PRODUCTION AND ASSESMENT OF COMPOST AS A BIO-FERTILIZER USING KITCHEN WASTE OF NIT ROURKELA HOSTELS AND STUDY OF COMPARATIVE PLANT GROWTH

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CERTIFICATE

This is to certify that the project report entitled "PRODUCTION AND ASSESMENT OF COMPOST AS A BIO-FERTILIZER USING KITCHEN WASTE FROM NIT ROURKELA HOSTELS AND STUDY OF COMPARATIVE PLANT GROWTH" submitted by SAMRAT BARUAH (111BT0265) and SHASHANK SRIVASTAVA (111BT0496) in the partial fulfillment of the requirement for the degree of the Bachelor in Technology in Biotechnology Engineering, National Institute of Technology, Rourkela is an authentic work carried out by them under my supervision. To the best of my knowledge the matter embodied in the report has not been submitted to any other Institute/University for any degree.

DATE: 11th May 2015

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF IMAGES

ABSTRACT

This research project deals with the production of compost generated from kitchen waste of NIT Rourkela and its utilization for the growth of "Helianthus annuus".The kitchen waste from hostels was collected and degraded in a compost bin of dimensions 57X36.5X31.5 (cmXcmXcm). Various parameters of the compost were monitored at an interval of 15 days up to 60 days .The pH of the compost was found to be decreasing from 7.71 to 7.19 on the 60^{th} day .Other parameters like total carbon%, nitrogen% , moisture, pH, C:N ratio and change in colour, texture and odour were also monitored. C:N ratio (%) was found to be decreasing from 55.6059 to 25.89609 (60^{th} day). The moisture of the compost was maintained between 55-50%. The study was carried forward by planting sunflower plant (Helianthus annuus) in different ratios of compost and soil of 1:1 and 2:1 respectively and two soil samples without compost were used as control to study the growth. Their change in shoot length and thickness were observed. It was found that the sample containing compost and soil in the ratio 2:1 had the best growth with a difference between initial and final shoot length of 5.9 cm. This was followed by the sample containing compost and the soil in the ratio of 1:1 which showed the difference as 5.5 cm. This experimental study concludes that compost made in a compost bin is also efficient and can be used as bio-fertilizer to enhance the plant growth.

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

If the unused food is left for some days, it is likely to attract flies that will ultimately produce a filthy smell polluting the environment that eventually leads to spreading of diseases. The problem of wastage of cooked or uncooked food needs no mention. Across the whole world every year million tons of food gets wasted which, if managed in a better way, not only can fill the stomach of many but also it can be put to use for a plethora of purposes. India is among the list of countries having high rates of food wastage. As per an estimate, food valued at 58000 crores (more than 40% of the amount produced) is wasted every year [1]. Not only this, India wastes food and vegetables amounted to worth 13300 crore every year [2]. However, if provided certain conditions properly, the same waste food can be used to produce a material that can enrich soil by enhancing the productivity and improving the soil texture making it more fertile. Since it is really a herculean task to stop all the food from getting wasted hence the actual problem lies in the disposal of the waste food and thus prevention from spreading of disease. On the other hand this huge amount of waste food can be utilized to value added products. In this context, an attractive option is production of compost as a bio-fertilizer that being eco-friendly can replace the chemical fertilizers which have a drastic impact on the food chain.

1.1 BIO-FERTILISER AND ITS ADVANTAGES

A bio-fertilizer is a material or a substance that contains living micro-organisms. It is applied to soil or to the plant surfaces to increase the supply of nutrients to the plants and thus enhancing their growth. Bio-fertilizers enhance the nutrient content of the soil using general process of nitrogen-fixation and solubilize the phosphorus content as well. The micro-organisms present in the soil restore the nutrient cycle and subsequently build organic matter. Bio-fertilizers can be used to grow healthy plants simultaneously enhancing soil health and soil sustainability. Such micro-organisms are preferably known as PGPR (Plant growth promoting rhizobacteria) and hence do not contain any chemical harmful to the soil. Bio-fertilizers are eco-friendly and more cost effective than chemical fertilizers and hence many of them are used since long time ago e.g Azotobacter, blue green algae etc [10].These act like green manure and contain efficient strains of special micro-organisms which enhance the availability of nitrogen and phosphorus content. They can also symbiotically associate with the plant roots (e.g leguminous plants) and convert complex organic materials into simple compound that causes change in colour and texture of the soil. They can enhance the crop yield by 25%-30% and provide stability to soil against drought and other soil-borne diseases.[11]

1.2 COMPOST

Compost or BLACK GOLD is a dark brown or black earthy substance that is formed due to the aerobic decomposition of complex compounds or bio-degradable waste present in the soil into simple ones. Compost is also known as humus and is highly rich in nutrients. The process generation of compost, known as composting, is marked by amendment in color, texture and odour of the soil. Compost increases the water and air holding capacity of soil, improves soil fertility and helps in healthy root development of plan.

