COMPARATIVE POTENTIALS OF COW DUNG AND POULTRY DROPPINGS BIOMANURE FROM BIOGAS PLANT ON GERMINATION AND GROWTH RATE OF *MORINGA OLIEFERA*.

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Abstract

Biomanure is a by-product obtained from the biogas plant after the digestion of dung or other biomass for the generation of methane rich biogas. Biomanure supplies essential nutrients; enhances water holding capacity and soil aeration; accelerates root growths and inhibits weed seed germination. Agricultural products (vegetables and fruits) obtained from this source are marked as 'Organic' and sold at higher prices at supermarket shelves. This study evaluated comparatively the potentials of spent slurries of cow dung and poultry droppings obtained from biogas plant as bio-manure to support germination and growth of Moringa oleifera. The floating top/tank digester method was used for the biogas production, using cow dung and poultry droppings as feedstock raw materials. The obtained spent slurries produced as by-products of biogas production were collected evaluated for their biomanure potential on an experimental farm where seedlings of Moringa oleifera were planted. The farm plot measuring $10M^2$ was then divided into four separate and equal portions of $2.5M^2$ and labelled A, B, C, and D to which 70kg/hectare of bio-manure slurry from either cow dung, poultry dropping, agricultural grade Nitrogen-Phosphorus-Potassium (NPK) fertilizer (positive control) or placebo (negative control) were applied respectively. On each of the portions at least 10 no seeds of the plant M. oleifera were planted and interval treatment with bio-manure/fertilizer was repeated. The portions were watered daily with equal amounts of water, exposed to same quantity of sunlight and monitored for five weeks until germination and growth of the seeds to a plant. For each of the plots samples the average rate of germination and percentage of germination plant height, stem size, number of leaves and dry weight was evaluated for growth rate. Comparatively, results reveal that biomanure from poultry dropping demonstrated a higher potential (83%) over cow dung bio-manure (70%) with respect to support of germination and growth rate of vegetable plant. It is therefore recommended that this technology of biogas production should be encouraged and adopted in farms, rural homesteads, schools, institutions and research centres not only for provision of affordable renewable energy but also as source of organic biomanure for sustainable agriculture.

INTRODUCTION

The concept of renewable energy creates the idea of waste management, by recycling a waste product of domestic origin (like food and vegetable wastes) or animal dung/droppings as raw materials for another product (e.g. biogas and bio-fertilizer) in an integrated production circle. Biogas is produced by the degradation of biological matter under anaerobic reaction in absence of free oxygen in a digester. Biogas can be produced through a simple or complex process depending on the targeted volume of the biogas to be produced. Additionally, its production creates a high-quality fertilizer and provides feedstock for the creation of petrochemical substitutes.

The maintenance of a clean environment by converting its waste into renewable energy and biodegradable components that is compatible with the environment is the current trend the world over, to sustain a habitable environment accompanied by socio-economic benefits (U.S. EPA. 2010). Farming is the major occupation in Nigeria, and significant quantities of agricultural wastes produced are not innovatively utilized. Examples of such wastes from animal production include the cow dung and poultry manure. By converting these filthy wastes into biogas, two very important products can be obtained: biogas to replace unreliable, unsustainable, climate unfriendly and expensive fuels, and bio-fertilizer to replace chemical fertilizers for increase crop yield. With these needs attended to, a farmer can look beyond the daily needs of his farm and plan for a better future for his family and community.

Biogas production can utilize various feedstock, majority of which are biomass. Common existing biomass from animal husbandry include dungs and poultry droppings and although various studies and horticultural practices have demonstrated their direct usage of both as organic manures, there are little or no information on possible potential usage of spent slurries of cow dung or poultry droppings obtained as by products from biogas plant. This study sets out to determine comparatively the potentials of spent slurries of cow dung and poultry droppings from biogas plant as bio-manures for germination and growth rate of *Moringa oliefera* – a very common, nutritionally and medicinally important vegetable plant.

METHODOLOGY

Sample collection

Cow dung and poultry droppings were obtained from a nearby farm in Zaria town. Approximately about 1000kg of each was collected and safely transported to the

research location where it is housed under shade constructed with timber wood and zinc coated steel roofing sheets.

