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Assessment of Brewery Waste Water Treatment Plant Sludge and prepare Organic Fertilizer by aerobic composting

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Declaration

We declare that this project report is submitted by us under the guidance of our mentor Mr. Mequanint. We assure that the report contains actual facts and events that we observed during assessment. We certified that this project final report and the proposal are our ordinal effort and to assure with our signature.

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Abstract

The main objective of the present study is to test the potential of the organic fertilizer which prepared from brewery waste water treatment sludge with bulking agent (i.e. Kieselguhr and banana peel) through composting in different ratio for 21 days. In compost unit nutrient balance, moisture content and aeration was adjusted to create suitable environment for microbes. Kijhald method and UV-Vis spectrophotometer was used to determine total nitrogen and total phosphorus respectively. The results showed the total nitrogen and total Phosphorus concentration, all nine Treatments, were best value as compare as organic fertilizer standard value. Among from the nine treatments, Treatment 4 (90% sludge and 10% Kieselguhr) was best and selected based on pH, Total-N, Total-P, Total-C, OM, Water retention capacity and it was free from pathogen load.

Therefore, the analysis of this compost revealed that it contained (Total N=3.85%, PH=6.80, Organic matter=56.68%, Water retention capacity=56.66% and Total P = 8.8%).The percentage of Organic Carbon of the organic fertilizer was 31.48%. And addition improved the organic carbon content of the soil significantly and the higher water retention capacity is linked to high organic matter and other nutrients.

Key words: - Sludge, Compost. Kieselguhr, Organic fertilizer

Acronyms

BOD…………………..Biochemical Oxygen Demand

BWS…………………..Brewery Waste Sludge

BWWS………………..Brewery Waste Water Sludge

C………………………Carbon

C/N……………………Carbon to Nitrogen ratio

COD…………………..Chemical Oxygen Demand

EPA………………….. Environmental Protection Agency

K………………………potassium

N………………………Nitrogen

OM……………………Organic Matter

P……………………….Phosphors

T-C…………………….Total carbon

T-N……………………Total nitrogen

T-P…………………….Total phosphorus

Treatment 1……………97 percent of Sludge to 3 percent Banana peels

Treatment 2……………94 percent of Sludge to 6 percent Banana peels

Treatment 3……………91 percent of Sludge to 9 percent Banana peels

Treatment 4……………90 percent of Sludge to 10 percent Kieselguhr

Treatment 5…………....80 percent of Sludge to 20 percent Kieselguhr

Treatment 6……………70 percent of Sludge to 30 percent Kieselguhr

Treatment 7……………50 percent of Sludge to 50 percent Kieselguhr

Treatment 8……………100 percent of Sludge

Treatment 9……………100 percent of Kieselguhr

WRC…………………..Water retention capacity

Synonyms

Treatment 1…………….Bucket 1

Treatment 2…………….Bucket 2

Treatment 3…………… Bucket 3

Treatment 4…………… Bucket 4

Treatment 5………….... Bucket 5

Treatment 6…………… Bucket 6

Treatment 7…………… Bucket 7

Treatment 8…………… Bucket 8

Treatment 9…………….Bucket 9

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Chapter One

1. Introduction

Wastewater generated from industrial activities such as breweries is the main threat to the surface and ground water qualities. The brewing industry is one of the largest industrial users of water. Even though substantial technological improvements have been made in the past, it has been documented that approximately 3 to 10 liters of waste effluent is generated per liter of beer produced in breweries [1].Beer Brewery is among the industries known for production of by-products (spent grains, spent yeast) and sludge from the waste water treatment plant at different stages of the manufacturing process [2].

The main brewery effluent sources include losses during bottle filling, cleaning (of returned bottles, fermentation and conditioning tank, vat and floors) and draining out tank bottoms[4].Untreated brewery effluents typically contain suspended solids (200-1000 mg/l), biochemical oxygen demand (BOD) (1,200–3,600 mg/l), chemical oxygen demand (COD) (2,000 – 6,000 mg/l),nitrogen (N) (25 – 80 mg/l), phosphorus (P) (10 – 50 mg/l), temperature in the range of 18-40^{0}C and pH value in between 3-12 [4].

Brewery waste water sludge is the sludge generated in brewing industry with high organic loading in terms of COD and BOD. Chemical analysis on brewery sludge revealed that it has high N, P, K, volatile fatty acids and nutrients which are important requirement for plant growth [5]. It also consists of various important organisms like heterotrophic fungi and actinomycetes [6]. The fertility of the soil can be improved because of the presence of these minerals and organisms [7]. Almost in Ethiopia the brewery waste water sludge deposited by landfill or used as organic fertilizer directly applied on the soil. It may pose potential risks to both environmental and public health from the accumulation of heavy metals and organic compounds as well as pathogen contamination [8].

Aerobic composting is a widely used technique with low operating and investment costs [9].

Raya Brewery located in Maychew, Ethiopia, to selected for the present study. The industry is manufacturing beer using barley, water and yeast as raw material.

1.1. Statement of the problem

Brewery wastewater sludge is improperly managed to discharge it as landfill or used as organic fertilizer directly applied on the soil. It may pose potential risks to both environment and public health from the accumulation of heavy metals and organic compounds as well as pathogen contamination. It brings about a rapid deterioration of the physical, chemical and biological qualities of the receiving water bodies. The decomposition of the organic matter depletes the dissolved oxygen in the water that is vital for aquatic life. And the turbidity and the color reduce the penetration of light which affects photosynthesis in the food chain. In order to minimize the environmental problems associated with nutrient in wastewater it is imperative to find ways and means of decreasing it before discharging that severely affects the ecosystem. This brewery sludge in its nature endowed by organic contents sourced from brewing process and most chemicals used in these industries are food graded.

Therefore, the focus of this project is to study potential assessment of brewery wastewater sludge as to be used organic fertilizer.

1.2. Objective

1.2.1. General objective

Assessment of Brewery Wastewater Treatment plant Sludge and Prepare of organic fertilizer by aerobic composting.

1.2.2. Specific objective

- To characterize brewery sludge waste effluents.
- To determine the pathogenic load of compost.
- To characterize composted products.

