

**PRODUCTION OF BIOORGANIC LIQUID FERTILIZER FROM
CAMEL MANURE AND ONION BULBS THROUGH HYDROPONIC
LETTUCE**

M.Sc THESIS

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**PRODUCTION OF BIOORGANIC LIQUID FERTILIZER FROM
CAMEL MANURE AND ONION BULBS**

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DEDICATION

This piece of work is dedicated to my beloved late mother Fatuma Usman.

STATEMENT OF THE AUTHOR

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ABBREVIATIONS/ACRONYMS

EC	Electrical Conductivity
FAO	Food and Agricultural Organization
NPK	Nitrogen, Phosphorus and Potassium
PCT	Patent Cooperation Treaty

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Production Of Bioorganic Liquid Fertilizer From Camel Manure And Onion Bulbs Through Hydroponic Lettuce

ABSTRACT

The bioorganic fertilizer obtained through aerobic fermentation comprises a number of growth substances, vitamins, antibiotics, amino acids and useful micro-organisms. Bioorganic liquid fertilizer not only increases bioorganic fertility of crops (in comparison to the control and prototype fertilizer), but also accelerates their maturation and nutrient quality. Thus, the present study was aimed to produce bioorganic liquid fertilizer from camel manure and groundnut husks through aerobic fermentation in open containers. The results indicated that Potassium (K), Calcium (Ca) and sodium (Na) were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. However, there were differences with respect to Carbon(C), Nitrogen (N), phosphorus (P) and Magnesium (Mg) contents .Comparison of mineral composition of bioorganic liquid fertilizer and compost tea solutions with the standard for some macronutrients requirement of plants indicated that the composition of both fertilizer solutions in the present study satisfies the standard with bioorganic liquid fertilizer being higher in mean values for most of the studied mineral plant nutrients. The bioorganic liquid fertilizer produced was evaluated by growing lettuce in pot experiment and result indicated that the performance of lettuce with bioorganic fertilizer was better than that of compost tea solution and soil grown plants. It can be concluded from the present study that bioorganic liquid fertilizer can be produced from locally available bioorganic fertilizer. Small holder farmers can get economic relief, because by using this technology, they can minimize the use of chemical fertilizer which is being expensive and not environmentally friendly.

Keywords: *Compost tea, Electrical conductivity, Organic Fertilizers, Plant macronutrients.*

1. INTRODUCTION

Organic fertilizers are obtained from animal manure or plant sources like green manure. Hence, organic manure can serve as alternative to mineral fertilizer (Dauda *et al.*, 2008; Mishra and Jain, 2013). Different organic manure influence differently in terms of growth and yield of plant, thus it is necessary to know the best source of organic manure and rates of application which help in increasing the growth and yield. Applying organic fertilizers improved vegetative growth characters, essential oil, some chemical composition of essential oil, and phosphorous content of *Ocimum basilicum* L. (sweet basil plants) (Khalid, 1996). Increasing the rates of organic material decomposing and releasing nutrient for plant uptake. they improve the physical properties of the soil as well (Dauda *et al.*, 2008; Sharafzadeh and Ordookhani, 2011).

Natural organic fertilizers used in plant cultivation are characterized by low efficiency and therefore in order to obtain high yield they are soil-applied in large quantities about 7 - 30 t/ha. On the other hand, intensive use of mineral or chemical fertilizers leads to significant mineralization of the soil and to a loss of fertility, and has been brought about pollution of water bodies since the era of green revolution. Thus, for sustainable and organic agriculture searching for new forms of ecologically clean bioorganic fertilizers and liquid utility formulations are useful in organic farming and ensuring the optimization of absorption of mineral nutrients of cultivated plants, obtaining high yields, reduction of chemical load of agricultural land and soil restoration. There are drastic shortages of such highly efficient bioorganic fertilizers, obtained by microbiological processing of poultry manure and animal husbandry and also their liquid utility forms (PCT, 2013).

The bioorganic fertilizer obtained through anaerobic fermentation comprises number of growth substances, vitamins, antibiotics, 18 amino acids and useful micro-organisms. However, the disadvantages include lack of finished product of effective micro-organisms balanced according to the generic composition comprising the following dominant genera: lactic fermentation bacteria *Lactobacillus* spp, photosynthetic bacteria and yeast *Spp*; presence in the finished product undesired foreign bacterial micro flora, insignificant speed of microbial fermentation in anaerobic conditions; seasonal restrictions on the use of prototype fertilizer depended on the domination of anaerobic cellulose-degrading micro-organisms; constant proportion and a limited

set of starting components, making it impossible to get a finished product, balanced for specific crops taking into account their biological characteristics and physiological needs; not very high physical-mechanical parameters and the quality of the finished product: high humidity, viscosity, heterogeneity; insignificant content of mineral nutrients and biologically active substances in the finished products (Sharafzadeh and Ordookhani, 2011).

To overcome such problems PCT (2013) has developed bioorganic liquid fertilizer which in addition to mineral nutrients, consists of aerobic fermentative process involving micro-organisms balanced according to the generic composition comprising dominant genera: lactic fermentation bacteria *Lactobacillus plantarum* and *Lactobacillus casei*, photosynthetic bacteria *Rhodospseudomonas palustris* and yeast *Saccharomyces cerevisiae*, ensuring microbiological diversification and a high content of biologically active substances. Such process of fermentation is advantageous in maintaining the microbial diversity and balance of the different groups of effective micro-organisms. This favors the maximum accumulation of nutrients and receiving of the bioorganic fertilizer having high degree of humification and homogeneous loose structure. The use of such fertilizer will enable the activation of soil microbiological processes and the synchronization of the function of the microorganism for the soil damaged by human activities, by ensuring bacterioand fungi stasis; develop the method of preparation of highly efficient bioorganic fertilizer, ensuring high speed microbiological fermentation, to preserve the microbiological diversification of efficient micro-organisms and a high utility value (Sharafzadeh and Ordookhani, 2011).

Bioorganic liquid fertilizer not only increases bioorganic fertility of crops (in comparison to the control and prototype fertilizer), but also accelerates their maturation. At the same time the biological value of products is increasing: the content of vitamins and carotene in vegetables is increased and the nitrate content is significantly reduced. The doses of applying fertilizer are reduced 2.0-2.2 times (PCT, 2013). In light of such justifications the present study has planned to produce bioorganic fertilizer through aerobic method using the organic raw material of the biological nature, the microbiological formulation in non-chlorinated water, to be used for organic farming, ensuring high yield, ecologically clean products, optimization of the absorption of mineral nutrients by the crops, clearing soil from harmful substances and pathogenic micro-

organisms, rebuilding the soil and reducing chemical burden of agricultural lands and at the same time an industrial-scale utilization of poultry and animal farming waste.

General Objective

- To produce ecologically clean bioorganic liquid fertilizer and check its quality through hydroponic growing of lettuce.

Specific Objectives

- To determine optimum concentration of major plant macronutrients in bioorganic liquid fertilizer;
- To determine the quality of bioorganic liquid fertilizer;
- To evaluate hydroponic growth of lettuce in pots so as to test the efficiency of bioorganic liquid fertilizer.