Biogas Plant Site and Size

A small-scale biogas production plant was set up at the East wing of the School of Applied Sciences (SAS), Nuhu Bamalli Polytechnic, Main Campus, Zaria. The land area was fenced, to cover half hectare of land, to accommodate the biogas plant and accessories and vegetable garden model farm for application/testing of the bio-manure. The biogas plant site was within a reasonable proximity to the laboratories of Department of Science Laboratory Technology, for utilization of the biogas. The criteria's for selecting an ideal plant site was that the ground (earth) was hard and compact, not waterlogged and damp, dry and away from shade hence have maximum day sunlight hours. The length of gas delivery pipeline was made as short as possible for effective gas delivery. There was enough protected space for slurry storage and water line and animal waste were safely stored under a shed within the site.

The biogas plant size was set up with 300 liters digester capacity, for cattle dung and poultry droppings feedstock, and an allowance for 200 cubic meter capacity for biogas storage. The volume of the mixture comprises of 150kg of either cow dung or poultry dropping mixed with 150 liters of water until and slurry is formed ready for feeding into the digester.

Preparation of Digester (Floating top/tank digester method)

The floating top/tank design digester is one that adapts itself particularly well to the materials at hand. In this design, the slurry is contained in a bottom tank, with another inverted tank or drum serving as a cap, which is lifted by the biogas as it is generated. The design can be adapted to use any size of tanks, with a larger diameter for the outer and smaller diameter for the inner tank and can be an excellent and inexpensive design to experiment with (Culhane 2012). The digester produced for this study consisted of a cylindrical 300-liter tank, open on top, in which the organic material is digested. A second, slightly smaller tank is placed in the larger tank, upside-down. The inner tank acts as both storage, and as a lid for the digester tank. As biogas is removed for use, the inner gas storage tank sinks back into the larger, outer tank. The gap between the tank walls is narrow enough to prevent significant quantities of oxygen from entering the digester, which would kill the anaerobic bacteria that produce the methane. The amount of biogas lost though the gap is negligible (Diver, 2002).

Experimental Set -Up

The biogas digester was started by preparing a 1:1 mixture of fresh animal manure and water and allowing this to ferment anaerobically for several weeks. Production of biogas is signalled by the rise of the inner tank due to the biogas pressure which can be tested by ignition from the jet of the outlet tank.

The slurry used was prepared by mixing 150kg of either sample (cow dung or poultry droppings) with 150 liters of water. To each digester, 30kg of water hyacinth was added and an appropriate volume was added until the desired 300 liters slurry volume was obtained. Each digester was thoroughly stirred by mechanical shaking, to ensure the formation of homogenous mixture. TAfter the experimentation which lasted for 3 weeks when the biogas production has dropped to its very lowest, the digester was stopped and the spent slurry collected spent slurries collected for further experiments.

Determination of Proximate Composition of the Spent Slurries.

Proximate analysis of the collected cow dung and poultry droppings slurries were carried out by determination moisture content, dry organic matter, carbon, nitrogen and ash content of the samples by standard method as described by Uzodinma et al., (2008).

Determination of its bio-manure potentials collected slurry

An experimental farm was then set up where seedlings of *Moringa oleifera* were planted after tiling the land. The farm plot measuring $10M^2$ was then divided into four separate and equal portions of $2.5M^2$ and labeled A, B, C, and D. To each of portions A, B, C an amount equal to standard rate of 70kg/hectare of bio-manure slurry from cow dung , poultry dropping and agricultural grade Nitrogen-Phosphorus-Potassium (NPK) fertilizer (positive control) were applied respectively to the soil while portion D received no bio-manure or fertilizer and served as ntive control. On each of the portions at least 10 no seeds of the plant *M. oleifera* were planted. Three weeks after, the treatment with bio-manure slurry was repeated. The portions were watered daily with equal amounts of water, exposed to same quantity of sunlight and monitored for five weeks until germination and growth of the seeds to a plant. For each of the plots samples the average rate of germination and percentage of germination were determined. Furthermore, each of the germinate plant was evaluated after 6 weeks for its height, stem size, number of leaves and dry weight.