1.3. Significant of the project

To show the production of compost fertilizer from brewery waste water sludge in our country Ethiopia. By composting of the organic sludge of brewery, it is possible to reduce emissions, leachates, Improve water holding capacity of soil and also to produce valuable products for soil amendments. The study will describe the potential value of brewery waste water sludge as an organic fertilizer. Since the physico-chemical nature of the sludge is unknown and the utilization of sludge will depend upon familiarity with the properties and characteristics, it also briefly discusses the composition of the sludge to identify potential scenarios for a more sustainable composting mechanism. And to substitute the imported chemical fertilizer by local produced compost fertilizer. It would be a boon to small and medium farmers who tend to borrow heavily for costly fertilizers.

Chapter Two

2. Literature review

Brewery waste sludge is the sludge generated in brewing industry with high organic loading in terms of COD and BOD. The malting and brewing industries use large volumes of water and 70% of the intake is discharged as effluent. Chemical analysis on brewery sludge revealed that it has high N, P, K, volatile fatty acids. It also consists of various important organisms like heterotrophic fungi and actinomycetes. The effluents discharged are found to have high organic and acidic content, which increases the BOD, COD and high organic load in the waste water contributive to dissolved carbohydrates, alcohols, suspended solids, yeast etc., which pollutes the water bodies considerably [10].

Compost supplies calcium, magnesium, sulphur and micronutrients and have a neutralizing value for the soil. The quality parameters that characterize the usefulness of compost in agricultural applications include organic matter content; nutrient content (N, P, K, Mg, and Ca), dry matter, particle size, bulk density and pH are the factors to be studied. Compost is considered a multifunctional soil improver. It is used in agriculture and horticulture as well as to produce topsoil for land restoration [11].

The C: N ration should be between 25:1 and 35:1 for most compost organisms to thrive and have a high degree of efficiency of N assimilation into microbial biomass. When the C/N ratio is too low, N is lost through ammonia volatilization. A C/N ratio greater than 40:1 promotes immobilization of plant-available nitrogen and slows the decomposition process because of limited. The optimum moisture content for compost is between 50% and 70% [12].

2.1. Plant nutrients

NPK fertilizer provides the nutrition needed for optimal plant growth. Plants could not survive without one of these essential nutrients.

2.1.1. Nitrogen

Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. In plants nitrogen is a part of chlorophyll (the green pigment) that is responsible for photosynthesis. Most of the nitrogen taken up by plants is from the soil in the forms of $NO3^-$. Nitrogen deficiency most often results in stunted growth, slow growth, and chlorosis. Because nitrogen is mobile, the older leaves exhibit chlorosis and necrosis earlier than the younger leaves. Soluble forms of nitrogen are transported as amines and amides. Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops. Nitrogen often comes from fertilizer application and from the air (legumes get their N from the atmosphere, water or rainfall contributes very little nitrogen) [3].

2.1.2. Phosphorus

Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis. It is important in plant bioenergetics. As a component of ATP, phosphorus is needed for the conversion of light energy to chemical energy (ATP) during photosynthesis. Phosphorus can also be used to modify the activity of various enzymes by phosphorylation, and can be used for cell signaling. Since ATP can be used for the biosynthesis of many plant biomolecules, phosphorus is important for plant growth and flower or seed formation.

A Phosphorus deficiency in plants is characterized by an intense green coloration in leaves. If the plant is experiencing high phosphorus deficiencies the leaves may become denatured and show signs of necrosis. High phosphorus content fertilizers, such as bone meal, are useful to apply to perennials to help with successful root formation [3].

2.1.3. Potassium

Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium. It helps in the building of protein, photosynthesis, fruit quality and reduction of diseases. Potassium regulates the opening and closing of the stomata by a potassium ion pump. Since stomata are important in water regulation, potassium reduces water loss from the leaves and increases drought tolerance.

Potassium deficiency may cause necrosis or intervene chlorosis. $K+$ is highly mobile and can aid in balancing the anion charges within the plant.

Potassium is used to build cellulose and an aid in photosynthesis by the formation of a chlorophyll precursor. Potassium is supplied to plants by soil minerals, organic materials, and fertilizer. Potassium deficiency may result in higher risk of pathogens, wilting, chlorosis, brown spotting, and higher chances of damage from frost and heat [3].

2.1.4. Organic matter/carbon content

The addition of organic matter also has been shown to increase ion exchange and buffering capacity and neutralize the soil PH. Soil organic matter can retain cations because of its negative charged sites. This is especially important where nutrient leaching, through rainfall or irrigation, is a problem. Poor soils also may have a low pH, which can be detrimental to plant growth, especially to plants sensitive to acidic conditions. The incorporation of organic matter can neutralize soil acidity and provide a buffer against drastic changes. Organic matter addition affects the diverse and important biological activities of soils. The incorporation of organic materials provides soil organisms with a new energy source that result in the increased diversity and activities of soil microbes. The effects of organic matter on soil microorganisms vary depending on soil type, source of organic matter, and decomposition status, but the populations of most soil organisms increase [18].

2.2. Composting process

Composting is a viable process of treating solid waste for beneficial use and destroying pathogens, diseases and undesirable weed seed. By properly managing air, moisture and nutrients, the composting process can transform large quantities of organic material into compost in a relatively short time.

During composting, the microorganisms consume oxygen while feeding on organic matter. Active composting generates a considerable amount of heat, and large quantities of carbon dioxide and water vapor are released into the air.

The carbon dioxide and water losses can amount to half the weight of the initial organic materials, so composting reduces both the volume and mass of the raw materials while transforming them into beneficial humus like material.

Composting is most efficient when the major parameters oxygen, nitrogen, carbon, moisture and temperature which affect the composting process are properly managed. Of the organic materials are rapidly metabolized. The need for oxygen and the production of heat are greatest during the early stages and then decrease as the process continues. If the supply of oxygen is limited, the composting process slows and the process becomes anaerobic (without oxygen). A minimum oxygen concentration of 5% within the pore spaces of the composting material is recommended for a well-managed compost facility (air contains about 21% oxygen) [14].

