at 28DAG there is statistical significant difference between the treatment and the control.

From the above information, it showed the effect of treated millet with bio fertilizer and untreated millet, whereby both treated and untreated plant give better result in length of the leaves early after germination, but at the end of the research, the treated plant with bio fertilizer will give best result, and this can also be because bio fertilizer release nutrients slowly and contribute to the residual pool of organic Nitrogen and Phosphorus in the soil, reducing Nitrogen leaching loss and Phosphorus fixation. These correspond with findings of Criollo *et al.*, 2011. 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 breakdown organic debris (Sondang and Anty, 2017).

CONCLUSION

The use of cassava peels as raw material for the production of bio fertilizer is a relevant alternative for disposal of this waste and even enables saddled value to waste which is normally disposed of. The objectives of bio fertilizer production are to reduce waste quantity, elimination of pathogens, and destruction of odour causing substance and to get a final product that can provide farmers and gardeners with a better alternative to chemical fertilizers. Considering the yield and above mentioned discussion it can be concluded that the millet performed well when applied bio fertilizer. Application of bio fertilizer increases early germination, length of the leaves, and length of the plant respectively.

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 biofertilizers 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 in to rivers

REFERENCES

Abershi, A. L., Stephen, E. C., & Clinton, U. C. (2024). Simultaneous Saccharification and Fermentation (SSF) of Blended Organic Fertilizer from Yam and Sweet Potato Peels. *Journal of Multidisciplinary Science: MIKAILALSYS*, *2*(2), 160-178.

Adegbehingbe, K., Faparusi, F., & Adeleke, B. (2021). Bioethanol production from cassava peels inoculated with saccharomyces cerevisiae and zymomonas mobilis. *Journal of Advances in Microbiology*, Vol. 2, 58-67.

Agbor, E.E, Bradbury J.H, Banea J.P, Tambi M.D, Mintop A.D, David K, et al. (2014). Awareness & knowledge of konzo and Tropical Ataxic Neuropathy (TAN) among women in Andom Village-East Region, Cameroon. *International Journal of Research and Review*. 1 (4):148–156.

Akanmu, A., Abiala, M., Akanmu, A., Adedeji, A., Mudiaga, P., & Odebode, A. (2013). Plant extracts abated pathogenicfusariumspecies of millet seedlings. *Archives of Phytopathology and Plant Protection*, 46(10), 1189-1205.

Akinrinola-Akinyemi, A., Asagbra, A., Asiru, W., Lalemi, M., Okere, V., Oluwawole, O. & Elemo, G. (2017). Viability of cassava peels spawn production and mushroom cultivation. *Open Agriculture*, 2(1), 250-254.

Bayitse, R., Hou, X., Bjerre, A., & Saalia, F. (2015). Optimisation of enzymatic hydrolysis of cassava peel to produce fermentable sugars. *Average Memory Balance Express,* 5(1).

Casida Jr, L. E. (1982). Ensifer adhaerens gen. nov., sp. nov.: a bacterial predator of bacteria in soil. *International Journal of Systematic and Evolutionary Microbiology*, *32*(3), 339-345.

Criollo, H., Lagos, T., Piarpuezan, E., & Pérez, R. (2011). The effect of three liquid bio-fertilizers in the production of lettuce (*Lactuca sativa L.*) and cabbage (*Brassica oleracea L.* var. capitata). *Agronomía Colombiana*, *29*(3), 415-421.

Eze, J. I. (2010). Converting cassava (manihot spp) waste from gari processing industry to energy and bio-fertilizer. *Global Journal of Researches in Engineering*, *10*(4), 113-117.

Pondja Jr, E. A., Persson, K. M., & Matsinhe, N. P. (2017). The potential use of cassava peel for treatment of mine water in Mozambique. *Journal of Environmental Protection*, *8*(3), 277-289.

Fadhallah, E., Juwita, N., Assa'diyah, I., Tullaila, S., Putri, S., Prayoga, R., & Iswahyudi, B. (2023). A review of potency of cassava peel waste and seaweed carrageenan as environmentally friendly bioplastic. *International Journal of Hydrological and Environmental for Sustainability,* 1(3), 146-159.

Fathima, A. A., Sanitha, M., Tripathi, L., & Muiruri, S. (2023). Cassava (*Manihot esculenta*) dual use for food and bioenergy: A review. *Food and Energy Security*, *12*(1), e380.

Grema, M., Ismail, H., & Muhammad, S. (2022). Comparative study on the effect of biofertilizer, organic and inorganic fertilizers on chlorophyll and moisture contents of pennisetum typhoides. *Umyu Scientifica*, 1(2), 1-7.

Htwe, A., Moh, S., Soe, K., Moe, K., & Yamakawa, T. (2019). Effects of biofertilizer produced from bradyrhizobium and streptomyces griseoflavus on plant growth, nodulation, nitrogen fixation, nutrient uptake, and seed yield of mung bean, cowpea, and soybean. *Agronomy,* 9(2), 77.

Husna, N. and Yuniarti, E. (2022). Formula application of n fixation and p solubilizing isolate from two soil type of paddy field on the growth and yield of rice (oryza sativa linn.). *Iop Conference Series Earth and Environmental Science,* 976(1), 012040. *International Journal of Systematic and Evolutionary Microbiology* 32:339–345.