Data was also collected on the model farm by monitoring the progress of germination and growth of vegetable treated with bio-manure (organic) and comparison with model farm (at the same location) being treated with chemical fertilizer. The average of these parameters for plot samples A, B, C, D were computed and compared.

Data and statistical analysis

Descriptive statistics were used to express the data collected. One way ANOVA was carried out to determine the level of significant difference (at 5% level of confidence) between two parameters under comparison.

RESULTS AND DISCUSSIONS

Proximate Composition of the Biomanure Slurries

Table 2 shows the proximate composition of spent slurry bio-manure collected from digesters after biogas production for 20 days. The results reveal that slurry bio-manure from cow dung had a higher moisture, organic matter as well as carbon-nitrogen ratio than poultry droppings. However slurry bio-manure from poultry droppings had higher ash content (36.00%) than the slurry from cow dung digester (25.00%).The pH values and carbon content of both slurries are in similar range, but the nitrogen content for poultry droppings slurry is higher than that of cow dung. Conversely, the carbon-nitrogen ratio of the slurry bio-manure from poultry droppings is lower (14.94) when compared with that of cow dung slurry (21.53)

Table 1: Proximate composition of spent slurry bio-manure of cow dung and poultry droppings after production of biogas.

Parameter	**Spent Slurry Bio-manure**	
	Cow Dung	**Poultry Droppings**
Total Moisture (%)	33.00	28.00
Ash (%)	25.00	32.00
Total Dry Organic Matter (%)	42.00	40.00
- Carbon (%)	28.00	26.16
- Nitrogen (%)	1.30	1.75
Carbon/Nitrogen Ratio	21.53	14.94
pH value	6.71	6.85

Table 1 shows the proximate composition of the spent slurry bio-manures obtained after the digestion of the cow dung and poultry droppings for biogas production.

There was significant increase of moisture level when compared with the level in feedstock pre-digestion. This was due to the amount of water incorporated for the digestion to proceed. Conversely, there was a drop in the organic matter contents for both samples and this can be explained on the fact that organic matter is the feedstock component that undergoes digestion to yield biogas. Therefore, the difference between the initial organic matter content pre-digestion and that after digestion represent the total organic matter that was digested to yield biogas. Comparing between the slurry samples, the cow dung slurry bio-manure had a higher moisture (38%) and higher carbon/nitrogen ratio (21.53) than the poultry dropping slurry bio-manure which had 28% moisture and 14.94 carbon nitrogen ratio. However, the level total dry organic matter level between the two bio- manure samples is almost the same (40% and 42%), so also is the pH value (6.71 and 6.85) while for ash content the poultry dropping bio-manure had higher ash contents (32%) than the cow dung bio-manure. The ability of manures to promote plant growth is dependent significantly on the organic matter content and the ash content which are the reservoirs of the necessary nutrients needed by plants for growth and development. Based on the foregoing, the proximate compositions of the two bio-manure slurries indicate the both have appreciable organic matter and ash content which can potentially support plant growths.

Effect of Bio-manure on Germination and Growth Rate of *Moringa oleifera*.

Table 2 shows the effect of bio-manure from spent slurry obtained after digestion of cow dung and chicken dropping for biogas production on the germination of *Moringa oleifera* seeds. Comparatively no statistical difference was observed with respect to germination rate and germination percentage for bio-manure from cow dung digester in comparison with the NPK fertilizer control group. However statistical difference exists when the poultry dropping group is compared with NPK fertilizer control group. Furthermore, there exist a statistical difference for germination rate and percentage between the cow dung group and the poultry dropping group with the latter being statistically higher. On the other hand, the negative control group (D) was statistically lower when compared with all the other three groups.

Table 2: Influence of bio-manures obtained as byproduct of biogas production vs NPK fertilizer on germination rate and germination percentage of seedlings of *Moring oleifera*.