2.2.1. Aerobic compost

The aerobic composting process starts with the formation of the pile. In many cases, the temperature rises rapidly to 70–80 °C within the first couple of days. First, mesophilic organisms (Optimum growth temperature range 20–45 °C) multiply rapidly on the readily available sugars and amino acids. They generate heat by their own metabolism and raise the temperature to a point where their own activities become suppressed. Then a few thermophilic fungi and several thermophilic bacteria (optimum growth temperature range 50–70 °C or more) continue the process, raising the temperature of the material to 65 °C or higher. This peak heating phase is important for the quality of the compost as the heat kills pathogens and weed seeds.

The active composting stage is followed by a curing stage, and the pile temperature decreases gradually. The start of this phase is identified when turning no longer reheats the pile. At this Stage, another group of thermophilic fungi starts to grow. These fungi bring about a major phase of decomposition of plant cell-wall materials such as cellulose and hemi-cellulose. Curing of the compost provides a safety net against the risks of using immature compost such as nitrogen (N) hunger, O deficiency , and toxic effects of organic acids on plants [14].

2.3. Factors affecting rate of compost production

2.3.1. Moisture

Optimum moisture content is essential for the microbial degradation of organic wastes. Aerobic decomposition can proceed at moisture content between 30 and 100 percent if aeration can be provided. Initially the moisture content may be between 45 and 75 percent with 50 to 65 percent as optimum [14].

2.3.2. Plant nutrients

Micro-organisms require C, N, phosphorus (P) and potassium (K) as the primary nutrients. Of particular importance is the C:N ratio of raw materials. The optimal C:N ratio of raw materials is between 25:1 and 30:1 although ratios between 20:1 and 40:1 are also acceptable. Where the ratio is higher than 40:1, the growth of micro-organisms is limited, resulting in a longer composting time. A C:N ratio of less than 20:1 leads to underutilization of N and the excess may be lost to the atmosphere as ammonia or nitrous oxide, and odour can be a problem. The C:N ratio of the final product should be between about 10:1 and 15:1 [16].

2.3.3. Temperatures

The process of composting involves two temperature ranges: mesophilic and thermophilic. While the ideal temperature for the initial composting stage is 20–45 °C, at subsequent stages with the thermophilic organisms taking over, a temperature range of 50–70 °C may be ideal. High temperatures characterize the aerobic composting process and serve as signs of vigorous microbial activities. Pathogens are normally destroyed at 55 °C and above, while the critical point for elimination of weed seeds is 62 °C. Turnings and aeration can be used to regulate temperature [16].

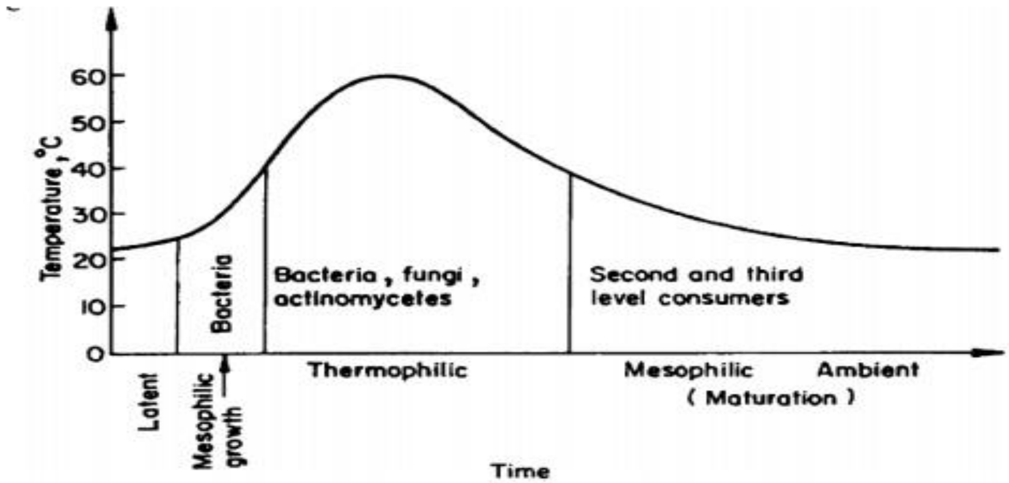

Figure 2. 2 composting process [15]

2.3.4. PH

The pH of compostable material influences the type of organisms involved in the composting process. The optimum pH range for most bacteria is between 6.0 and 7.5. The optimum levels for composting are between 6.0 and 8.0 and between 4.0 and 7.4 for the end product [14].

2.4. Bulking agent

It is an organic matter that contain plant nutrient in order to facilitate or initiation for composting process and it has the source of nutrient like NPK for plant growth.

2.4.1. Kieselguhr

Diatomaceous earth also known as D.E., diatomite, or kieselgur/Kieselguhr, is a naturally occurring, soft, siliceous sedimentary rock that is easily crumbled into a fine white to off-white powder. It has a particle size ranging from less than 3 micrometers to more than 1 millimeter, but typically 10 to 200 micrometers. Depending on the granularity, this powder can have an abrasive feel, similar to pumice powder, and has a low density as a result of its high porosity. The typical chemical composition of oven-dried diatomaceous earth is 80 to 90% silica, with 2 to 4% alumina (attributed mostly to clay minerals) and 0.5 to 2% iron oxide. Kieselguhr is contain silica oxide by nature it used excavate or adsorb heavy metal from composting material [19].

2.4.2. Banana peel

Dried banana peels are 42 percent potassium, more than most other organic substances, such as manure at 0.5 percent, wood ash at 10 percent and cantaloupe rinds at 12 percent. Potassium promotes the movement of water and nutrients between cells. It also strengthens stems and protects plants from disease. Because the plant is healthier, it might flower more. After the plant blooms, potassium can improve the quality and size of any fruit or nuts [20].

Banana peels are 3.25 percent phosphorus, one of the other major nutrients that plants need to grow. Phosphorus helps rooting, improves winter hardiness and speeds up flowering and fruiting. Banana peels inserted in the soil near the roots are an effective way to get phosphorus to your plants, because the peels break down quickly in the soil. This immediacy is helpful, because phosphorus is not mobile in the soil [20].

One of the benefits of fertilizing with banana peels is that they break down quickly either in the soil or in compost making those nutrients available to plants sooner than nutrients from other organic materials [20].