2. LITERATURE REVIEW

2.1.Organic Fertilizers

Recently, attention has been drawn to the use of organic fertilizers which used to be an ancient practice of maintaining soil fertility. The attention directed towards organic manure is as a result of the high cost of chemical fertilizers and their long term negative effect on the chemical properties of the soil (Norman, 2004; Tirol-Padre *et al.*, 2007). A reports by Ruder and Benn (2013), reiterates the high cost of fertilizers world-wide by pointing to the rapid increase in the price of inorganic fertilizers in the U.S.A.Organic fertilizers on the other hand have the ability to improve soil organic matter, soil structure, soil chemical properties and soil microbial activity. They again maintain the productivitye of the soil (Chandra, 2005; Tirol-Padre *et al.*, 2007; Bhattacharyya *et al.*, 2010 and Lasmini *et al.*, 2015).

2.2.Composition of Camel Manure

The manure of herbivorous animals varies in the concentration of nutrients, in moisture content and in consistency (Hanski, 1987). It generally consists of two components, the relatively low quality remains of undigested plant material and a high quality component derived from the micro-organisms in the mammalian gut and their products. The vegetation upon which an animal grazes affects the chemical composition of the dung. Green leaves of young grass plants are high in protein and low in cell wall materials, while leaves of woody plants contain more protein and less fibre than grass (Owen-Smith, 1982).

Camel manure contains N% 2.37, P% 0.49, K% 1.14, Ca % 1.95, Mg % 0.98, Fe (ppm) 233, Mn (ppm) 688, Zn (ppm) 415 (Sabouni *et al.*, 2018).The amount of nutrients provided depends on the nutrient content of the manure (lb of nutrient / ton of manure) and the amount of manure applied (ton of manure / acre). The amount of manure applied per acre (called the *application rate*) is typically based on the nitrogen needs of the plants. However, phosphorous requirement can also be used to determine the application rate. (Nraes, 1990).

2.3. Composition of Onion Peels (*Allium cepa*)

Onions (*Alliums cepa*) possess strong characteristic aromas and flavors, which have made them important ingredients in food (Ly *et al.*, 2005). It has been shown that bioactive compounds are present in every part of onion bulb (Benitez *et al.*, 2011). Onion is a potent cardiovascular and anticancer agent, with hypocholesterolemic, antioxidant, antiasthmatic, and antithrombotic activity (Moreno *et al.*, 2006). Onion is one of the major sources of dietary flavonoids which contain anthocyanins, that is responsible for the red or purple color observed in some varieties, and flavones (quercetin) that may contribute to the production of yellow and brown compounds found in the skins of many onions. Quercetin has demonstrated antioxidant and free radical scavenging power and its capability to protect against cardiovascular disease (Bonaccorsi *et al.*, 2008, Benítez *ET AL.*, 2011). However, onion skins contain higher concentrations of quercetin aglycon than the flesh (Downes *et al.* 2009). Onion bulbs found to have (4.72%) soluble sugars, (3.78%) soluble proteins, (60.47 mg/100g DW) calcium, (3.17 mg/100g DW) magnesium and (9.11 mg/100g DW) sodium, (136.82 mg/100g DW) potassium and (107.33 mg/100g DW) phosphorus; and trace elements: (30.16-160.69 mg/Kg) iron, (23.30-41.46 mg/Kg) aluminium, (26.87- 66.08 mg/Kg) zinc, (24.73-28.83 mg/Kg)copper, 911.53-17.39 mg/ Kg) manganese and (4.38-5.11 mg/Kg) nickel (Azoom *et al.*, 2015).

2.4. Difference between Fresh and Composted Manures

There was an obvious reduction in total C in composted manures as compared to fresh manures. The reductions in total C was 15% for buffalo, <17%for caw,<29%for poultry,<32for goat manure (Murphy, 2006). Generally, the source of raw material influences the humification process during composting (Beegle and Wolf, 2002). This is not unexpected since composting is essentially a biochemical process in which C and N are mineralized and lost in gaseous forms as carbon dioxide, ammonia, N₂O and N₂ (Eneji *et al.*, 2003a). Eneji *et al.* (2003b) also reported a decrease in total C by 18% after 195 days of co-composting animal wastes. It has been reported elsewhere that chemical composition affected the decomposition rate of all organic matter including crop residues (Kumar and Goh, 2000; Martens, 2000), compost (Tiquia *et al.*, 2002), and manure (Gordillo and Cabrera, 1997).

Irshad *et al.* (2011) reported a marked decrease in extractable $\text{NH}_4\text{-N}$ during composting. Fresh manure had 87 mg kg^{-1} of NH compared with only 15 mg kg^{-1} after 100 days of composting. Fresh (non-composted) manures had much higher total N content than composted manures and among sources, total N varied in the order buffalo > poultry > cow > camel > goat. Since the content of N declined significantly with composting, it would be necessary to supplement the manure with inorganic sources of N when applied as fertilizer. The lower total N in composted samples may also infer that the use of composted waste would be less polluting. Adler and Sikora (2005) observed an increased inorganic N and decreased water-extractable P as the organic matter decomposed. Others have also observed a decrease in water-extractable P over time with different types of composts (Traore *et al.*, 1999).

Potassium (K) content among livestock manures substantially decreased after composting. The decreased K in composted samples could be attributed to the formation of insoluble K complexes in the presence of inorganic elements or changed pH value. Viller *et al.* (1993) reported differences of 42 and 55% in the contents of available Ca and Mg extracted with acetic acid after composting of the manure. Eneji *et al.* (2003c) reported that manure was an ample source of macro- and micronutrients upon application to soils. Chemical composition of manure can influence the amount of nutrients released, and the rate at which they are released. Significant correlations have been reported between the initial chemical composition of organic residues and the mineralization rate (Mafongoya *et al.*, 1990).

2.4.1. Macronutrients

Sodium (Na) .A few plants needed in Na to help the concentration carbon dioxide, but most plant use only trace amount to promote metabolism. Nitrogen (N) encourages leaf and shoots growth. It is a component of chlorophyll, and gives plants their greenness. If there is too little nitrogen, plants become stunted and pale. If plants are overdosed with nitrogen, they will grow too fast and become soft and sappy – an invitation to pests. Phosphorus (P) or phosphate encourages healthy growth in every part of the plant including the roots. Only small quantities are needed. A deficiency in phosphate shows as stunted growth. Potassium (K) or potash is associated with the size and quality of fruit and flowers. It toughens up plants and protects them from pests and diseases and its deficiency shows as small flowers and fruits and yellowing or browning of the

leaves. Magnesium (Mg) is another greening agent. A deficiency shows as chlorosis, which is a yellowing of the leaves starting between the veins. It is easily remedied by adding organic matter to the soil. Calcium (Ca) helps to manufacture protein. Sulphur (S) is part of plant protein and also helps to form chlorophyll. Lack of sulphur is unusual where the soil is rich in organic matter (Jokella *et al.*, 2004).