	No of Seeds Planted	**No of Seeds that Germinated**	**Germination Rate**	**Germination Percentage (%)**
Group A - CD	30	21^{b}	1.05^{b}	70^{b}
Group B - PD	30	25^{c}	1.25^{c}	83^{c}
Group C- NPK	30	22^{b}	1.10^{b}	73^{b}
Group D - Control	30	15^{a}	0.75^{a}	50^{a}

Values with different letter superscript in the columns are statistically different (p>0.05)

Table 3 reveals the influence of the bio-manure from spent slurry of biogas production on average shoot and growth parameters of *Moringa oleifera* over a six weeks study period. The seedling height and number of leaves at the end of the six weeks experimental period shows that group A treated with poultry dropping slurry had the highest height (23.21cm) and highest average number of leaves (13.15) which are statistically higher than the average heights and number of leaves of the seedlings in the cow dung slurry treated group B, NPK treated group C (positive control) and the no treatment group D (negative control). The group D control which is the no treatment group had the least seedling height (12.00cm) and number of leaves (7.69). Similarly, the seedling thickness is statistically lower in the group D control when compare all the other three treated groups. Cumulatively, the total dry weight of the seedling shows that the poultry dropping treated group B had the highest value (3.77g) which is statistically higher than that of cow dung treated group A (2.68g) and NPK treated group C (3.02g). The no treatment control group D had the least total dry weight (1.95g) when compared with the other groups.

Table 3: Influence of bio-manures obtained as byproduct of biogas production vs NPK fertilizer on shoot and growth parameters of *Moringa oleifera* seedlings over 6 weeks' period.

	Seedling Height (cm)	**No of Leaves per Seedling**	**Thickness of Seedling (cm)**	**Total Dry Weight (g)**
Group A - CD	16.10^{b}	9.70^{b}	0.48^{b}	2.68^{b}
Group B - PD	23.21^{c}	13.15^{c}	0.51^{b}	3.77^{d}
Group C - NPK	17.17^{b}	10.79^{b}	0.49^{b}	3.02^{c}
Group D - Control	12.00^{a}	7.69^{a}	0.36^{a}	1.95^{a}

Values are means of seedling analyzed. Values with different letter superscript are statistically different (p>0.05).

The spent slurry from the biogas digester are rich in organic matter as well as ash content (inorganic minerals) as illustrated by the proximate analysis results in Table 1. These could serve as potential bio-manures for crop production, thereby making the entire biogas production system circular with no by-products or wastes needed to be discarded. The study investigated the potentials of these bio-manures in supporting the germination and growth rate of a typical vegetable crop *Moringa oliefera.* The results in Table 2 and 3 shows the influence of these bio-manures on the germination and growth rate of the vegetable respectively. It can be seen that the Group B treated with poultry dropping (PD) slurry had a statistically higher germination rate (1.25) and percentage (83%) than the Group A treated with cow dung bio-manure (1.05 and 70%) and also group C treated with NPK fertilizer (1.10 and 73%) respectively. Furthermore, all the groups treated with either bio-manure or fertilizers supports germination better than the control group which was treated with non. This suggests that the bio-manures have potential for promoting germination with poultry droppings bio-manure having superiority over cow dung bio-manure slurry. This variation might be due to the poultry dropping bio-manure having a higher ash content (32%) that the cow dung bio-manure (25%), since both manures have relatively same organic matter contents (40% and 42%). Ash contents represent the inorganic mineral contents of samples and this include essentially phosphorous and potassium which a vital mineral nutrients needed by plants (Fry, 1973). In Table 5, the various seedlings growth parameters are presented after analysis. The results similarly reveal that the group B treated with poultry dropping bio-manure have higher shoot and growth parameter than the group treated with cow dung manure (group A), that treated with NPK fertilizer (Group C) as well as the control (Group D) which is not treated. This further affirms the superiority of the poultry droppings manure with respect to support of plant growth over the bio-manure resulting from cow dung. This realization is also not unrelated to the relative high ash content of the poultry bio-manure.

Conclusion and Recommendations

The study shows that the spent slurries obtained from the biogas production can be used as bio-manures to support plant growth in agriculture with poultry dropping bio-manure having a comparative advantage over cow dung bio-manure with respect to support of germination and growth rate of

vegetable plant. The research has demonstrated that harnessing the biogas technology utilizing cheap locally available feedstock will contribute not only in provision clean and affordable energy for heating purpose but will also provide quality bio-manure that could be used for small scale agricultural purposes such as vegetable farming. It is therefore recommended that the utilization of bio-manure produced as byproduct of biogas production should be promoted and encouraged among small holder farmers.

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