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(Research Article)

Composting of Phumdi biomass using saw dust as bulking agent

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Abstract

Phumdis are removed from the Loktak Lake and disposed at the nearby available space and to the town (Moirang) which is very hazardous to the environment. Dumping of highly decomposable organic waste like phumdi in densely inhabited town Moirang and is very appalling act. From various studies its known that dumping of high organic waste in open area increases leachability leading to contamination of groundwater and greenhouse gas emissions. In present study, phumdi composting is done to minimize the phumdi disposal at open site, behaviour towards soil and effectiveness as a compost and promote the use of phumdi compost as an organic fertilizer. In order to meet the requirement of this studies a detailed literature review was carried out and laboratory experiments works were performed as well as on site plant studies were also conducted. Different combination of different materials was used for the composting process. From our findings the result shows addition of bulking agent enhances faster degradation process making the compost mature fastly and helps in reducing dumping at open site. Also composting can be the best alternative for utilization of this huge harvested green phumdi biomass and promoting the chemical free fertilizer.

Keywords: Composting; Phumdi; Total Kjeldahl nitrogen (TKN); Volatile Matter

1. Introduction

Due to rapid increase of global population, urbanisation and industrialization has led to fast generation of massive solid waste from various sectors likes of agricultural, commercial, domestic, industrial and institutional [1]. Rapid production of waste has led to one of the major environmental challenges of today. Among this waste, organic solid wastes emerge strong attention comprising of organic biodegradable waste. Management of this organic solid waste is a major setback mainly in less developed nations resulting in degradation of environment, atmosphere and disturbing the ecological cycles [2].

Uncontrolled dumping of organic solid wastes on outskirts of towns and cities has created serious environmental implications in terms of ground water pollution and leading to global warming also affecting public health. Scholars as well as policymakers need their attention towards managing the waste containing valuable organic matters by preventing and minimizing that worth reusing, recycling and recovering.

Current waste management systems need to admit an alternative waste disposal method, new ideas and technologies which are more conventional and sustainable and end products is a valuable resource. As an alternative waste disposal method, composting [3] can be the solution which divert waste from incinerator, landfill, pyrolysis and gasification decrease groundwater contamination, reduce air pollution and greenhouse gas emissions and generate useful end products called humus [4]. Humus helps the soil more fertile and healthier and producing high yield.

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Composting is a biological process which converts solid waste into humus that can be used as organic fertilizer. Bacteria and other microorganisms help the organic solid waste decompose faster in presence of oxygen. Compost can be either aerobic or anaerobic, but mostly aerobic composting is more favourable since they require lower technical complexity and capital investment than anaerobic composting. Aerobic composting is also less time-consuming method and minimise odour problem at lower temperature. Composting can safely transform waste to less pollutant and hazardous substances [5] reducing their possible impact to the environment thereby increasing soil fertility, crop yielding capacity [6] and water holding capacity of the soil reducing soil erosion [7].

Since there is rapid generation of solid waste, many research has carried out in composting to minimise the waste by using different materials but only few researched the phumdi composting [8] ; [9]. This research studies the composting of phumdi, its behaviour towards soil and its effectiveness as compost. This will help in creating awareness [10] and promoting chemical free fertilizer thereby enhancing soil fertility and improving plant health.

Phumdi is a floating island with a unique composition, that flows on the water surface of Loktak Lake, Manipur. Loktak Lake is one of the wetlands in India [11] among which it was declared as Ramsar Site by Ramsar Convention in 1990 [12].; [13] Phumdi are made up of dead organic matter and live biomass [14] and they are rich in nutrients.

Due to exponential rise in number of phumdi huts and human perturbation in the lake and other anthropogenic pressures led to the rapid proliferation of phumdi [14] in the lake. Phumdi proliferation in the Loktak Lake is partly attributed to the enrichment of nutrients which fuelled the growth of phumdis can choke the entire lake and reduce water holding capacity by accelerating sedimentation [14]. Being rich in nutrients they can serve as organic compost for farmers, reducing the use of harmful pesticides and chemical fertilizers.