2.4.2. Micro-nutrients

Micro-nutrients (B, Cl, Cu, Fe, Mn, Mo, Ni, Zn), are involved in metabolic processes in plant cells and is needed in low quantities. The micro-nutrients are redox-active so they act as active catalysts and serve as cofactors in enzyme and stabilize the enzyme activator protein (Hansch, 2009). Therefore, with more complete nutrient available in granular organic fertilizer, they can support the growth of red onion better than inorganic fertilizers. Micronutrients are. Manganese (Mn) helps make chlorophyll and protein. A deficiency in Mn shows as stunting and yellowing of new leaves. Iron (Fe) has similar roles to that played by magnesium. Only the tiniest quantities of iron are needed. Iron deficiencies are most likely occurring on chalky soils. Symptoms of lack of iron are pale leaves with brown edges on the margins. Copper (Cu) and zinc (Zn) are needed to activate enzymes. Boron (B) is an important element for growing plant tissues. A lack of Boron could cause "corkiness" in fruit and vegetables. Molybdenum (Mb) helps to produce protein. Oxygen, carbon and hydrogen are taken up from sunlight, air and water by photosynthesis (Jokella, *et al.*, 2004).

The standard for macronutrient composition as developed by McKenzie (1998) was indicated in Table 1

Table 1. Recommended nutrient ranges for lettuce¹

Nutrient	Range	Target level
N	2.5-4.0%	3.5%
P	0.4-0.6%	0.45%
K	4.0%-7.5%	5%
Ca	0.9-2.0%	1.0%
Mg	0.3-0.7%	0.35%
S	0.1-0.3%	0.1%
Fe	50-150ppm	130ppm
Zn	25-50ppm	40ppm
Mn	30-55ppm	50ppm
Cu	5-10ppm	8ppm
B	15-30ppm	20ppm
Mo	NA	0.03ppm

1. young mature wrapper leaf sampled prior to heading. higher N(4-5%) concentrations will be found if young matured leaves are sampled in the early growing stages (6-8 leaf stages). Source: Maggio et al. (2012)

2.5. Components of Bioorganic Fertilizer

Bioorganic fertilizer contains macro and micro-nutrients, vitamins, amino acids and useful microflora in addition to set of mineral nutrients for plants in the proportion, wt.%: total nitrogen (1.3 - 7.5), total phosphorus (P_2O_5) (0.7 -7.5), total potassium (K_2O) (0.8 -7.5), calcium (6.5- 15.0), magnesium(1.9 - 2.3); mg/kg: iron(600 - 970), copper(125 - 150), manganese (60 - 110), zinc (138 - 240), cobalt(1-5) as well as effective micro-organisms, balanced according to the generic composition in the proportion, CFU/ml: lactic fermentation bacteria (*Lactobacillus plantarum* $>1.5 \times 10^3$ - 1.5×10^5 , *Lactobacillus casei* $> 3.5 \times 10^2$ - 3.5×10^4), photosynthetic

bacteria(*Rhodopseudomonas palustris* $> 4.5 \times 10^2 - 4.5 \times 10^4$) , yeasts (*Saccharomyces cerevisiae* $> 7.1 \times 10^2 - 7.1 \times 10^4$). Furthermore, bioorganic fertilizer consists of biologically active substances in the following proportion: enzymes such as urease (50-65 mg N-NH/10 g/24 hours), dextranase (20-35 g glucose/g/5 days), invertase (50-150 mg glucose/100 g/18 hours), glucose oxydase (10-25 micromol of glucose/1 g/24 hours); polysaccharides (0.05-0.15 wt.%), from which 13-30% of the total contents- easy for hydrolyze, comprising 30% neutralized, 10.5 - 17.4% - acid (polyuronides), 7.0 - 24.5% - monosaccharides; lipids (0.18-0.4 wt.%); amino acids, mg/g of dry matter substances: tryptophan (0.05-0.07), cysteine (1.7-2.0), hydroxylysine (0.8-1.2); organic acids (5.0 - 5.2 wt.%), including lactic acid and succinic acid (2.5-3.4); vitamins, microgram/g of dry matter substances (0.05-0.17), including niacin (0.008- 0.02), nicotinic acid (0.005-0.07), folic acid (0.006-0.08); humus substances, wt.%: humic acids (7.8-8.2), fulvic acids (3.4-3.7).

The microbiological formulation is used in the activated form. In order to obtain the activated microbiological formulation, the nutrient medium on the basis of a sterile beet molasses, wheat bran, apple vinegar and electrochemically activated (cathodic) spring or deep well water having Redox-potential of 700-800 mV is used. All operations, involving the preparation of nutrient mixtures, are carried out under aseptic conditions. Activation of the microbiological formulation is carried out in a bright room, not exposed to direct activity of sunlight. The activated microbiological formulation is prepared not earlier than 20 days before its using. In order to do that, a 1 litre of beet molasses and 3 litres of water preheated to a temperature of 50-60°C is placed in a 10-litre sterile container. It is thoroughly mixed until completely dissolving of beet molasses and cooled. A mixture, prepared from 1 litre of sterile wheat bran, 1 litre of the microbiological formulation and 3 litres of sterile water, is then added. After stirring, the pH of the nutrient medium is brought to the value of 4.5-4.8 by using cider vinegar. Under the lid of a tightly sealed container for activation should not be the air. The temperature in the process of activation is maintained in a limits 28 - 32°C, which results in the optimum conditions for reproduction of useful micro-organisms and the inhibition of the growth of pathogenic microflora is prevented. With the growth of effective micro-organisms (on 3rd-4th day) a pH decreases to 3.5 (mafongoya, et al 2004)

Compliance with the described methodology of preparation of the activated microbiological formulation allows to reach 32-35 times higher accumulation of effective micro-organisms biomass, which are the active substance of the formulation, in comparison to the initial content of the biomass. The obtained activated microbiological formulation comprises effective micro-organisms balanced according to the generic composition in the proportion, CFU/ml: Lactic acid bacteria: *Lactobacillus plantarum* > 1.5×10^7 , *Lactobacillus casei* > 3.5×10^6 , photosynthetic bacteria: *Rhodopseudomonas palustris* > 4.5×10^6 , yeast: *Saccharomyces cerevisiae* > 7.1×10^6 (PCT, 2013).

3. MATERIALS AND METHODS

3.1. Study Area

The experiment was conducted in Central laboratory of Haramaya University. Haramaya University is found at about 513 km East of Addis Ababa. The University is located at 9°24'N latitude and 42° 01' E longitude with an elevation of 2044 m.a.s.l.

3.2. Experimental Material

6kg camel manure was collected from Haramaya University Poultry Farm, and 6kg onion peels was obtained from collection at home. Compost tea a concentrated organic liquid fertilizer that is made from steeping biological active compost in aerated bacteria, fungi and other microbes. Compost tea that was used as a control was obtained from Bate district, Haramaya. Fermentation solution was prepared by mixing 500g teff flour to one liter of groundwater following the procedure used by Unnisa (2015).