The whole experimental study comprised of two main process

1. Composting
2. Comparative growth study of plant

1.2.1 COMPOSTING

Composting the process of decomposition and recycling of the complex bio-degradable compounds into simple ones resulting in the production of dark matter known as humus. It takes hundreds of years for the nature to build 1 inch of the layer of humus rich soil.[12]However using the same process the organic waste generated inside a home/ hostel can be used as bio-fertilizer for the plants. Such a process can be performed in a pit formed by digging a ground or even in specially designed compost- bins. The decomposition process can be made more efficient if certain factors are taken into consideration before the process. Some of these factors are Carbon content, Nitrogen content, air and water. Also it must be noted that Carbon: Nitrogen ratio plays a major role in the composting process.

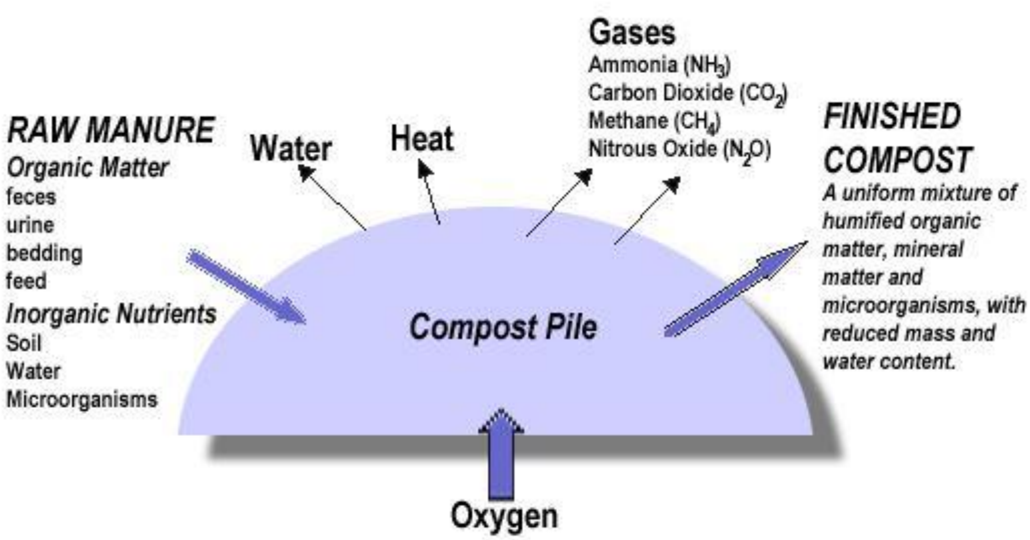


Image1(a)

Source: (Rynk,1992)

1.2.2 FACTORS AFFECTING COMPOSTING PROCESS

1. **CARBON: NITROGEN RATIO**: This ratio is the basic key for a composting process. All living organisms have a fixed C:N ratio in their tissues. It is this ratio that actually decides the path of a decomposition process by micro-organisms. All micro-organisms require carbon as a source of energy and hence it forms basic building block of life. On the other hand, nitrogen is quintessential for the synthesis of proteins, genetic material and cell structure. Hence there needs to be a proper balance between carbonaceous materials (often termed as brown materials as they are dry) and nitrogen rich materials (often termed as green as they are fresh and moist). For a fast production of compost, C:N ratio needs to be between 25-35:1(Rynk,1992). If the ratio is too high having high carbon content, process of decomposition slows down. Alternatively if the amount of nitrogen exceeds and the ratio is too high, it gives a stinky smell.[13]

   .

2. **PRESENCE OF ADEQUATE AIR AND MOISTURE**: These factors are again important for the metabolism of micro-organisms performing decomposition. If there is too much moisture, it leaves no space for oxygen resulting in anaerobic conditions. On the other hand at very small levels of moisture microbial activity halts.

3. **TURNING**: Turning refers to aeration of the compost pile so that every part of the pile receives oxygen and the aerobic decomposition process is not hampered. Turning creates new passage for moisture and hence breaks the large lumps to increase the surface area for the action of micro-organisms to be more efficient. It also helps in release of excess nitrogen in the form of ammonia and hence helps in maintain C:N ratio.

1.2.3 GENERAL CONDITIONS FOR COMPOSTING

Condition	**Ideal**	**Acceptable**
C:N Ratio	25-35:1	20-40:1
Ph	6.5-8.5	5.5-9.0
Temperature	54-60‘C	43-66’C
Moisture Content	45-60% w/w	40-65%

Source (Rynk et at.1992)

Table 1(a)

1.5 OBJECTIVE

i. **To produce and assess parameters of compost made in a bin using kitchen waste of NIT Rourkela hostels.**

ii. **To study comparative growth of Helianthus annuus in four different samples containing different ratios of soil and compost.**