2.5. Analysis of physico-chemical properties of the brewery waste sludge

Table 2. 1 Analysis of physico-chemical properties of the BWS [21, 22, 25]

Parameters	Brewery waste effluents		
	Volume16 Issue 2, (Apr.2015) [25]	K. Kanagachandranet al.,(2006) [22]	E.KalatziGR-26504 [21]
Total nitrogen (%)	0.34	4.5	1
Total carbon (%)	----	27.1	10
Total organic matter (%)	----	48.8	18
Total phosphorus (%)	0.44	3.3	1
C:N ratio (%)	---	6.0	10
Moisture (%)	---	10.7	60
pH	8.2	6.97	6.5
Bacterial count (cfu/g)	$0.2 \pm 5.0 \times 10^{10}$		

2.6. Analysis of physico-chemical properties of compost BWS

Table 2. 2 Analysis of physico-chemical properties of the composted BWS [21, 22]

Parameters	Composted BWS	
	K.Kanagachandran et al.,(2006) [22]	E.KalatziGR-26504 [21]
Total nitrogen (%)	1.1	<1
Total carbon (%)	9.8	<15
Total organic matter (%)	17.7	27
Total phosphorus (%)	0.6	1
C:N ratio (%)	8.9	<15
Moisture (%)	13.2	65
pH	8.6	6.6

2.7. Microbiological Analysis for Sludge Sample

The sludge sample was analyzed for the presence of pathogenic microorganisms. The detected microbes were quantified and compared with the EPA standard.

In order to count the living microbes in organic fertilizer product by different methods, it is required that dilution of the organic fertilizer is carried out to a level where the microbes can be counted correctly and accurately as specified by each methodology and the organic fertilizer sample must be distributed thoroughly and homogeneously in the diluents as much as possible. The quantity of organic fertilizer sample to be used for each analysis depends on the homogeneous characteristic of the sample used. In general, the sample should not be less than 10 g [17].

Chapter Three

3. Materials and Methods

3.1. Materials

3.1.1. Equipment

Mass balance(To measure mass of sample), Digital PH meter(To measure PH), Stove and Furnace (Used to heating and burning), Flask ,Test tubes and beakers (used to for collecting chemicals or sample), Magnetic Stirrer(To stirred or mixing the sample), Thermometer(To measure temperature), plastic buckets(To put sample in it), Perforated baseplate (To supply oxygen), Digestion flask and Distillation flask (Determine total nitrogen), Plastic bin(To collect dewater sample and burying), filter paper(To filter aide),Methyl and Clayton indicator(for indicators),Pipette (used to drop solution for titration),Autoclave (LS-B150L) (used to protect samples from external contamination), Petri-dishes (used to growth microorganism),Colony Counter (SC6) (used to count microorganism load), UV-Vis (used to determine total phosphorus).

3.1.2. Chemicals

Tap water (to moisturize), Dewatered brewery sludge, HCl (To prepare solution for nitrogen determination), Conc. H_2SO_4 (To determine total nitrogen and phosphorus), NaOH (N titration purpose), Maximum recovery diluents (used to sample dilution), distilled water and Plate Count Agar were used to prepare the media.

3.2. Methods

3.2.1. Sample collection

Brewery wastewater sludge and Kieselguhr was brought from Raya brewery Share Company and Banana peels was collected from Bahir Dar city.

3.2.2. Sample preparation

After sample collection the sample were sieved through a 1.8mm sieve, Then the sample were stored in a sample bottle for the next process.

3.2.3. Experimental Setup

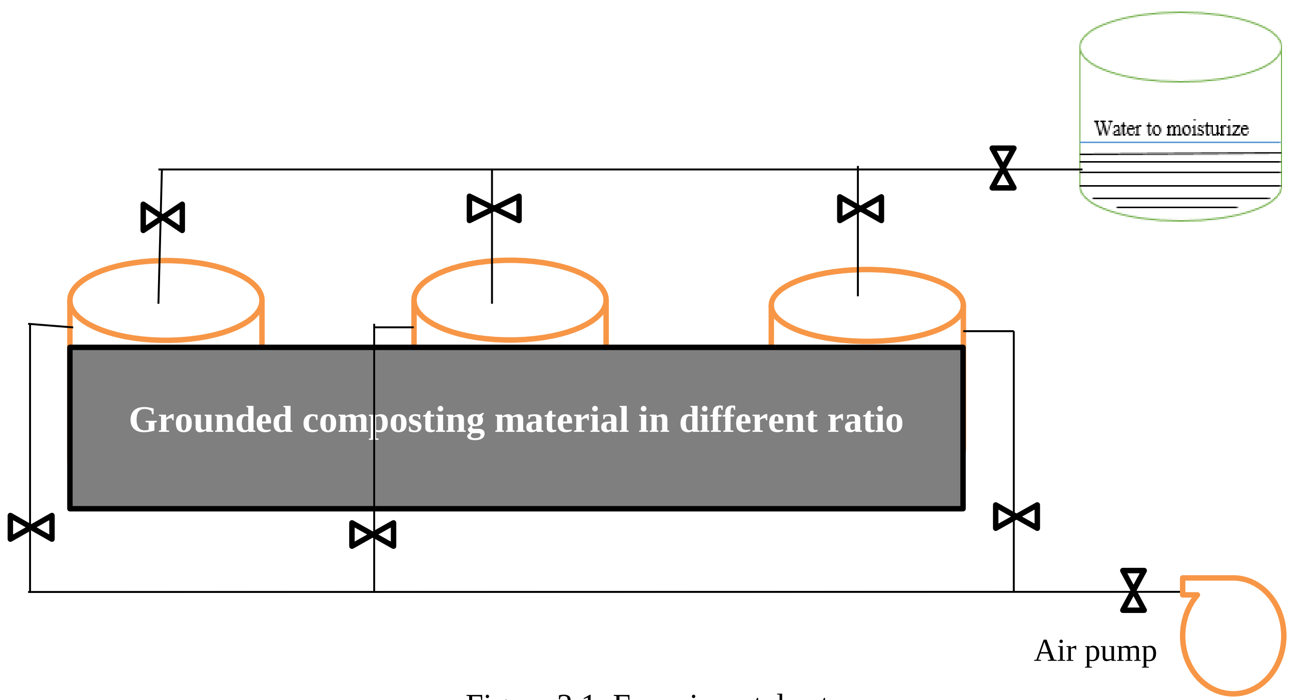

Figure 3.1. Experimental setup

Nine different plastic buckets were prepared for composting and divided in to three groups such as Treatment A, Treatment B and Treatment C based on different bulking agent.