Cow dung also called as cow manure is a natural agricultural by-product, which serves as a biofertilizer and biopesticide, enhancing soil fertility and water holding capacity. There is interaction between fungi and bacteria in presence of chlorophyll enhancing decomposition process and also helping the growth of microbial population thereby providing nutrients (nitrogen, phosphorous, manganese and potassium) to the plants [15]. By nature, cow dung possesses many benefits like anti-bacterial, pest repellent and disinfectant characteristics, also it is used as preservatives and in production of energy. The characteristics of cow dung can vary from place to place depending upon many factors including cattle diet and cattle rearing management [16].

Sawdust, a waste product of wood processing has a wide range of characteristics. Due to these characteristics its widely used in applications such as adsorption, energy production, and material recovery. Sawdust mainly consists of cellulose, hemicellulose, and lignin [17].

Composting of phumdi will make it more sustainable method than dumping the organic waste in and around the lake area by reducing environment degradation, ground water contamination and greenhouse gas emission. In this way compost can be promote and used as an organic manure [18].

2. Material and methods

2.1. Feedstocks

Phumdi was collected from Loktak lake, Manipur and brought to the Field Engineering Lab, Department of Civil Engineering, NERIST where the composting was done. The materials were grounded manually to make sure the size is within 2-5 cm. Cow dung was collected from a local cow farm at Doimukh, Arunachal Pradesh and Saw dust was bought from a furniture store located at Nirjuli, Arunachal Pradesh. Dry leaves were also gathered from the fallen tree leaves inside the campus of NERIST. Feedstock were made into two trials, P_1 and P_2. In P_1, 10 kg of phumdi was mixed with 3 kg of sawdust and 1 kg of dry leaves whereas in trial P_2, 10 kg of phumdi were mixed with 3 kg of sawdust, 2 kg of cow dung and 0.5 kg of dry leaves. Composting was done in the composting bin with a size of 1m x 2.5m x 3m and provisions were also made to get proper aeration during the process.

Figure 1 Collection of Phumdi biomass from Loktak lake, Manipur

Table 1 Initial characteristics of the feedstock materials

Parameters	Sawdust	Cow Dung	Phumdi	Dry Leaves
pH	5.74 ± 0.18	6.55 ± 0.03	6.00 ± 0.15	5.0-7.5
Nitrogen	0.33 ± 0.28	1.52 ± 0.16	2.10 ± 0.02	0.5-2.5
MC (%)	12.65 ± 4.03	85.2 ± 0.45	88.8 ± 1.2	5-15
Ammonia (mg/kg)	0.31± 0.02	28 ± 0.07	0.30 ± 0.02	10 -100
VS (%)	26.67 ± 4.7	88.6 ± 3.15	70.1 ± 1.1	70 - 90
Ash Content (%)	73.33 ± 4.73	11.4 ± 2.23	29.9 ± 1.1	10 - 30
EC (ms/cm)	4.22 ± 0.2	3.21 ± 0.02	3.1 ± 0.14	0.2-1.5
TOC (%)	49.57 ± 3.84	49.62 ± 1.76	40.5 ± 3.84	40 - 50
C: N Ratio	148.70 ± 14.85	25.85 ± 1.25	34.5 ± 5.8	20 - 80

For each trial, 500g of the compost were taken from three different points (15-20 cm below the surface) and triplicates were formed after thorough mixing of the samples. Sampling was done for every five days for both the trials for a period of 45 days. Out of the 500g, 200g were put at 4ºC for determining parameters to be measured in fresh. The remaining were oven dried at 105ºC for 24 hours to measure moisture content and the same is ground and sieved using 0.22 mm sieve. The ground sample was put inside an air tight container for further physio chemical analysis.