Htwe, A. Z., Moh, S. M., Soe, K. M., Moe, K., & Yamakawa, T. (2019). Effects of biofertilizer produced from Bradyrhizobium and Streptomyces griseoflavus on plant growth, nodulation, nitrogen fixation, nutrient uptake, and seed yield of mung bean, cowpea, and soybean. *Agronomy*, *9*(2), 77.

Onwudike, S. U., Asawalam, D. O., & Ano, A. O. (2016). Influence of agro-wastes on soil properties, growth and yield of maize (Zea mays L.) in an acid ultisol of Owerri, Imo State.

Kortei, N., Dzogbefia, V., & Obodai, M. (2014). Assessing the effect of composting cassava peel based substrates on the yield, nutritional quality, and physical characteristics of pleurotus ostreatus (jacq. ex fr.) kummer. *Biotechnology Research International*, 2014, 1-9.

Mare, E., Sarah, M., & Husin, A. (2023). Biogas production from cassava peels utilizing fixed bed bioreactor with silica gel media. *Journal of Physics Conference Series*, 2421(1), 012020. s

Mathimaran, N., Sekar, J., Thimmegowda, M., Prabavathy, V., Perisamy, Y., Raju, K., … & Mäder, P. (2020). Intercropping transplanted pigeon pea with finger millet: arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria boost yield while reducing fertilizer input. *Frontiers in Sustainable Food Systems*, 4.

MN, G., Ismail, H., & Muhammad, S. (2022). Effect of biofertilizer, organic and inorganic fertilizers on the growth parameters and root colonization of pennisetum typhoides (burm f.) under greenhouse conditions. *Arid-Zone Journal of Basic & Applied Research, 1(2),* 93-103.

Nosheen, S., Ajmal, I., & Song, Y. (2021). Microbes as biofertilizers, a potential approach for sustainable crop production. *Sustainability*, 13(4), 1868.

Nwokoro, O., Anya, F., & Eze, I. (2013). The use of microorganisms in increasing the protein yield of cassava (manihot esculenta crantz) peel wastes. *Polish Journal of Chemical Technology,* 15(2), 112-115.

Ogbo, F. (2010). Conversion of cassava wastes for biofertilizer production using phosphate solubilizing fungi. *Bioresource Technology*, 101(11), 4120-4124.

Olanbiwoninu, A. and Odunfa, S. (2015). Production of fermentable sugars from organosolv pretreated cassava peels. Advances in Microbiology, 05(02), 117-122.

Otaiku, A. (2019). Biofertilizer impacts on cassava (manihot esculenta crantz) cultivation: improved soil health and quality, igbariam, nigeria. *World Journal of Agriculture and Soil Science*, 4(1).

Pan, I., Dam, B., & Sen, S. K. (2012). Composting of common organic wastes using microbial inoculants. *3 Biotechology*, *2*, 127-134.

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.

Qasim, M., Younis, A., Zahir, Z. A., Riaz, A., Raza, H., & Tariq, U. (2014). MICROBIAL Inoculation Increases The Nutrient Uptake Efficiency For Quality Production Of *gladiolus grandiflorus*. *Pakistan Journal of Agricultural Sciences*, *51*(4).

Pondja, E., Persson, K., & Matsinhe, N. (2017). The potential use of cassava peel for treatment of mine water in mozambique. *Journal of Environmental Protection*, 08(03), 277-289.

Saharan, K., Schütz, L., Kahmen, A., Wiemken, A., Boller, T., & Mathimaran, N. (2018). Finger millet growth and nutrient uptake is improved in intercropping with pigeon pea through "biofertilization" and "bioirrigation" mediated by arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria. *Frontiers in Environmental Science*, 6.

Simate, G. and Ndlovu, S. (2015). The removal of heavy metals in a packed bed column using immobilized cassava peel waste biomass. *Journal of Industrial and Engineering Chemistry*, 21, 635-643.

Sondang, Y., Alfina, R., & Anty, K. (2015, October). Karakteristik Mikroorganisme Lokal (MOL) dari Berbagai Sumber Bahan Organik. In *Prosiding Seminar Nasional: Ketahanan Pangan dan Pertanian Berkelanjutan, Tantangan dan Peluang Implementasi Teknologi dalam Perspektif Nasional* (pp. 104-109).

Sondang, Y., Alfina, R., & Anty, K. (2015, October). Karakteristik Mikroorganisme Lokal (MOL) dari Berbagai Sumber Bahan Organik. In *Prosiding Seminar Nasional: Ketahanan Pangan dan Pertanian Berkelanjutan, Tantangan dan Peluang Implementasi Teknologi dalam Perspektif Nasional* (pp. 104-109).

Thilakarathna, M. and Raizada, M. (2015). A review of nutrient management studies involving finger millet in the semi-arid tropics of asia and africa. *Agronomy,* 5(3), 262-290.

Yomeni, M.O., Akoroda M.O., Dixon A. G. O. (2010). Cassava *(Manihot esculenta Crantz)* stems quality for root production effectiveness Proceeding on 11th International Society for Tropical Root Crops, African Branch Symposium, Kinshasa, DR Congo.

Zúñiga-Soto, E, Mullins E, Dedicova B. (2015). *Ensifer*-mediated transformation: an efficient non Agrobacterium protocol for the genetic modification of rice. Springer Plus 4, 1–10.