Treatment A

Table 3.1 Proportion of compost materials for sludge and banana peels

No	Treatment A%		
	Bucket 1	Bucket 2	Bucket 3
Sludge	97	94	91
Banana peels	3	6	9

Treatment B

Table 3.2 Proportion of compost materials for sludge and Kieselguhr

No	Treatment B%		
	Bucket 4	Bucket 5	Bucket 6
Sludge	90	80	70
Kieselguhr	10	20	30

Treatment C

Table 3.3 Proportion of compost materials for sludge and Kieselguhr

No	Treatment C%		
	Bucket 7	Bucket 8	Bucket 9
Sludge	50	100	----
Kieselguhr	50	------	100

3.3. Adjusting composting parameters and compost brewery sludge

Nine different amount of samples were taken in nine buckets contain with different amount of bulking agent. Samples were open air atmospheric conditions at room temperature. The samples were thoroughly mixed and buried in the ground. These buried samples were given time to be composited or digested for about 21 days. During burying, the mixture were mixed and watered after every three days to maintain moisture content of 55%.

3.4. Analysis of physico-chemical properties of the BWS and composting

3.4.1. Determination of Moisture Content

The solid sludge was dried for two days in an oven set at 105°C. The samples were cooled in a desiccators having silica gel as a drying agent before re-weighing. The moisture content of the samples was determined as a percentage of the dry mass. To apply the same producer for composted product

The relevant calculation is:

$$\text{Moisture \% by weight} = \frac{(B-C)*100}{B-A} \quad \ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where:

A = weight in grams of the empty sample bottle;

B = weight in grams of the bottle plus material before drying;

C = weight in grams of the bottle plus material after drying.

3.4.2. Determination of pH

The pH for solid sludge was determined as follows:25 g of sludge was dried at 105°C in oven dryer was transferred to 150 ml stopper conical flask (alternatively graduated cylinder) and ultra-pure deionized Millie water was added to make the total volume of 100 ml. The solution was shaken on a magnetic stirrer for approximately 15 minutes until the sample was thoroughly dispersed. Finally, the pH meter was set up and pH was measured. To apply the same producer for composted product.

3.4.3. Water retention capacity

Raw BWWS and composted products were compared with 25g of (raw BWS, Kieselguhr and soil) measured respectively and transferred into funnel with filter paper. Tap water (100 mL) was added gradually to each of cups containing relevant samples and measured filtered water and recorded the value. To apply the same producer for composted product

$$\text{Water retention capacity by \%} = \frac{(A-B)*100}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where:

A=Initial volume (ml) of water added in each sample;

B=Final volume (ml) of water after filtration.

3.4.4. Determination of pathogenic load of compost.

23.5 gm. Plate Count Agar was weighed and diluted in 1000 mL distilled water. The solution was stirred gradually while boiled and then cooled in the Hood to have the media. In order to dissolve the sample, 9.5 gm. Maximum recovery diluents was weighed and diluted in 1000 mL distilled water.

Aseptically, 10 g of sample and 90 ml maximum recovery diluents were added in a stomacher bag and blended for 2 minutes in the Homogenizer. This gives 1:10 dilution of the original sample called the homogenate. In serial decimal dilutions preparation, test tubes for each dilution scheme (10^{-2} -10^{-6}) were labeled. The homogenate (10^{-1} dilution) was shaken and immediately 1 ml homogenate was transferred to the test tube of 9 ml Maximum recovery diluents water using sterile pipette. The tube was capped and shaken vigorously. As the dilutions is additive, this results $1/10\times1/10= 10^{-2}$. Before withdrawing, the 10^{-2}tube was vigorously agitated and 1 ml was transferred to the other 9 ml Maximum recovery diluents. This represents a 10^{-3} dilution. The tube was capped and shaken vigorously. The same process was repeated to produce 10^{-4}, 10^{-5}, 10^{-6} dilutions (all done in the Hood).

Prepare pour plate:-From each dilution (10^{-2} to 10^{-6}) 1 ml was pipetted and taken into separate, duplicate, marked Petri dishes. Note to agitate the tube before removing each aliquot. 20 ml molten Plate Count Agar was added on to the plates. Then the sample dilutions and agar medium were uniformly mixed through alternate rotation, and back- and-forth motion of the plates on a flat level surface. The agar was allowed to harden, Petri dishes were inverted and incubated at 35 ± 1^0C for 48 h.

3.4.5. Determination of Carbon Test/Organic matter

Organic matter in sludge contains carbonaceous material was tested through Carbon Test. 25gm of sample was weighed and heated in the furnace up to 450°C for 30 min. Organic matter was start burning when the temperature reaches to 250°C and completely burned at 450°C and then by subtracting the initial weight from the final weight. To apply the same producer for composted product

$$\text{Organic matter} = \frac{(A-B)*100}{A} \quad \ldots\ldots\ldots 3$$

Where:

A=Initial weight of each sample before burning;

B=Final weight of each sample after burning.

3.4.6. Determination of Total Carbon

$$\text{Total carbon by } (\%) = \frac{\text{Total Organic matter } (\%)}{1.8} \quad \ldots\ldots\ldots 4$$

[24].

3.4.7. Determination of Total Nitrogen

The Kjeldahl method used for estimation of total N:-

0.5 g of the sample will be put in a distillation flask with about 250 ml of water. Then 5 ml of NaOH solution (40 percent) will be added and mix well. The heating will be started, and distil about 100 ml of liquid into a measured quantity of standard acid (0.1M HCl). The distillate will be titrated with standard NaOH (0.1M) to determine the remaining amount of unused acid, using boric acid solution for indicator. The acid used to neutralize ammonia is equivalent to the N content in the sample. Carry out a blank. To apply the same producer for composted product

The relevant calculation is:

$$\text{Percent NH4} - \text{N} = \frac{(A-C)-B}{W} * 0.0014 * 100 \quad \ldots\ldots\ldots 5$$

Where:-

A = ml of standard acid (0.1M HCl) taken to receive ammonia;

B = ml of standard alkali (0.1M NaOH) used in titration;

W = weight of the sample taken;

C = ml of standard alkali used in the blank, 1ml 0.1M HCl = 0.0014 g N

3.4.8. Determination of Total Phosphorus

1g sample was digested in H2SO4 and diluted with 165ml HCl. The solution was filter the precipitate with filter paper until 100ml. Then total phosphorus was measured by uv-vis Spectrophotometer. To apply the same procedure for composted product.