CHAPTER 2

LITERATURE REVIEW

2.1 COMPOSTING

Composting is a very common household method to use the organic waste. In the compost organisms convert the organic material present into carbon di-oxide, humus and heat.[3] The economic and one of the most sustainable alternative of waste management is composting .Composting is basically a natural way of treatment of organic waste management but nowadays it is practiced with various changes to the technology. Thermo-composting is comprised of a short interval of high temperature treatment followed by a period of lower temperature which facilitates mass reduction, waste stabilization and pathogen reduction.[4] Kitchen waste is made up of considerable amount of processed food prepared for human consumption and all other constituents like plastics and paper. While people give attention to recycle inorganic wastes such as plastics, glass and papers, the organic waste can be recycled into compost [6]. To increase nutrient levels of the soil support plant growth, use of the microbial fertilizers in the agricultural lands is a regular practice done by the farmers [7]. Agriculture assumes an imperative part in economy of many countries. Nonetheless, quick harvest creation with unseemly cultivating practices has crumbled the natural matter present in the soil, which brings about decrease in the microbial action that can influence its physical, compound, and organic conditions [7] which decrease in area profitability and yields. To take care of this issue, manufactured composts were dependably thought to be a superior approach to enhance the dirt ripeness and yield efficiency however lamentably the intemperate utilization of these makes various genuine ecological and wellbeing dangers [8]. To minimize these risks, regularly happening natural manures, to be specific, creature and plant fertilizers, fall deposits, and nourishment and urban squanders are better substitute of economically accessible composts. Reports demonstrated that natural cultivating enhances soil piece, fruitfulness, and soil fauna which over the long haul have a useful impact on product creation [8].

Micro-organisms involved in composting

Composting has been defined as intense microbial activity leading to decomposition of most biodegradable materials [7]. Microbial variety is a necessity for the composting process.[10]. An extensive assortment of mesophilic, thermotolerant and thermophilic vigorous microorganisms (e.g. microscopic organisms, actinomycetes, yeasts, what's more, growths) are included in the fertilizing the soil process[14]. Their consolidation into soil increments richness (e.g. nitrogen fixers, nitrifiers, sulfur oxidizers), structure (e.g. exopolysaccharide makers), and can have different impacts as a consequence of high movement and populace levels, and additionally through particular biochemical attributes of the microorganisms[14].

2.1AMOUNT OF KITCHEN WASTE GENERATED FROM NIT ROURKELA HOSTELS

DAY	**HALL-8(VS)**		**Hall 7(HB)**		**Hall 4/5 (DBA/MSS)**		**SHIFTS**
	DRY (L)	**WET(L)**	**DRY (L)**	**WET (L)**	**DRY(L)**	**WET(L)**	
1	150	350	150	150	150	150	2
2	150	300	150	150	150	150	2
3	150	300	150	150	100	200	2
4	200	350	150	150	100	150	2
5	150	300	150	150	150	200	2
Day	**HALL 2/3(MV & GDB)**		**Hall 6 (CVR)**				
	Un-Cooked Wastes (L)	**Cooked Wastes(: L)**	**Un-Cooked Wastes(L)**	**Cooked**	**HALL Mess Name**		No. of Students
1	150	300	200	250	Hall 8 (VS)		1300
2	200	250	150	300	Hall 7 (HB)		550
3	150	300	150	250	Hall 4/5 (DBA/MSS)		850
4	150	250	200	300	Hall 2/3 (MV/GDB)		950
5	200	300	150	300	Hall 6 (CVR)		1000

Table 2(a)[15]

CHAPTER 3

MATERIALS AND METHODS

3.1 SEGREGATION OF WASTE GENERATED

Waste was found to be mainly of two types: **Dry and wet waste**

Source of Dry Waste: Peels of vegetables, roots, stem, leaves and paper

Source of Wet waste: Cooked Food

3.2 PRODUCTION AND CHARACTERISATION OF COMPOST

A compost bin was made out of cuboidal thermocol box with the dimensions kept as 57X 37.5 X 31.5 (cm x cm x cm).Then holes were made in the wall and floor of the bin for proper aeration and efflux of water. Then a layer of soil approximately 6 cm depth was poured in the compost bin. This was followed by pouring a layer of dry kitchen waste (collected from different hostels) up to a depth of 6 cm in the compost bin which was followed by the second layer of soil of some 6 cm depth. Some brown elements like brown leaves and green elements like fresh leaves were also added after every layer of soil. This was done to ensure the adequate amount of nitrogen and carbon for the decomposition process. Water was regularly sprayed to maintain the moisture content within 50-55%. The compost was regularly turned done at every 7^{th} day to ensure the availability of oxygen and moisture for the microbes.

3.2.1 pH measurement of compost

The pH of the compost was regularly monitored at an interval of 15 days to observe the microbial activity. In this process 100mg of sample was taken to which 200ml of distilled water was added. Then the solution was mixed in a magnetic stirrer for 15 minute. The solution so obtained was then filtered using a filter paper. The solution was then taken for centrifugation at 1500 rpm for 5 minutes. The supernatant was collected and the pH was measured with the help of a pH meter.

3.2.2 Carbon and Nitrogen analysis of compost

The carbon and nitrogen content of the compost was monitored regularly at an interval of 15 day. This was achieved using a CHNS analyzer. The sample was taken in small aluminium foils. The weight of sample could be between 5mg and 10mg .The sample was loaded in the CHNS analyzer. The observations were noted after 24 hours.

3.2.3 Measurement of moisture content of the compost

The moisture content of the compost was monitored regularly at an interval of 15 days.100 mg of sample was taken in a petri plate. The petri plates were kept in a dry oven for 72 hours. The samples were weighed again after 72 hours. The moisture content were calculated by the formula (w1-w2/w1) where

W1= Initial weight of the sample
W2= Final weight of the sample

3.3 MICROBIAL ANALYSIS OF COMPOST

Experiment 1: Media preparation

Materials Required:

Nutrient agar and distilled water

Equipment Used:

Weighing balance, Glassware's like beakers, petri plates, measuring cylinder, Autoclave machine**,** markers, spatula and cotton plugs

Method:

2.8 gm of nutrient agar was added in 100ml distilled water in a conical flask. The mouth of the conical flask was closed by a cotton plug. The conical flask was named with a marker and the media was autoclaved for 15 minutes.