2.2. Physico-chemical analyses

Temperature was measured by using a digital thermometer. It was monitored from various location of the composting bin for both the trials. Moisture content was determined by putting the samples in the laboratory oven at 105ºC for 24 hours. The dried sample was then heated at 550 ºC in muffle furnace to find the volatile matter of the compost. pH and electrical conductivity were obtained by using digital pH-meter and digital conductivity meter respectively. Total Kjedahl nitrogen was measured by using Kjeldahl's Apparatus.

3. Results and Discussions

3.1. Temperature

In aerobic composting, bacteria start thriving even at lower temperatures allowing to degrade and the bacteria become active as go on and release heat leading to an increase in temperature and decomposing faster. It is observed that the addition of sawdust and cow dung together boosted the growth of microbes helping the compost to degrade faster [19].

In trials P_1 and P_2, the maximum temperature is achieved on the completion of 20th and 15th days at 56°C and 61˚C, reaching thermophilic temperature marking which is an index of decomposition. Gradually temperature has been dropped to ambient temperature in both the trials. Higher temperature helps in killing pathogens and weed destruction by the micro-organisms. For microbial activity in the compost, temperature must be maintained in the range of 50°C-70ºC.

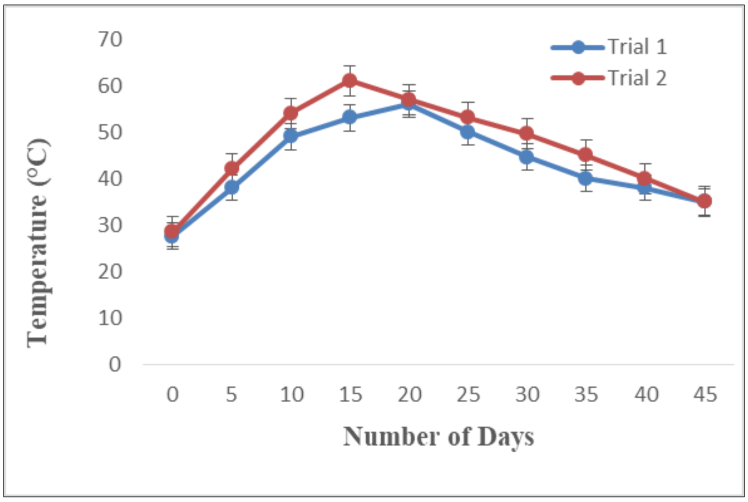

Figure 2 Variation in temperature

3.2. Moisture content

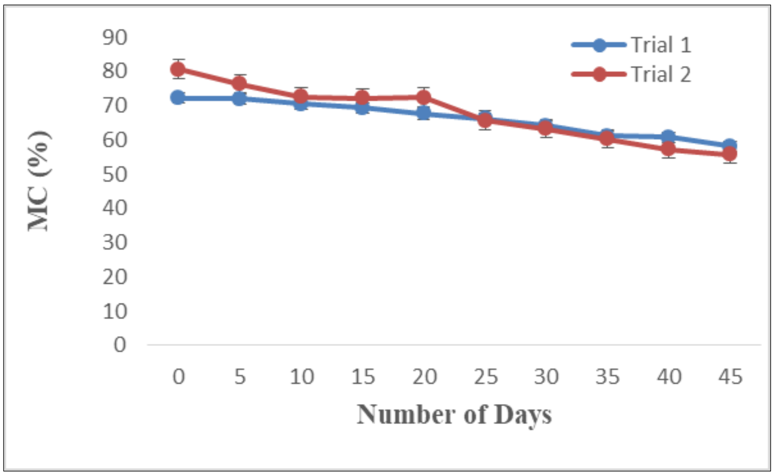

Figure 3 Variation in Moisture Content (MC) during composting

Initially at the start of composting, moisture content is high containing 72.27% in trial P_1 and 80.68% in trial P_2, which is not desirable for compost it may lead to anaerobic condition making the compost anaerobic loss of nitrogen. As temperature rises up in the compost, the moisture level gradually drops down [20] due to the evaporation and addition of bulk agent. On the 45th day of composting, the moisture value has been dropped to 58.12% in trial P_1 and 55.74% in trial P_2.