Chapter Four

4. Result and discussion

4.1. PH for raw materials

Table 4.1Experimental PH value for raw materials

Sample code	PH for raw materials
Sludge	7.59
Kieselguhr	9.12

Table 4.1 shows the PH value of raw materials (Sludge and Kieselguhr) the value indicates both are basic property.

4.2. PH for compost product

Table 4.2Experimental PH value for Compost product

Sample code	PH for Compost product
Treatment 1	7.28
Treatment 2	7.35
Treatment 3	7.36
Treatment 4	6.80
Treatment 5	6.81
Treatment 6	7.20
Treatment 7	6.38
Treatment 8	6.88
Treatment 9	7.30

Table 4.2 shows the PH value of compost products the value indicates some of neutral and the others are basic property because of a compost product PH value is between 6- 7.4.

4.3. Water retention capacity for raw materials

Table 4.3 Experimental value of water retention capacity for raw materials

Sample code	Initial value of water added(ml)	final value of water after filtration(ml)	Calculated data/ result of Water retention capacity by (%)
Sludge	100	34	66.00
Kieselguhr	100	40	60.00
Soil	100	78	22.00

Table 4.3 shows Water retention capacity for raw materials, 100 ml of water added for all samples and filters by using perforated cups, finally measured the filtered water and recorded the value. From the above data the value of sludge is highest from those alternatives since the sludge can be high water retention capacity because of high amount of water can be absorbed and Kieselguhr water retention capacity is high as compare as soil.

4.4. Water retention capacity for Compost product

Table 4.4 Experimental value of water retention capacity for compost product

Sample code	Initial value of water added(ml)	final value of water after filtration(ml)	Calculated data/ result of Water retention capacity by (%)
Treatment 1	60	24	60.00
Treatment 2	60	28	53.33
Treatment 3	60	16	73.33
Treatment 4	60	26	56.66
Treatment 5	60	22	63.33
Treatment 6	60	29	51.66
Treatment 7	60	32	46.66
Treatment 8	60	26	56.66
Treatment 9	60	33	45.00

Table 4.4 shows Water retention capacity for compost product since 60 ml of water added for all samples and filter by using perforated cups, finally measured the filtered water and recorded the value. From the above data all treatments are increase from 23% to 51.33% for soil water retention capacity. Especially the value of Treatment 3 is high from those alternatives since Treatment 3 can be high water retention capacity due to the ability of high amount of water can be absorbed.

4.5. Raw material Total organic matter by (%)

Table 4.5 Experimental value of total organic matter for raw material

Sample code	initial weight of raw material value	final weight of raw material	Calculated data/ result of total organic matter by (%)
Sludge	25	11.82	52.72
Kieselguhr	25	18.00	28.00

Table 4.5 shows total organic matter by (%) for Raw materials, from the above data the value of sludge is high from those given data since the sludge can be contain high amount of organic matter.

4.6. Compost product Total organic matter by (%)

Table 4.6 Experimental value of total organic matter for compost product

Sample code	initial weight of raw material value	final weight of raw material	Calculated data/ result of total organic matter by (%)
Treatment 1	25	13.83	44.68
Treatment 2	25	14.00	44.00
Treatment 3	25	13.16	47.36
Treatment 4	25	10.83	56.68
Treatment 5	25	15.00	40.00
Treatment 6	25	15.83	36.68
Treatment 7	25	14.67	41.32
Treatment 8	25	14.00	44.00
Treatment 9	25	21.67	13.32

Table 4.6 shows total organic matter by (%) for Compost product, from the above data the value of Treatment 4 and Treatment 3 are high from those alternatives since Treatment 4 and Treatment 3 can be containing high amount of organic matter.

4.7. Raw materials Total carbon by (%)

$$\text{Total carbon by } (\%) = \frac{\text{Total Organic matter } (\%)}{1.8} \quad \text{From equation 4.}$$

Table 4.7 Experimental value of total carbon for raw materials

Sample code	Calculated data/ result of total organic matter by (%)	Calculated data/ result of total carbon by (%)
Sludge	52.72	29.29
Kieselguhr	28.00	15.55

Table 4.7 shows total carbon by (%) for Raw materials by applying the above formula to determine the value of each sample and from the table the sludge is relatively higher than Kieselguhr by containing of total carbon.

4.8. Compost product Total carbon by (%)

Table 4.8 Experimental value of total carbon for compost product

Sample code	Calculated data/ result of total organic matter by (%)	Calculated data/ result of total carbon by (%)
Treatment 1	44.68	24.82
Treatment 2	44.00	24.44
Treatment 3	47.36	26.31
Treatment 4	56.68	31.48
Treatment 5	40.00	22.22
Treatment 6	36.68	20.37
Treatment 7	41.32	22.95
Treatment 8	44.00	24.44
Treatment 9	13.32	7.4

Table 4.8 shows total carbon by (%) for compost product by applying the above formula to determine the value of each sample and from the above table the Treatment 4and Treatment 3 are relatively higher amount of total carbon containing than those alternatives.

4.9. Raw materials Total Nitrogen by (%)

Table 4.9 Experimental value of total nitrogen for raw materials

Sample code	Total nitrogen by (%)
Sludge	5
Kieselguhr	0.76

Table 4.9 shows Total nitrogen by (%) for Raw materials, after the Kjeldahl method used for estimation of total Nitrogen. From the above table the value of the sludge is higher as compare as Kieselguhr because of the sludge can be contain high amount of total nitrogen.