Experiment 2: Serial Dilution

Materials Required:

10 Test tubes, a test tube stand**,** micropipette**,** compost sample.(1g)**,** distilled water (10mL)

Method:

1gm of compost sample was taken in 10 ml of distilled water and this was named as solution A. 10 test tubes were taken and each test tube was marked from1 to 10. This was followed by filling 10ml of water in each of the test tube. 1ml of the solution A was taken with the help of a micropipette and poured in test tube 1. Similarly 1ml of sample was taken from test tube 2 and poured in test tube 3. This procedure was repeated 10 times up to the 10^{th} test tube. After the serial dilution was complete the 10-9 diluted sample was kept aside for culturing bacterial strains and counting of the microbial plate.

3.4 SAMPLES FOR COMPARATIVE GROWTH STUDY OF PLANT HALIENTHUS ANNUUS

Under this study four bins containing samples of soil and compost in different ratios of w/w were taken.

Sample	**Ratios (Compost: Soil)**
Sample A	0:1 (Pure soil)
Sample B	2:1
Sample C	0:1 (Pure soil)
Sample D	1:1

CHAPTER 4

RESULTS AND DISCUSSION

4.1CHARACTERIZATION OF THE COMPOST

Physical Characterization

4.1.1 Colour

The colour of the compost was found to be changed and on the 60th day it showed a large blackish content showing the formation of humus. The variation in the colour at a regular interval of 15 days is mentioned in the following table:

No. of days	Change in colour
0th	Kitchen waste+ soil
15th	Brown
30th	Brownish Black
45th	Black Content increased
60th	Large amount of Black Content

TABLE 4(a): Change in colour with time

4.1.2 Texture

The texture of the soil was also found to be changed in the due course of process as monitored at an interval of every 15 days. The variation in the texture of the soil is mentioned in the table below:

TABLE 4(b) Change in texture with time

No. of days	Change in Texture
0th	Hard soil particles+ Kitchen waste
15th	Size of soil particle reduces, soil softens
30th	Further reduction in particle size
45th	Loose soil particles
60th	Extremely soft soil and small particles

4.1.3 Odour

Odour of the pile/ compost was monitored which on monitoring, showed variation as mentioned in the table below:

Table 4(c): Change in odour with time

No. of days	Change in Odour
0th	Smell of fresh food waste, no smell
15th	Very Bad smell
30th	High level of smell
45th	Tolerable smell, large scale decrease
60th	Odourless

Image 4(a) Compost after 60 days

From the above observations it was found that the texture, colour and odour of the pile varied from the 1st day to 60th showing decomposition process is in progress. During the initial phase there was no smell from the pile but after 15th day smell of the pile gradually became stinky that increased till 30th day. The smell changed to tolerable on 45th day and vanished completely by 60th day. The sources of rotten smell were raw material and ammonium released from nitrogen rich materials. This shows that the release of ammonia increases first and then decreases. The soil softened causing breaking of large lumps of soil and the colour changed to dark brown showing increased amount of humus that is fertile in nature.

Chemical Characterization

4.1.4 pH

The measurement of pH of the compost was done regularly to observe the activity of microbes. The variation in pH is mentioned in the table below:

Table 4(d): Variation in pH with time

No. of days	Variation in pH
0^{th}	7.71
15^{th}	7.69
30^{th}	7.63
45^{th}	7.42
60^{th}	7.19

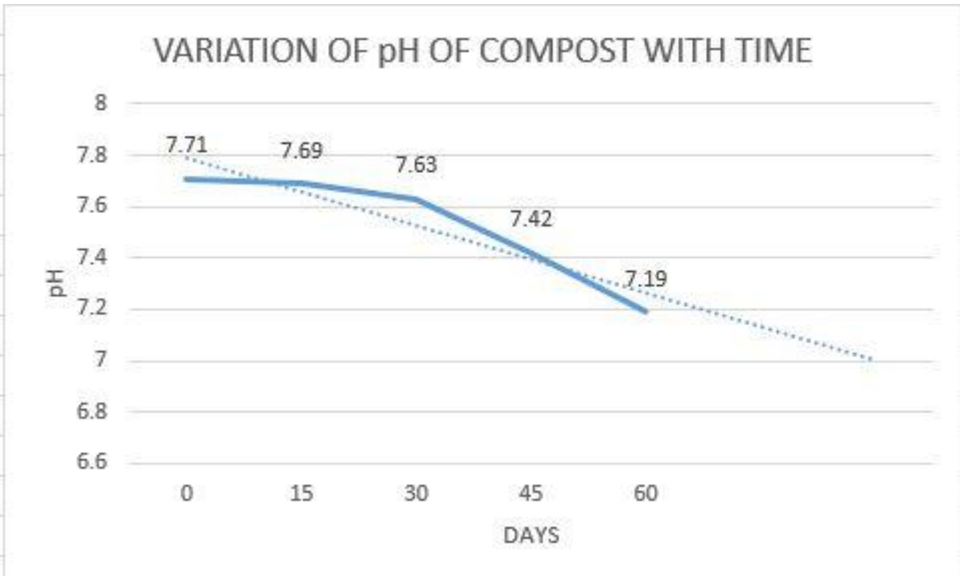


Fig 4(a): Variation in pH with time

Image 4(b) pH meter

pH was found to be decreased due to the formation of humic acid that turns the organic matter into humus. Humic acid formation takes place due to the activity of microbes.