3.3. Experimental Procedure and Data Collection

Aerobic Digestion: the fermentation process was carried out under aerobic condition in two replications based on the method suggested by PCT (2013) as follow: clumps of camel manure and chopped banana peels were formed in the open container covered with cotton cloth (the proportion of the cake: peels = 1:1). The starting clamp components were successively arranged in layers with a height of 0.4 m each. The formed clumps were sprayed with diluted activated microbiological formulations including yeast and lactic bacteria. The microbial formulations were prepared from yeast powder and coagulated milk (as a source of lactic acid bacteria) with non-chlorinated water in the proportion of 1:50. Mixing and spraying water on the clamp was done periodically. The fermentation process was done in open container at ambient temperature for aerobic microbiological fermentation, until cycle of a fertilizer production completed (being without any flavor).

The output components of the bioorganic fertilizer was left in the open container to complete finishing of the technological process of the fertilizer production. The degree of readiness of the bioorganic fertilizer was determined according to physico-mechanical and organoleptic

properties (homogeneity, looseness, lack of smell). When the above conditions are observed the duration of a complete technology cycle was taken around 40 to 50 days. Finally quantitative analysis for composition of macronutrients in bioorganic fertilizer was determined as per procedures below.

3.4. Determination of Total Nitrogen Content

Nitrogen contents of fertilizer solution and compost tea (control solution) were determined by the Kjeldahl method consists of three steps: digestion, distillation, & titration.

Sample Digestion: sample solution was stirred into a beaker using a VELP magnetic stirrer for 60 sec. at 700 rpm, then 5 ml of sample was added into a 250 ml test tube, by using a pipette, For each sample: 2 catalyst tablet CM (3.5g K₂SO₄, 0.1g CuSO₄, 5H₂O Missouri); 20 ml concentrated sulphuric acid (96-98%); 5 ml of hydrogen peroxide (~ 30%) was added into test tube. Banks with all chemicals and without sample were prepared. The Digestion Unit was connected to a proper aspiration pump and a fume neutralization system to neutralize the acid fumes created during digestion phase. The samples was digested for 15 minutes at 150 °C, plus 15 minutes at 250 °C and 40 minutes at 420 °C.

Distillation and Titration: the test tubes were cooled down to 50-60°C. The samples were distilled according to the following parameters 50ml H₂O (dilution water); 0.1N H₂SO₄ as titrant solution; 70ml NaOH (32 %); 6.38 Protein factor; 30ml H₃BO₃ (4 % with indicators). Distillation & Titration analysis time was 4 minutes for one test. The percentage nitrogen was calculated according the equation:

$$\%N = \frac{[(\text{ml standard acid} \times N \text{ of acid}) - (\text{ml blank} \times N \text{ of base})] - (\text{ml std base} \times N \text{ of base}) \times 1.4007}{\text{weight of sample in grams}}$$

Where “N” represents normality of acid or base “ml blank” refers to the milliliters of base needed to back titrate a reagent blank if standard acid is the receiving solution, or refers to milliliters of standard acid needed to titrate a reagent blank if boric acid is the receiving solution. When standard acid is used as the receiving solution.

3.5. Determination of Phosphorus Content

2.5l (accurate to 0.1 ml) liquid sample of biorganic liquid fertilizer and compost tea solutions were weighed, and put into a 125mL Erlenmeyer flask. Then, 10mL HNO₃ was added and heated on the electric hot plate. Samples were subjected to acid oxidation to make phosphorus react with vanadium ammonium molybdate and form yellow complex compound in nitric acid solution. After fully reacted, the flask was taken off the electric hot plate and left until it was cooled off. Then after, 10mL HClO₃ was added and the content of the flask was heated back on the electric hot plate. If the solution turns black, it was taken off and 5mL HNO₃ was added and continued heating till the solution turns into colorless or amber and with white smoke. When there was 3-5mL left in the flask, it was cooled off and transferred into a 50mL volumetric flask and meter volume. Spectrophotometer was used to determine the absorbance at the wavelength of 440nm with an aim to quantitatively analyze the content of phosphorus. The blank experiment was carried out at the same time.

The preparation of the standard curve standard was prepared to result in the following final concentrations: 0mL, 2.5mL, 5mL, 7.5mL, 10mL and 15mL will be taken from standard stock solution of phosphorus to a 50mL volumetric flask respectively. Then, 10 mL vanadium-ammonium molybdate reagent and metered to 50mL with water was added. The concentrations of this series were 0_g/mL, 2.5_g/mL, 5_g/mL, 7.5_g/mL, 10_g/mL and 15_g/mL respectively. After coloration at 25-30°C for 15 min, the absorbance at the wavelength of 440 nm was determined using 1cm colorimetric cylinders. The standard curve was plotted with the absorbance as Y-axis and the concentration of phosphorus as X-axis (Appendix fig 1). A blank solution was prepared by pipetting 4.0 mL of the vanadate-molybdate reagent into a 25.0 mL volumetric flask and brought to volume with distilled water. After 10 minutes but no more than 30 minutes, the percent transmittance at 440 nm was measured. A calibration curve (Appendix fig 6) was prepared by plotting absorbance as a function of ppm (mg/ml) phosphate_ phosphorus

$$absorbance = -\log \left(\frac{\%T}{100} \right)$$

The phosphorus concentration of the sample solution is obtained according to the standard curve. The content of phosphorus in the sample is calculated according to formula:

$$X = \frac{C \times V \times V_2}{m \times V_1 \times 1000} \times 100$$

Where X: phosphorus content the sample, mg/100 g; C: the concentration of phosphorus that is obtained from the standard curve, mg/mL; V: the metered volume after the sample elixation, mL; V1: the volume of the sample solution that is taken, mL; V2: the metered volume of the coloration solution, mL; m: the mass of the sample, g.

3.6. Determination of Potassium content

The atomic absorption method was organized in such a way that the same diluted samples could be used for both sodium and potassium analyses, since these elements are often determined were ten times more concentrated than sodium standards. The standards was prepared in water and cesium was added at the concentration of 1000 mg/l. Cesium was also added to the diluted fertilizer solution samples. Easily ionized elements (such as the alkali metals) enhance the absorbance of other alkali metals because of ionization effects, the effects being greater at higher flame temperatures. Apparently, the atoms of another easily ionized element provide additional electrons that cause some of the atoms of the first element to return to the ground state, thus causing an increase in absorbance. For example, this enhancement of the absorbance of sodium metal in the presence of potassium (and vice versa) can be eliminated by the addition of a suitable amount of another alkali metal, such as cesium (Perkin and Elmer Corporation, 1973).

Sample preparation: 50ml of the samples was filtered and transferred in to the beaker and 5 drops of 1M HCl was added. The acidified sample was heated gently (not to evaporation) on hot plate for 7 minutes at 35°C then cooled for 5 minutes and 3 drops of hydrochloric acid was added to dissolve deposited carbonates of metals and heated again for another 5 minutes to confirm the loss of organic constituents in the form of carbon dioxide and cooled for few minutes and ready for analysis. Since organic impurities were almost removed from the sample by heating.