4.10. Compost product Total nitrogen by (%)

Table 4.10 Experimental value of total nitrogen for compost product

Sample code	Total nitrogen by (%)
Treatment 1	2.952228663
Treatment 2	3.960811756
Treatment 3	3.848075962
Treatment 4	3.848460616
Treatment 5	3.541291742
Treatment 6	3.37265094
Treatment 7	2.742902839
Treatment 8	2.02979702
Treatment 9	0.755546672

Table 4.10 shows Total nitrogen by (%) for Raw materials, after the Kjeldahl method used for estimation of total Nitrogen. From the table the value of Treatment 2, Treatment 3 and Treatment 4 are higher than as compare as those alternatives because of those Treatment can be contain high amount of total nitrogen.

4.11. Raw materials Total Phosphorus by (%)

Table 4.11 Experimental value of total phosphorus for raw materials

Sample code	Total phosphorus by (%)
Sludge	8.284075
Kieselguhr	4.029397

Table 4.11 shows total phosphorus by (%) for Raw materials, after determination of total phosphorus by (%) using uv-vis Spectrophotometer. From the table the value of the sludge is higher than Kieselguhr because the present of total phosphorus in sludge or brewery waste water sludge is higher than Kieselguhr.

4.12. Compost product Total Phosphorus by (%)

Table 4.12 Experimental value of total phosphorus for compost product

Sample code	Total phosphorus by (%)
Treatment 1	9.959139
Treatment 2	8.507174
Treatment 3	6.691856
Treatment 4	8.801547
Treatment 5	8.495214
Treatment 6	8.111829
Treatment 7	6.868084
Treatment 8	8.820303
Treatment 9	2.548881

Table 4. 12 shows Total nitrogen by (%) for compost product, after determination of total nitrogen by using uv-vis Spectrophotometer. From the above table the value of the Treatment 1, Treatment 4 and Treatment 8 are higher than as compare as from those alternatives since it contain high amount of total phosphorus.

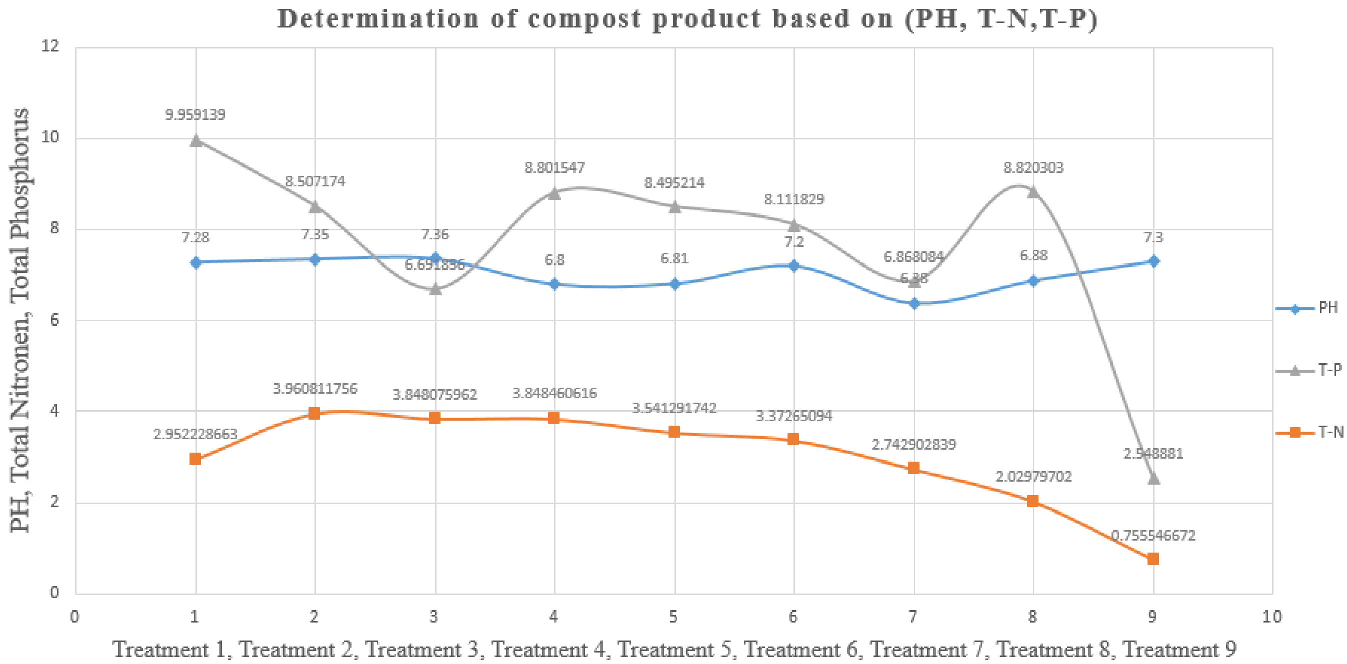

Figure 4. 1 Determination of compost product based on PH, Total Nitrogen and Total Phosphorus

Figure 4.1 shows the values of PH, total nitrogen and total phosphorus according to each value to evaluate the optimum from those alternatives since the value of total phosphorus is high in treatment 1 but the value of PH and total nitrogen are lower. In treatment 4 the value of PH and total nitrogen are higher, but the value of total phosphorus is medium. Therefore from the above figure treatment 4 is selected because of its containing the optimum value of PH, total nitrogen and total phosphorus.