4.1.5(a) **Carbon Content**

The carbon content of the compost was estimated using CHNS analyzer. The variation that was observed is mentioned in the table below:

No. Of days	**Variation in Carbon (%)**
0th	1.4813
15th	1.3128
30th	1.3056
45th	1.2575
60th	0.9660

Table 4(e): Variation in carbon% with time

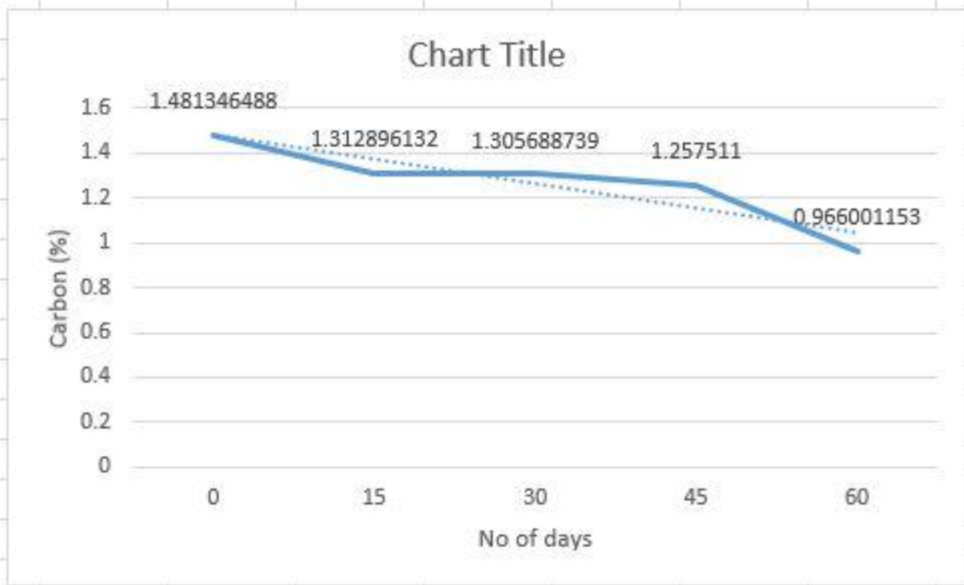


FIG 4(b) Graph showing variation of carbon% with time

4.1.5 (b) Nitrogen Content

The nitrogen content of the compost was monitored at an interval of every 15 days using CHNS analyzer. The variation so seen is mentioned in the table below:

Table 4(f): Variation in Nitrogen% with time

No. of Days	**Variation in nitrogen (%)**
0th	2.6640
15th	2.8518
30th	3.6473
45th	3.8842
60th	3.7302

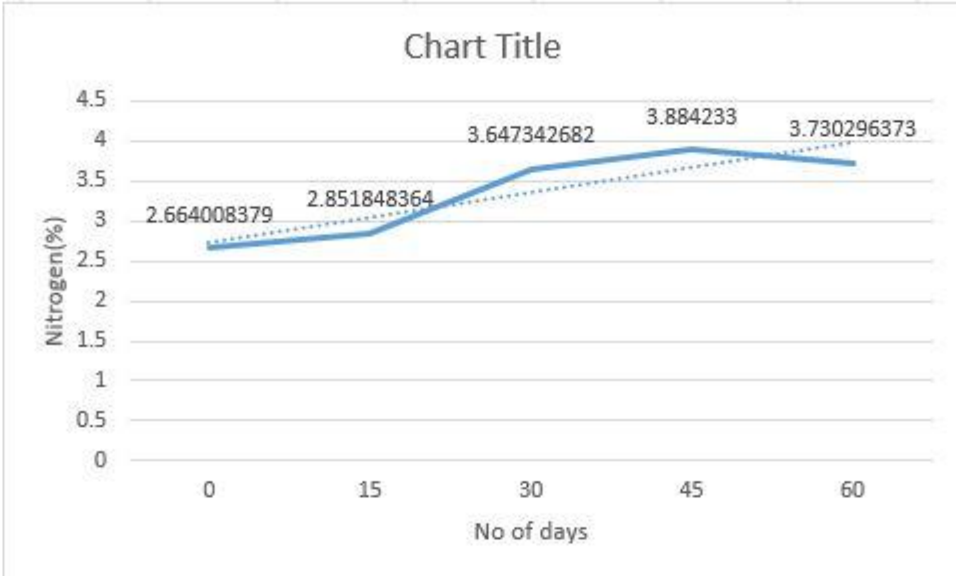


FIG 4(c) Graph showing variation of nitrogen% with time

4.1.5(c) Carbon: Nitrogen Ratio

After obtaining the amount of carbon and nitrogen, their ratio was calculated because this ratio determines the activity of microbes and acts a balanced diet for them. The variation in the ratio (in percentage form) is mentioned in the table below:

Table 4(g): Variation in carbon: nitrogen ratio(%) with time

No. of days	**Variation in Carbon: Nitrogen (%)**
0^{th}	55.6059
15^{th}	46.0366
30^{th}	35.7983
45^{th}	32.3742
60^{th}	25.8960

Fig 4(d): Graph showing C:N ratio % with time

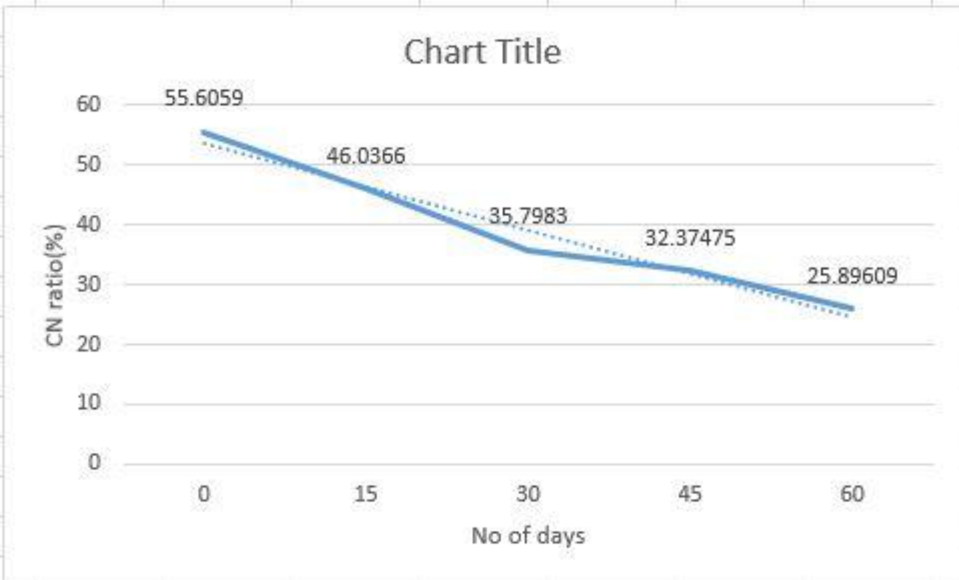


IMAGE 4(c): CHNS ANALYSER (OUTSIDE VIEW)

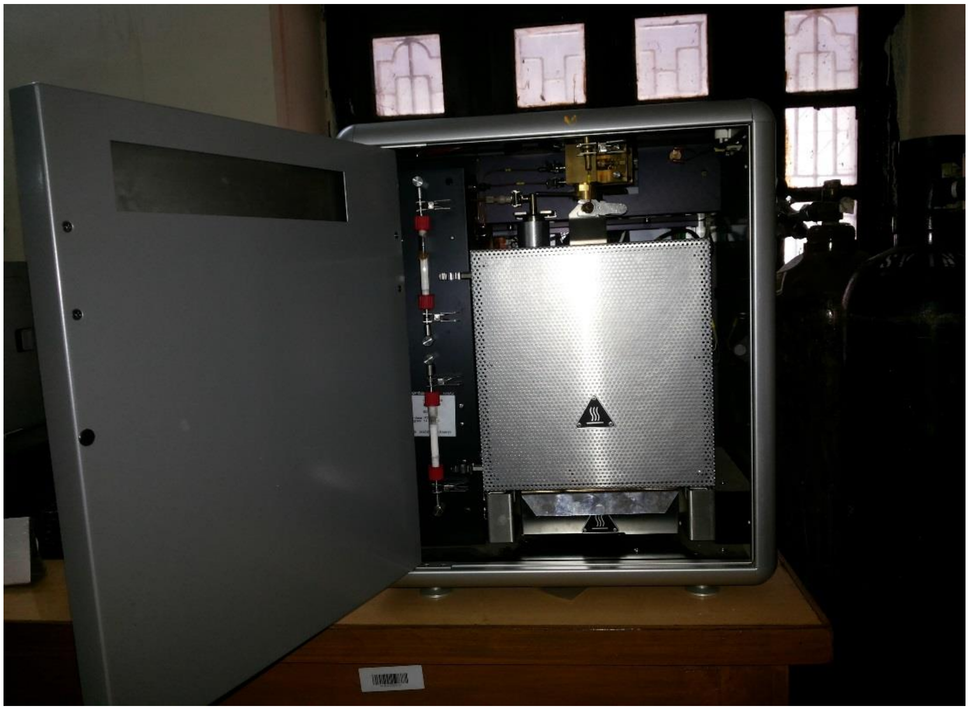


IMAGE 4(d): Carbon Hydrogen Nitrogen Sulphur ANALYSER (INSIDE VIEW)

A slight decrease in the pH value was observed which showed the activity of microorganisms and the formation of humic acid. The carbon content was found to decrease and hence the C:N ratio, making the composting process effective. The reduction in C is in the form of CO_2 causing reduction in total dry mass (Hamoda et al. 1998). Adequate C:N ratio acts as a balanced diet for micro-organisms which on the 60th day came down to 25.8960% from 55.6059% on 1st day. This happened because carbon is used as a source of energy by micro-organisms. Nitrogen basically exists in two forms. One is nitrate nitrogen **(NO_3-N)** and the other one is ammonia nitrogen **(NH_4-N)**. The rising trend line in the nitrogen content shows significant increase in the nitrate content (Neto et al. 1997. However a small amount of nitrogen loss also occurs in the form of ammonia because of which the stinky smell of the pile was found to decrease gradually (Liao et al. 1995). The smell so experienced increases from the day 1st and then slowly vanishes while reaching the day 60th. This loss of nitrogen was comparatively lesser as compared to the loss of carbon. The amount of loss of nitrogen in the form of ammonia is inversely proportional to the C:N ratio giving a stinky pile and hence maintaining ammonia concentration is important to avoid nitrogen loss and preventing bad odour.