Standard stock solution preparation: stock solution was prepared from analytical reagent grade NaCl and KCl dried in oven at 105°C for 1hour. 1.91 g of KCl was taken into 1000 ml flask and

its volume was made up to the mark with the help of distilled H₂O. In this way a 1000 ppm of potassium solution was prepared. To make 10 ppm potassium solution, 10ml of 1000ppm solution was taken into 100 ml flask and its volume was made up to the mark with the help of distilled water. Similarly, to make 20 ppm potassium solution, 20 ml of 1000 ppm solution was taken into 100 ml flask and its volume up was made up to the mark with the help of distilled water. In the same way, standard solutions of 30 ppm, 50 ppm, 60 ppm and 70 ppm standards were prepared from stock solution.

Preparation of working standards: Five 100ml volumetric flasks were prepared and labeled as 2ppm, 4ppm, 6ppm, 8ppm and 10ppm. The assigned concentrations were prepared by adding 2ml, 4ml, 6ml, 8ml and 10ml of 100ppm stock solution in to 2ppm, 4ppm, 6ppm, 8ppm and 10ppm flasks respectively and filled to the mark. The blank solution was prepared from 2ml of 1MHCl and deionized water. The instrument was then calibrated by aspirating the working solution in the order of blank then standard analyte solution. After the calibration curve (appendix fig 3) is established, and the samples were aspirated into the flame photometry through nebulizer from sample 1 to sample 6. In between each measurement there was aspiration of blank solution to avoid the effect of contamination or error in concentration reading. The concentration of each metal ion is determined selectively at specific wavelength. The maximum wavelength at which Na⁺ determined is 589nm and K⁺ is at 766nm (Table 1).

Table 2. Elements and their emission wavelenghts (nm)

Element	Emission wavelength(nm)	Flame color
Potassium (K)	766	Violet
Sodium(Na)	589	Yellow
Calcium (Ca)	622	Orange

3.7. Determination of Quality of Bioorganic Fertilizer Solution

3.7.1. PH measurement

PH measurement was based on procedure used by Patel and Lakdawala (2014) as follows:

Calibration Standard Preparation: two buffers were selected that bracket the expected sample pH. The first near the electrode isopotential point (pH 7) and the second buffer near the expected sample pH. A pH 7.00 buffer pouch was opened or a graduated cylinder was to transfer 30 mL of pH 7.00 buffer into a 50 mL beaker.

Sample Preparation: 40 mL of the sample liquid bioorganic fertilizer was measured by using a graduated cylinder and added into a 50 mL beaker. The beaker was covered with a watch glass. The electrode was placed in a prepared sample with the electrode tip fully immersed in the solution. The measure key was pressed on the meter. The pH icon was flashed as the measurement was being made. Determination of the quality of bioorganic fertilizer solution based on PH range was based on the standard (Table 2).

Table 3. Rating of bioorganic fertilizer solution based on pH values

Category	Range of pH value	Suggestion for remedy of bioorganic fertilizer solution
Acidic	<6.5	Requires liming for reclamation
Normal	6.5-7.8	Optimum for most crops
Alkaline	7.8-8.5	Requires application of organic manures
Alkali	>8.5	Requires gypsum for amelioration

Source: Patel and Lakdawala (2014).

3.7.2. Electrical Conductivity (EC) Measure

A 2:1 by volume method was used to measure EC based on modified procedure used by Rhoades *et al.*, (1999). Whereby a volume of mix was measured and twice as much water was added. The electrical conductivity (EC) is a measure of the total soluble salts, or the soluble nutrients (or ions) present in a growing media. The determination of electrical conductivity (EC) is made with a conductivity cell by measuring the electrical resistance of a 1:2 solute: water suspension. The determination of EC generally involves the physical measurement of the materials'

Electrical resistance (R), which is expressed in ohms. The reciprocal of resistance is conductance (C). It is expressed in reciprocal ohms, i.e., mhos. When the cell constant is applied, the measured conductance is converted to specific conductance (i.e., the reciprocal of the specific resistance) at the temperature of measurement. Electrical conductivity meter & cell measures fraction of the specific resistance; this fraction is the cell constant ($K = R/R_s$).

Often, and herein, specific conductance is referred to as electrical conductivity, EC:

$$EC = 1 / R_s = K / R.$$

Procedure for conductivity: 0.746 g KCl was dissolved (previously dried at 105 °C for 2 hours) and the volume was made to 1 L with CO₂ free deionised water. This solution has an electrical conductivity of 1.413 dS/m at 25 °C. 50 mL deionised water was added, and mechanically shaken at 15 rpm for 1 hour to dissolve soluble salts. The conductivity meter was calibrated according to the manufacturer's instructions using the KCl reference solution to obtain the cell constant. The cell was rinsed thoroughly. The electrical conductivity of the 0.01M KCl was measured at the same temperature as the soil suspensions. The conductivity cell was rinsed with the sample bioorganic fertilizer suspension. The conductivity cell was refilled without disturbing the settled solute. The value indicated on the conductivity meter was recorded. The cell was rinsed with deionised water between samples. For EC, researchers adopted the term “mho”- “ohm” written backwards. 1dS/m = 1mmho/cm = 1000µmho/cm. Units used for measuring electrical conductivity of water are MicroSiemens per centimeter µS/cm, millisiemens per centimeter (mS/cm) and DeciSiemens per meter dS/m. Determination of the quality of bioorganic fertilizer solution based on EC range was as in Table 3. Electrical conductivity can be converted to estimate total dissolved solids by using the following equation (Detay, 1997):

$$TDS(ppm) = 0.64 \times EC(\mu S/cm) = 6.4 \times ECmS/cm = 640 \times EC(dS/m).$$

Table 4. Rating of bioorganic fertilizer solution based on electrical conductivity .

Range of EC	Rate of bioorganic fertilizer solution
< 0.8 ds/m	Normal
0.8-1.6 ds/m	Critical for salt sensitive crops
1.6-2.5ds/m	Critical to salt tolerant crops

Source: Patel and Lakdawala (2014).

3.8. Pot experiment for testing bioorganic fertilizer solution

The fertilizer solution was tested by growing lettuce in pot. The experimental design was complete randomized design (CRD) in two replications. Soil samples were taken randomly from Rare field and placed in pots. Four Ethiopian mustard seeds were planted in each pot. In the experimental pots half liter of bioorganic fertilizer was added during planting. However, in the control group no nutrient was applied only 500ml of water was added to each pot during planting. Then both experimental and control groups were irrigated with water as it was needed so as to prevent moisture stress. Thereafter 3 to 4 leaf stage half liter of fertilizer solution was added to experimental group. That is totally one liter of fertilizer solution was used.

3.9. Data analysis

Quantitative data were analyzed by using quantitative method such as frequency, percentage and mean and standard deviation using Microsoft office excel and SAS software (Version 9.2).