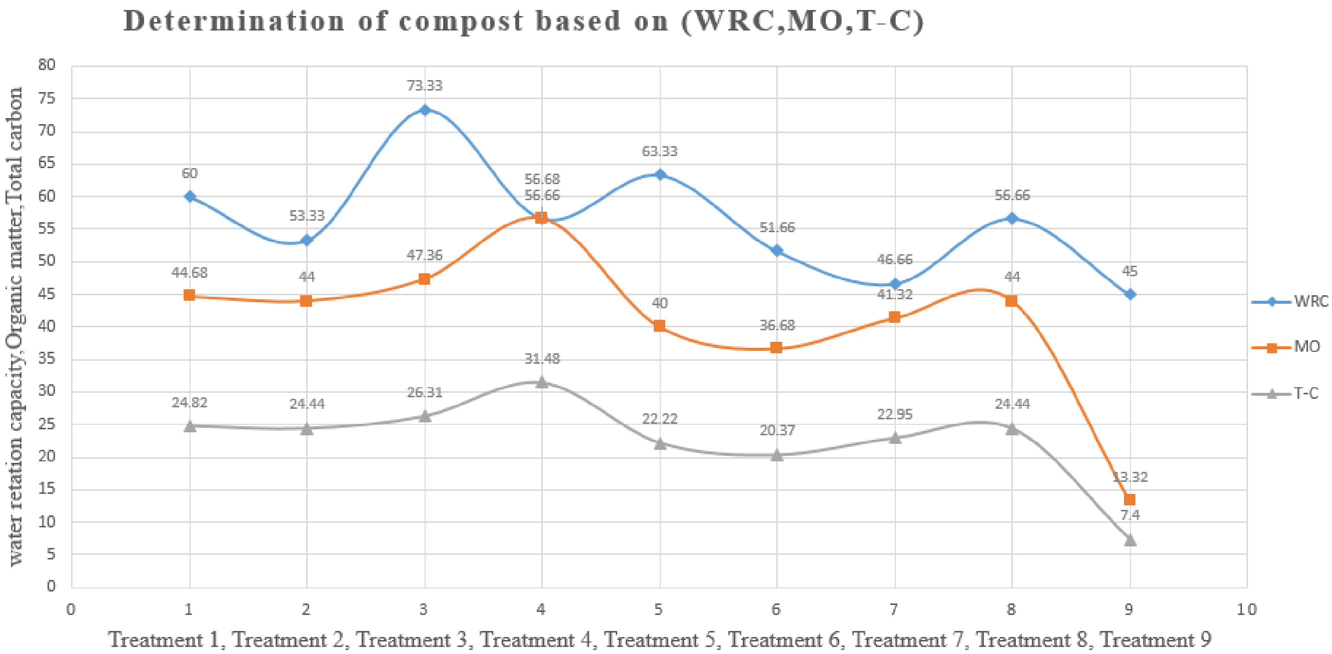

Figure 4. 2 Determination of compost product based on Water retention capacity, organic matter and Total carbon

Figure 4.2 shows the values of water retention capacity, organic matter and total carbon according to each value to evaluate the optimum from those alternatives since the value of water retention capacity is high in treatment 3 but the value of organic matter and total carbon are lower. In treatment 4 the value of organic matter and total carbon are higher than in all alternatives but water retention capacity is lower, Even if its value is low but higher than water retention capacity of soil .Therefore from the above figure treatment 4 is selected because of its contain the optimum value of water retention capacity, organic matter and total carbon.

4.13. Pathogenic load of compost product

As shown from the result the end composted product are free from pathogenic load. That means the result was spread.

4.14. Characterization of compost product

Table 4.13 characterization of compost product

No	Parameter					
	PH	Total Nitrogen (%)	Total phosphorus (%)	Total carbon (%)	Organic matter (%)	Water retention capacity (%)
Treatment 1	7.28	2.952228663	9.959139	24.82	44.68	60.00
Treatment 2	7.35	3.960811756	8.507174	24.44	44.00	53.33
Treatment 3	7.36	3.848075962	6.691856	26.31	47.36	73.33
Treatment 4	6.80	3.848460616	8.801547	31.48	56.68	56.66
Treatment 5	6.81	3.541291742	8.495214	22.22	40.00	63.33
Treatment 6	7.20	3.37265094	8.111829	20.37	36.68	51.66
Treatment 7	6.38	2.742902839	6.868084	22.95	41.32	46.66
Treatment 8	6.88	2.02979702	8.820303	24.44	44.00	56.66
Treatment 9	7.30	0.755546672	2.548881	7.4	13.32	45.00
Standard value of organic fertilizer [23,26]	4-7.4	1.5-3.5	0.5-1	15-20	25-30	>soil water retention capacity

As shown from the above table 4.13 characterized the parameter most Treatments are satisfy based on the result of PH, Total Nitrogen, Total Phosphorus, Total Carbon, Organic Matter and Water retention capacity compare to standard value. Among those Treatment 4 is best based on all parameter value and the water retention capacity is higher as compare as soil water retention capacity.

Chapter Five

5. Conclusion and Recommendation

5.1. Conclusion

Managing industrial wastes is one of the most important urban environment problems of today. With rapidly increasing population and a growing trend of industrial development, problems related to the management of industrial wastes have become of considerable magnitude in Ethiopia. The problem is more acute in cities where relatively large number of manufacturing plants is concentrated.

Brewery is among the industries known for production of by-products (spent grains, spent yeast) and sludge from the Waste Water treatment plant at different stages of the manufacturing process. Based on the findings of this study, to prepare organic fertilizer from brewery waste water treatment sludge with Kieselguhr as bulking agent. It was realized that have the best nutrient value for plants and free from pathogenic load since the result shown spread, an application of 90% brewery waste water treatment sludge with 10% Kieselguhr (i.e. treatment 4), is practically feasible for optimum ratio.

In addition to this, currently the brewing industry are growing in Ethiopia and the disposal of waste water sludge is a big issue in both environmental and economic aspect. In this regards this thesis show the possibility of sludge as organic fertilizer after composting, because of results presented in this work have shown that BWS can be a valuable source of nutrients for plants and Kieselguhr can be used as bulking agent. Agriculture dependent developing countries such as Ethiopia rely mainly on imported inorganic chemical fertilizers and thus by products such as compost of brewery waste water sludge could play a role in the development of the economy in an environmentally friendly manner.

Generally compost product contains plant nutrients and is also high in organic matter, making it highly beneficial as soil fertility.

5.2. Recommendation

1. More research should be carried out on how to determine the optimum sludge soil ratio, to get better result on soil amendment.
2. Economic implication of delivering waste to the end user must be studied.
3. Further researches should be conducted on determining total potassium content.

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Appendix

All experimental pictures




Raw BWWS Raw Kieselguhr Raw banana peels Raw material sieving




Weighted raw material Experimental setup Sample Preparation Moisturizing of samples




Composting of samples PH of raw materials PH of compost product WRC of raw materials


WRC of compost product


Boiled of Plate Count Agar


Count the microbe


weight compost before burning


Weight compost after burning


1.4% boric acid solution with indicator


After distillation to determine T-N


Filtration of samples for T-P


T-P determination by using UV-Vis Spectrophotometer