4.1.6 Moisture

The moisture content was achieved by regularly spraying water in the pile. The variation in the moisture content was monitored at an interval of 15 days which is mentioned below:

Table 4(h): Variation in moisture % with time

No. of Days	Variation in moisture (%)
0th	54.35
15th	56.73
30th	54.79
45th	58.95
60th	48.86

FIG 4(e): Graph showing variation in moisture % with time

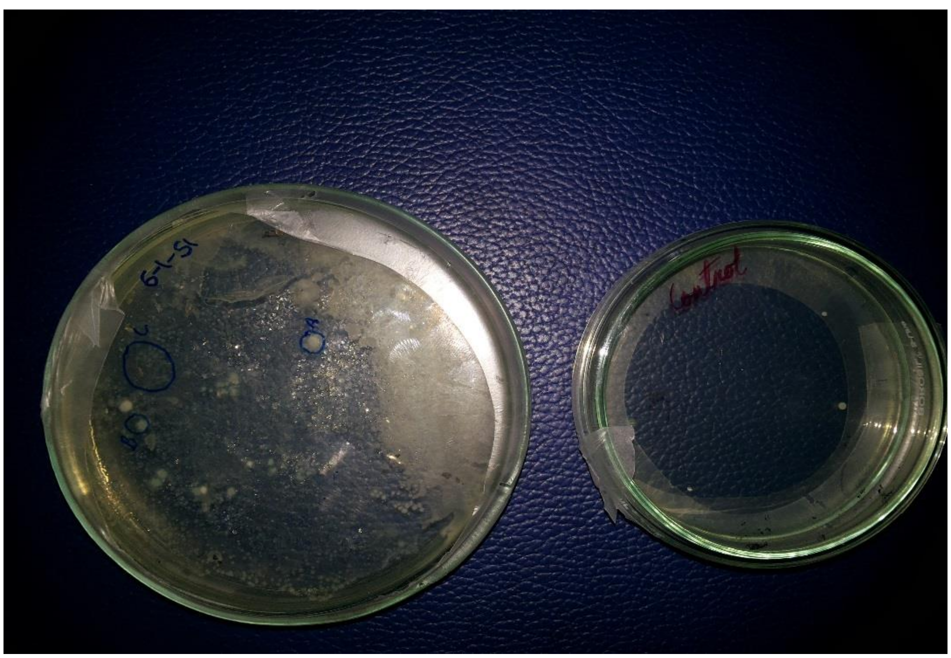
IMAGE 4(e) Dry Oven

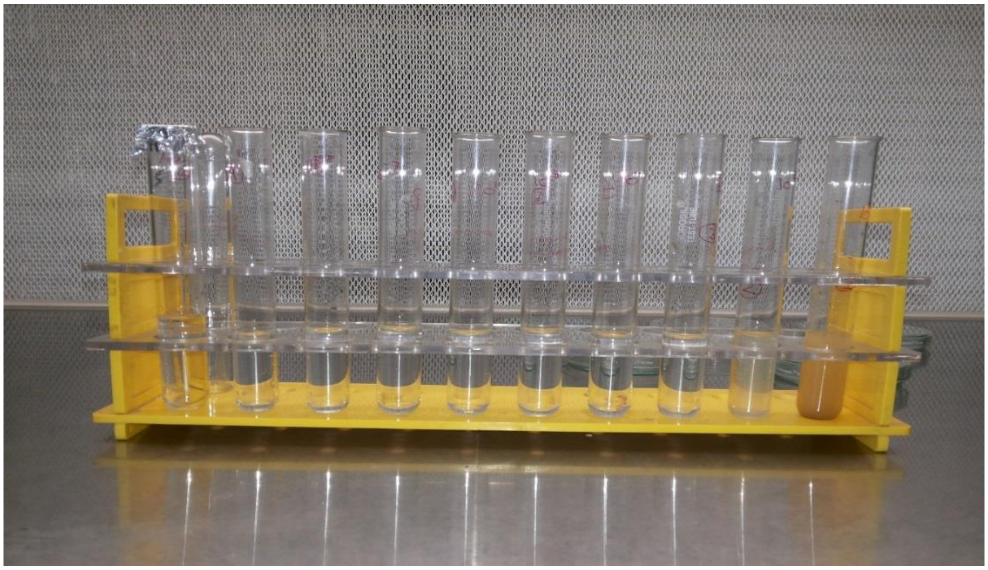
The moisture content is very important in aerobic processes and it was kept between 55%- 50% throughout the whole process. Micro-organisms require moisture to assimilate nutrients, metabolize new cells and reproduce. Water is also produced as a part of decomposition process (J.Jelin et al. 2011). If the water is accumulated at a much faster rate than evaporation, oxygen flow is hampered resulting in anaerobic conditions (Kiyohiko,1985). The moisture content if crosses 65% causes slowing of the composting process and if it is below 20% microbial activity again slows down.