3.3. Electrical Conductivity

EC is measured because high salinity is not desirable for plant growth, higher salinity decreases the production rate of the crop [21]. High EC values in final compost slow down the plant rooting and reduce the transportation of water and nutrients into the plant. Higher the salts may also indicate high nutrient contents. EC is an indicator of the mobility of anions and cations. As we can see in the graph that EC increases gradually from 0.19% to 1017% in trial P_1 and in trial P_2 from 0.34% to 1.87%, maintaining the minimal value below 4 dS/m.

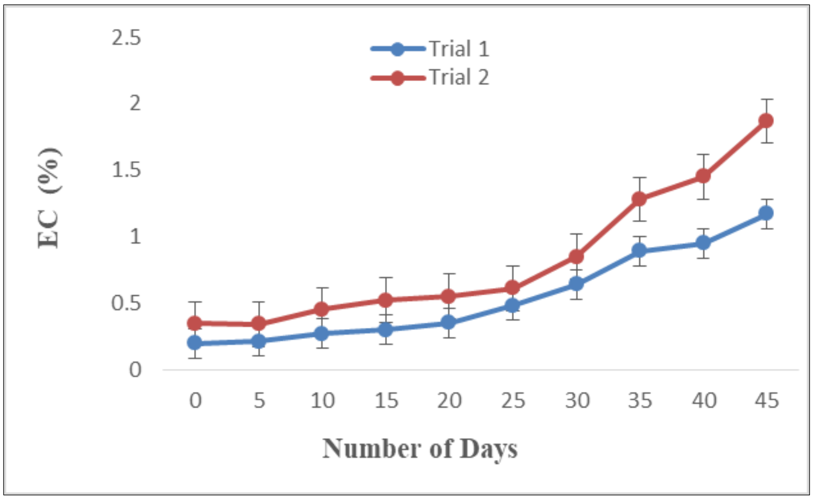

Figure 4 Variation in Electrical Conductivity (EC) during composting

3.4. pH

As decomposition started acids are formed which helps in breakdown of cellulose. pH value varies with time, the minimal pH value is observed at the starting of compost, in trial P1 its 6.5 whereas in trial P2 the value of pH is 6.8. On the 45th day of compost pH value increase in both the trial making up to 7.46 and 7.86. Throughout the observation pH is maintain between 6-8, indicating development of decomposition process**.**

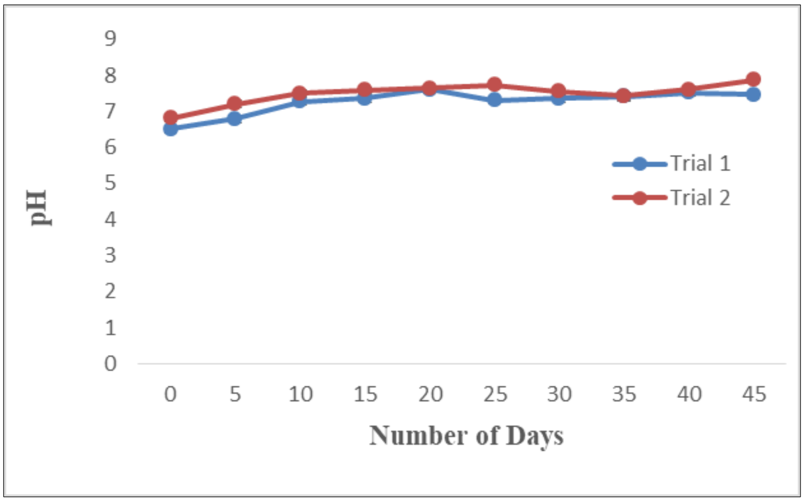

Figure 5 Variation in pH during composting period

3.5. Total Nitrogen

The total nitrogen of the samples was analysed using Kjeldahl method. For a finished compost, the normal range of nitrogen lies between 0.5% to 2.5% on a dry basis and from our observation it's found that 0.42% and 0.32% being the lowest in trial P_1 and P_2. At initial ammonia level was high as days passes level decreases as maturity of compost increases.