4. RESULT AND DISCUSSION

4.1. Production of Bioorganic liquid fertilizer through aerobic fermentation in Open container

Sample bioorganic liquid fertilizer solution produced from mixture of camel manure and onion peels as indicated in Fig 1. 6gm of camel manure and chopped onion peels were co-fermented in open container covered with cotton cloth (so as to prevent entry of insects) for 45 days at ambient temperature. It was found that 4 liters of bioorganic liquid fertilizer solution were produced from 6 grams of co-fermented substrates. This finding was in accordance with PCT (2013) who recommended aerobic fermentation of organic wastes as an efficient process of bioorganic solution fertilizer production. The rising prices of fertilizer in market looking for an idea to force someone else to meet the needs of the crops they planted (Food Waste to Energy and Fertilizer, 2010). If chemical fertilizer continuously used, it could kill microorganism in the soil and causing the soil to become infertile (Mason *et al.*, 2011). Utilization of organic food waste as a liquid fertilizer is expected to solve these problems and can help increasing the economy by farmers and housewives in the village of bate (Unnisa, 2015).

4.2. Determination of Plant Macronutrient Composition of bioorganic Liquid fertilizer solution

Macronutrient composition of bioorganic fertilizer and compost tea solutions was shown in Table 5. Potassium (K), Calcium (Ca) and also sodium (Na) were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. However, there were no significance differences with respect to Carbon(C), Nitrogen (N), phosphorus and Magnesium (Mg) contents of the solutions. It also indicated that percentage macronutrient compositions of bioorganic fertilizer solution was found to be greater than those of compost tea solution in all studied macronutrients. This finding was in accordance with Monisha and Rameshaiah (2016) who produced liquid fertilizer from vegetable waste.

The impact of natural organic matter on fertilizer properties and consequently on plant development is far more noteworthy despite the fact that the rate of natural organic matter (OM) is less in the dirt (Kalpana *et al.*, 2011). Nitrogen is the essential supplement and makes up 1-4% of dry weight of plants and it frames chlorophyll, amino acids, proteins, alkaloids and

protoplasm. Since the measure of chlorophyll in the plant decides the sugar combination, nitrogen, as it were, might be said to control this movement. At the point when there is less uptake of nitrogen, the leaves stay little and light yellow in shading (Basu, 2011).

Table 5. Macronutrient composition of bioorganic fertilizer solution and compost tea

Treatment	P	K	Ca	Mg	Na
Compost tea	1.19±0.03a	2.50±0.19b	2.15±0.20b	1.27±0.01a	1.27±0.24b
Bioorganic	1.43±0.26a	4.00±0.46a	4.43±0.62a	2.58±0.61a	3.81±0.06a

Means followed by same letter within a column were not significantly different at 0.05. Probability level based on DMRT (Duncan's Multiple Range Test).

Phosphorus is a pre imperative for microbial development in the watery bodies. The expanded convergence of phosphate is the key element for the eutrophication of surface water. Substantial algal development happens when phosphate is available in water and thus it is undesirable. Subsequently the determination of phosphorus is vital to water examiner and limnologist. Substantial amounts of phosphate have been utilized as a part of cleansers, composts and sugar industries (Hugh, 2010).

4.3. Determination of the quality of Bioorganic liquid fertilizer

The quality of biorganic liquid fertilizer solution produced in the present study was measured with respect to PH, EC and C:N ratio as in Table 6. It was indicated that both compost tea and bioorganic liquid fertilizer solutions fulfill the basic requirements of plant macronutrients (Table 6) with respect to electrical conductivity and C:N ratio. However the PH needs adjustment to the neutral range between 6.0 to 8.0 which is optimum for most crop plants. The mineral composition of bioorganic liquid fertilizer solution and compost tea solutions (Table 1) was compared with the standard for major macronutrients requirement of plants. It was found that the composition of both fertilizer solutions in the present study satisfies the standard with bioorganic liquid fertilizer being higher in mean values for all of the studied parameters. The bioorganic fertilizer produced in the present study fulfills those minimum requirements. However, further evaluation of fertilizer should have to be done by conducting field experiments for various crop plants. Since fertilizer requirement depends on nature of the soil, crop plant types and other

environmental factors. The present fertilizer was produced as 4L per 6 grams of substrate (4L/6gms). Further dilution can be conducted depending on the economy of the user and performance evaluation.

Table 6. Quality of liquid fertilizer solution

Treatment	PH	EC	C	N	CN
Compost tea	7.85±0.35a	0.58±0.02b	25.49±0.91a	3.57±0.45a	7.22±1.16b
Bioorganic	6.02±0.68a	0.81±0.04a	39.23±1.52a	3.11±0.35a	12.69±0.93a

Means followed by same letter within a column were not significantly different at 0.05. Probability level based on DMRT (Duncan's Multiple Range Test). PH: power of hydrogen; EC: electrical conductivity; C:N: carbon to nitrogen ratio.

Potassium is essential in deciding the osmotic weight of plant liquids, and K⁺ insufficient plants are described by wasteful water use. Plant development is influenced, and the more established leaves show lack manifestations as rot starting at the edges of tips and leaves. The most terrific capacity of magnesium is its fundamental part in the chlorophyll particle (Mark *et al.*, 2007). Thus, it is essential to calculate the available potassium present in soil. Calcium and magnesium has magnificent physical conditions. It grows through uprightness of the flocculation and collection of essential particles which permit free development of water without stagnation and contains adequate air for the best possible air circulation of plant roots. Such dirt is very gainful which supplies fundamental plant supplements (Laboratory Testing Procedure for Soil & Water Sample Analysis, 2009).

The carbon content of fertilizer solution in the present study, was found to be 53.85% (Table 6). The determination of natural carbon in composts serves in an indirect way as measure of accessible nitrogen. In most of the fertilizer cases the minimum carbon content or organic matter was found to be approximately 6-7% (Monisha and Rameshaiah, 2016).

Sulfur is a fundamental supplement for plant development. In recent years, sulfur deficiencies have turned out to be more frequent and the significance of sulfur in yield generation is turning out to be increasingly perceived (Nagornyy, 2013). Boron is a fundamental supplement for

development and improvement of solid plants. Boron compounds are utilized as a part of little fixations as micronutrients in manures. At the point when utilized as a part of extensive fixations they work as herbicides, algaecides and different pesticides (Motsara and Roy, 2008). Manganese (Mn) is a critical plant micronutrient and is required by plants in the second most noteworthy amount contrasted with iron. Like whatever other component, it can have a restricting variable on plant development on the off chance that it is lacking or lethal in plant tissue (Testing Methods for Fertilizers, 2013).