Biological Characterization

4.1.7 Calculation of Microbial Load

Image 4(f) Different colonies on a petri plate





Two different types of colonies were found marked as A and B in the above figure. Colony forming unit, CFU is given as

C.F.U= no. of colonies/inoculum size (mL) X dilution factor C.F.U/mL

Here we took inoculum size as 0.1 mL, dilution factor as 10^{-9} and observed the microbial load at every 30th day. The colonies were manually counted and on the 60th day the colonies were too numerous to count (TNTC).

Table: Variation of CFU with time

NO. OF DAYS	**C.F.U/mL**
0th	36×10^{8}
30th	9.8×10^{9}
60th	TNTC

4.2 COMPARATIVE GROWTH ANALYSIS OF SUNFLOWER PLANT

For this study, we made 4 bins containing 4 samples; Sample ‘A’ and Sample ‘C’ containing soil without compost (used as control). The other sample ‘B' containing compost and soil in the ratio of 2:1(2 parts of compost mixed with one part of soil w/w). The last sample ‘D’ had compost and soil in the ratio 1:1 (w/w). The growth of the sunflower plant Helianthus annuus was studied every week for a period of 15 days. The sunflower plant was chosen because:

1. It shows faster growth in high temperatures particularly spring season. Hence variation can be measured more precisely.
2. Easily available
3. It is drought resistant and can also survive in high levels of water. So it was apt for experimental study in a place like Rourkela where there is a lot of fluctuation in weather.

Then height and thickness of the plant were measured using the threading method. In the method the range of the thread covered after winding it around and along the stem gave the change in thickness and height of the plant respectively.

Table 4(i): Analysis of the growth of the plant measured on different dates

Dates	Parameters (in cms)	Sample A (Pure soil)	Sample B Ratio 2:1	Sample C (Pure Soil)	Sample D Ratio 1:1
12-04-2015	**Height**	11.3	11.4	11.1	11.3
	Thickness	0.21	0.22	0.23	0.24
19-04-2015	**Heigh**t	13.6	14.3	13.5	14.0
	Thickness	0.23	0.25	0.25	0.27
26-04-2015	**Height**	16.3	17.3	16.1	16.8
	Thickness	0.25	0.27	0.27	0.29

From the data we observed faster growth of plant in the Sample B with ratio 2:1 than the plant kept in the sample A containing pure soil. Similarly growth in Sample D (ratio 1:1) was found to be better than that observed in Sample C (pure soil). Hence a large amount of the food waste (measuring in tons) generated from NIT Rourkela Hostels can be used to increase soil fertility not only inside the campus but also in agricultural farms outside the campus. The increased water holding capacity of the soil, nutrient quantity and quality can improve the crop yield in places like East India where the laterite and the red soils generally lacks nutrients. The whole process if scaled up can be of a great help to the poor farmers as the method is cost effective with high returns.

4.2.2 OBSERVATION

DATE 12-04-2015

Image 4(h)

SAMPLE A (control) SAMPLE B(2:1)

SAMPLE C(control) SAMPLE D(1:1)

DATE 19-04-2015

SAMPLE A (control) SAMPLE B(2:1)

SAMPLE C(control) SAMPLE D(1:1)

DATE 26-04-2015

SAMPLE A (control) SAMPLE B(2:1)

SAMPLE C (control)

SAMPLE D(1:1)

CHAPTER 5

CONCLUSION

The project aims at the production of compost from kitchen waste and its use for the growth of plants. The compost was prepared from the kitchen waste of the hostel of NIT Rourkela and the physical and chemical characterization of the compost was done. Parameters like C:N ratio (%) and pH were found to be decreasing with respect to time. Variation in other parameters like nitrogen and carbon (%) were also studied. The moisture content was kept between 55-50%. It was found that during the composting process the carbon content and C:N ratios decrease with time. During composting 50% of the organic matter is found to be fully mineralized producing carbon di oxide and water. Plant growth study using a sunflower plant was done. It proved that compost made in a compost bin can be as effective as compost made by digging up the soil. In this way we assessed various parameters of a compost as a bio-fertilizer and then studied the comparative growth of sunflower plant. The plant grown in sample containing compost and soil in the ratio of 2:1 was found to have the best showing maximum growth among all other samples.

It was also found that the combination of micro-organisms with the compost makes it a good bio-fertilizer that improves plant growth and enhances soil fertility. Some of the advantages and disadvantages of composting process are:

ADVANTAGES: It destroys pathogens as a result of variation in many parameters, decreases bulk of raw inputs (there is a decrease as much as 50% in the final volume), stabilizes nutrients as organic compounds and the stable organic nutrients are released more slowly providing plants with a more sustained source of nutrients for growth. It is a cost-effective process. **DISADVANTAGES**: Emission of carbon di oxide, ammonia and other gases in the initial phases and run-off from the piles must be controlled to prevent movement of nutrients in the ground and aeration and moisture have to be managed throughout the process. However the advantages associated with the composting process are much more than the disadvantages particularly because of its cost-effective nature.

CHAPTER 6

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