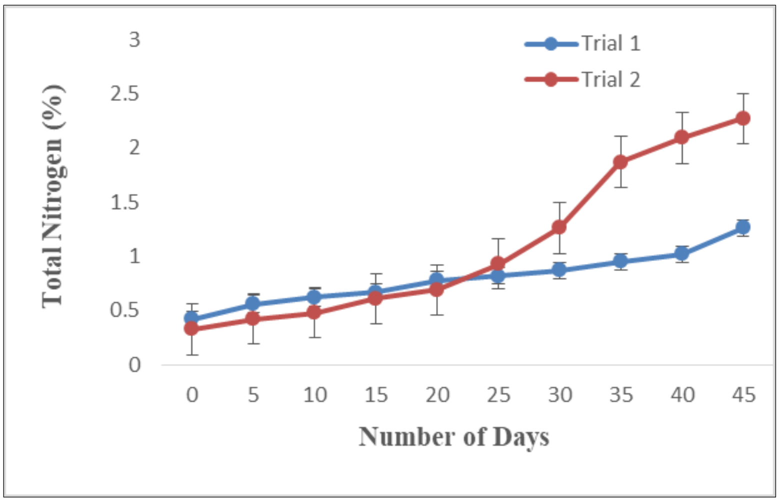

Figure 6 Variation in Total Nitrogen during composting

3.6. Volatile Solid

Present of organic matter content indicates volatile solid which decrease during the composting process due to degradation of the organic components by the microorganisms and loss of carbon in the form of CO_2. From our finding its observed that there is declination in volatile solid. In trial P_1 and P_2, present of organic matter is high due to phumdi presence reaching up to 72.27% and 80.68%. but at the end of compost due to reduce in moisture and evaporation, volatile solid value drops down to 58.12% in trial P_1 and 55.74% in trial P_2. After ignition loss of weight is classified as organic material and residual as ash.

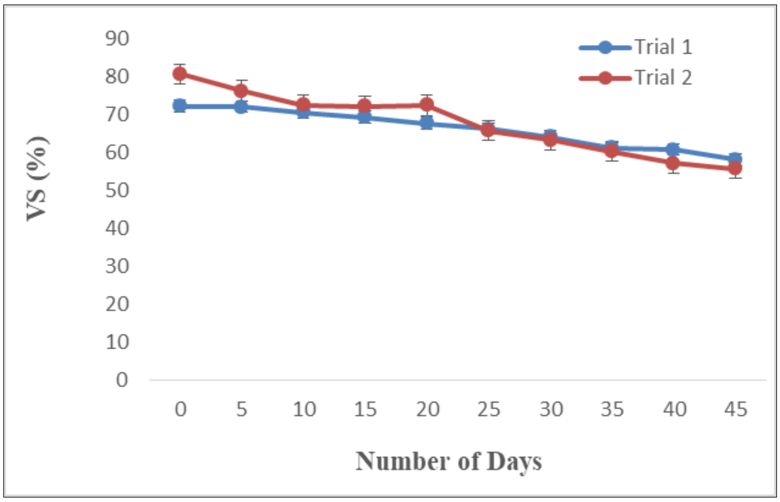

Figure 7 Variation in Volatile Solid (VS)

4. Conclusion

From our studies it can be concluded that organic phumdi biomass can be utilized effectively by converting into compost. Addition of bulking agent like sawdust enhanced the rate of degradation of biomass and converting into mature compost. The variation in the physico-chemical parameters also indicates the feasibility of using phumdi as compost feedstock material. Hence this can be also an alternative path of treating organic waste into chemical free fertilizer which further helps in replacing chemical fertilizer making it a sustainable waste management.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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