4.4. Testing the bioorganic liquid fertilizer through pot experiment

The bioorganic liquid fertilizer produced was evaluated by growing Ethiopian lettuce in pot experiment in two replications. It was indicated in Table 6 that the performance of lettuce irrigated with bioorganic fertilizer solution was better than of these compost tea solution and soil grown plants. However, there was no significance difference for number of leaves per plant (NLP). For hydroponic growth of lettuce on sawdust (as inert material), significance difference between compost tea and bioorganic fertilizer solutions was also observed for BMW, HWP and DM. No significance difference with respect to NLP. In contrast, Similar study was conducted by Unnisa (2015) who conducted pot culture experiments in triplicate to test the toxicity of the organic liquid fertilizer for seed germination. Liquid fertilizer has many advantages because of easy process, inexpensive and no side effects. The resulting benefits are very likely to fertilize crops, to maintain the stability of nutrient elements in the soil and reducing the bad impacts of chemical fertilizers. In addition to a liquid fertilizer that can be sold in the market, liquid fertilizer can be used for agriculture purpose or in the premises for plantation.

Table 7. Performance of lettuce in greenhouse

Medium	Treatment	BMW	NLP	HWP	DM
Soil	Compost	56.92±2.41a	6.50±0.71a	28.00±1.84b	94.00±2.84a
	Bioorganic	62.71±3.41a	8.50±0.71a	46.25±1.20a	77.50±3.54b
SW	Compost	69.45±1.17b	7.00±1.41a	34.40±1.56b	86.50±2.12a
	Biorganic	92.77±3.49a	10.00±1.41a	76.40±1.56a	54.00±1.41b

Means followed by same letter within a column were not significantly different at 0.05. Probability level based on DMRT (Duncan's Multiple Range Test). BWP: biomass weight per plant (gm); NLP: number of leaves per plant; DM: days to maturity; HWP: head weight per plant.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary and Conclusions

The present study has produced bioorganic liquid fertilizer solution from oil cake and banana peels through aerobic fermentation in open containers. The result indicated that Potassium (K), Calcium (Ca) and also sodium (Na) were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. However, there were no significance differences with respect to Carbon(C), Nitrogen (N),phosphorus(P) and Magnesium (Mg) contents of the solutions.

Both compost tea and bioorganic liquid fertilizer solutions fulfills the basic requirements of plant macronutrients with respect to electrical conductivity and C:N ratio as a quality standard for organic fertilizers.

Comparison of mineral composition of bioorganic liquid fertilizer and compost tea solutions with the standard for major macronutrients requirement of plants indicated that the composition of both fertilizer solutions in the present study satisfies the standard with bioorganic liquid fertilizer being higher in mean values for most of the studied mineral plant nutrients. however the Ph of both solutions need amelioration.

It can be concluded from the present study that bioorganic liquid fertilizer can be produced from locally available substrates. Small holder farmers can get economic relief, because by using this technology, they can minimize the use of chemical fertilizer which is being expensive and not environmentally friendly.

5.2. Recommendations

- The commercially available chemical fertilizer supplies not only limited number of macronutrients but also expensive. Thus, the present study has produced quality organic fertilizers from locally available substrates having diverse composition of minerals. Small holder farmers can easily produce it locally and use it so as to reduce dependence on chemical fertilizers and their devastating effect on the environment. However, further studies are required to optimize fermentation durations and conditions.

- The present study has checked the quality of the fertilizer by its mineral composition and pot experiment by pH, EC, C and N content as well as by C:N ratio. Further studies are required to conduct field evaluation of the fertilizer solution and its impact on the quality of the nutrients.
- The bioorganic fertilizer solution produced in the present study will be helpful for hydroponic farming. Thus, studies are required to evaluate the fertilizer solution in hydroponic experiment.
- Further studies are also required to conduct cost and benefit analysis (economic study) fertilizer solution.

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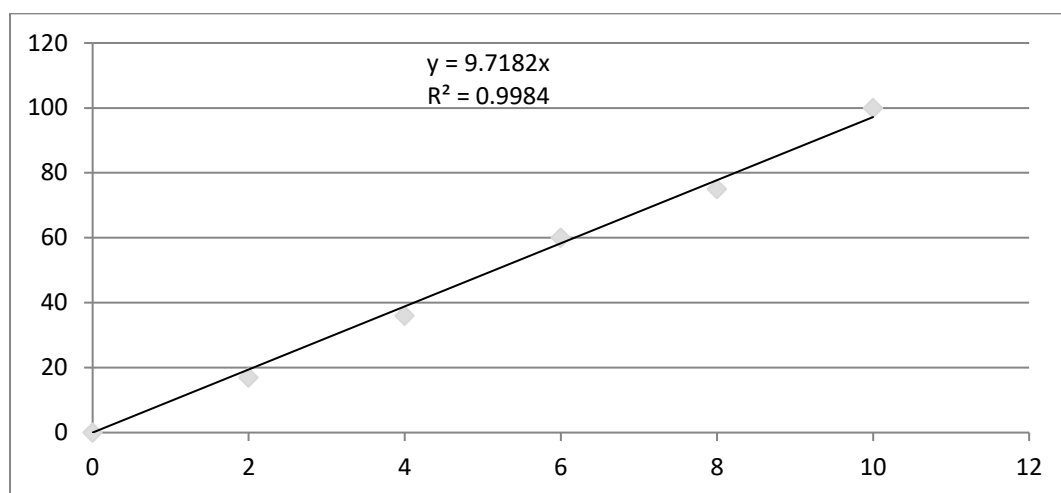
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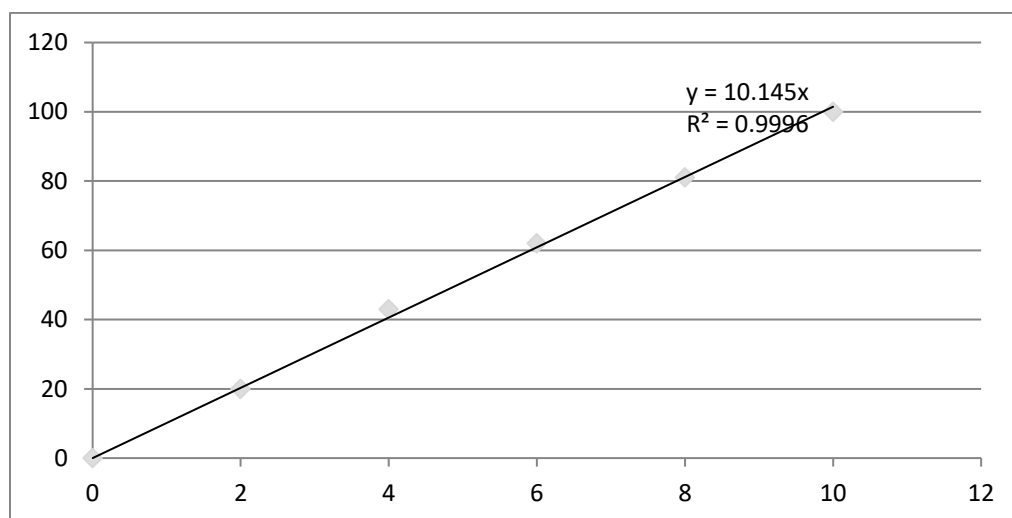
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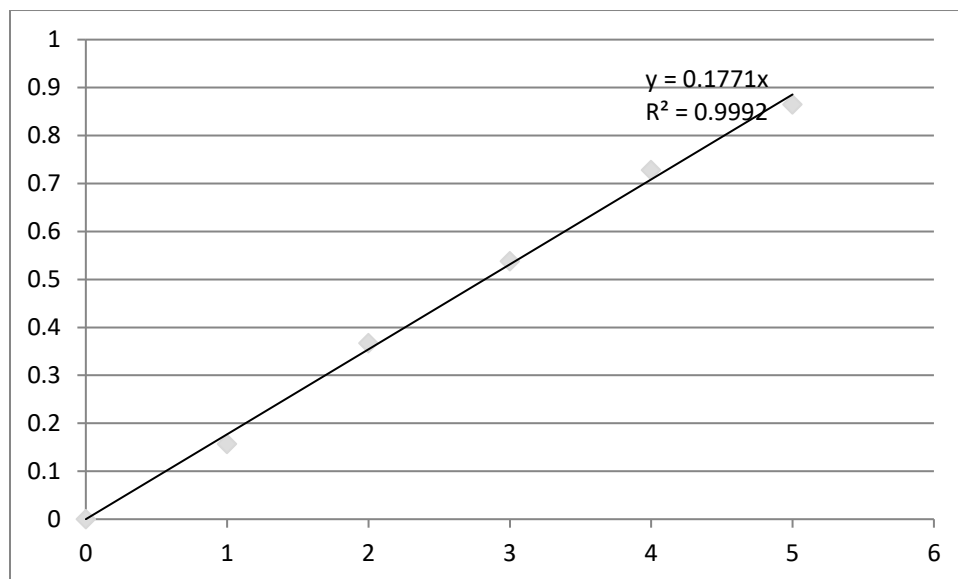
7. APPENDICES



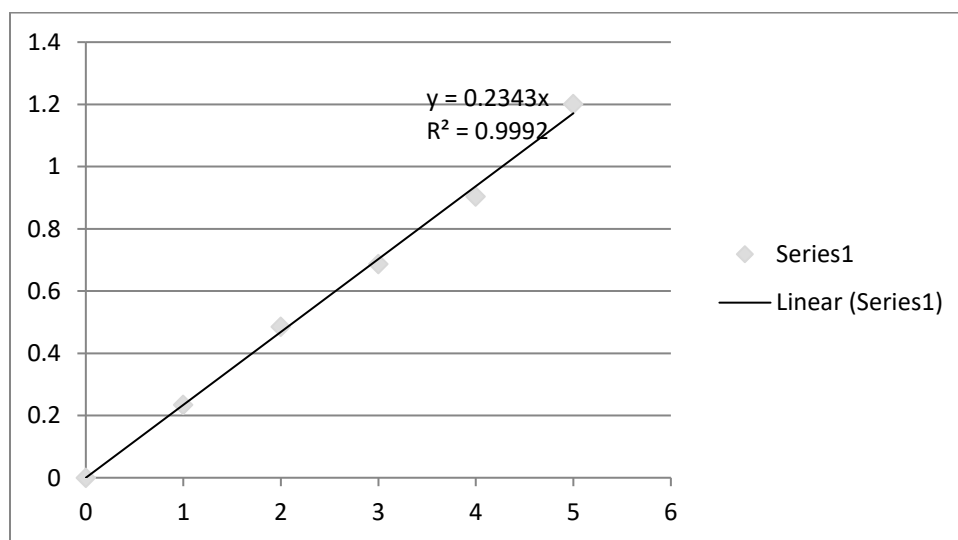
Appendix Figure 1. Standard curve for determination of potassium(K)



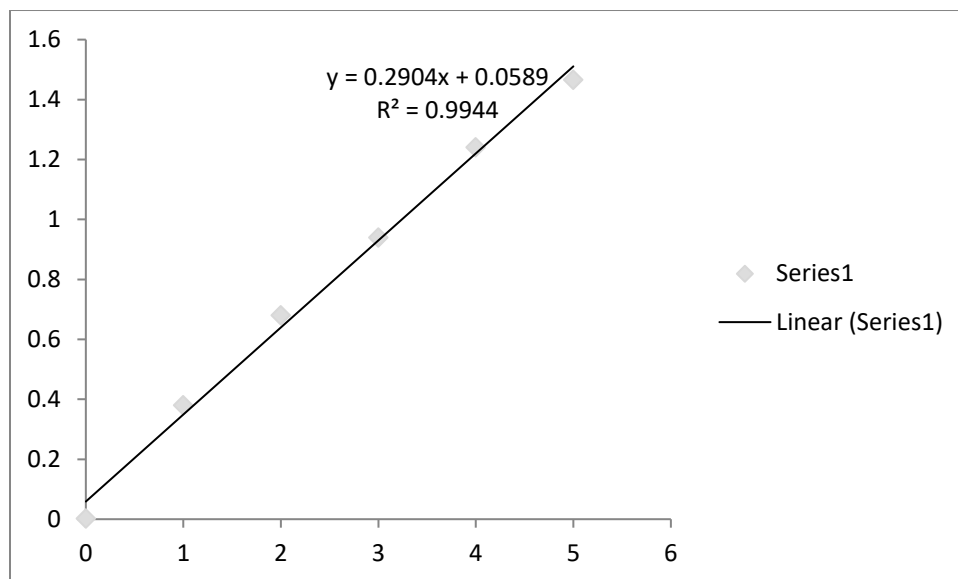
Appendix Figure 2. Standard curve for determination of sodium (Na)



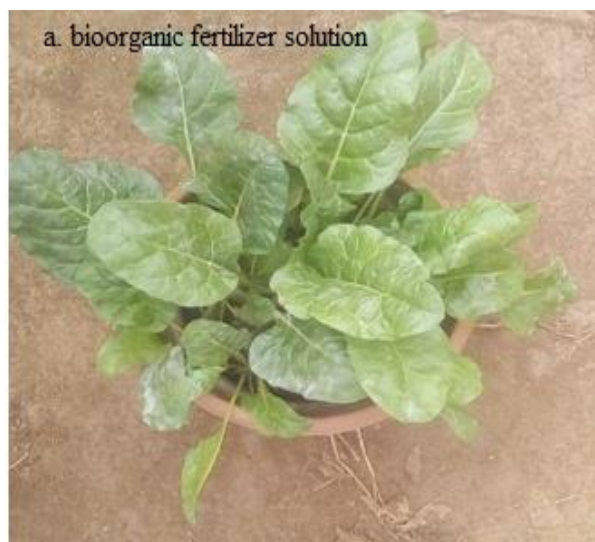
Appendix Figure 3. Standard curve for determination of Magnesium (Mg)



Appendix Figure 4. Standard curve for determination of Calcium (Ca)



Appendix Figure 5. Standard curve for determination of (P)



Appendix figure 6. Growth of lettuce on soil treated with (a) bioorganic fertilizer; (b) compost tea



Appendix Figure 7. Hydroponic growth of lettuce using bioorganic fertilizer on (a) soil; (b) sawdust