COMPOSTING OF LEATHER SHAVING DUST: WASTE TO WEALTH APPROACH IN TANNERY

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ABSTRACT

Leather industries play a vital role in the economic growth of Bangladesh. Leather processing consists of a series of chemical and mechanical operations. Each and every operation produces a substantial amount of wastes. Shaving is one of the indispensable mechanical operations where a significant amount of solid waste solid is produced known as ‘shaving dust’. This study is focused on the composting of shaving dust with cow dung and chicken manure. The leather shaving dust was mixed with the cow dung, chicken manure in different ratio maintaining carbon to nitrogen ratio 25-30:1(C/N=25-30:1) and observed for 60 days in aerobic (open-air) condition. To evaluate composting, samples were collected in different interval conducting physicochemical tests. The final composts were tested for the quantitative analysis nitrogen (N), phosphorus (P), potassium (K) and sulfur (S) content. The obtained data were compared with the standard. Results indicate that compost produce from the leather shaving dust could be used as a soil conditioner.

Keywords: *Leather shaving dust, composting, NPKS.*

1. INTRODUCTION

Every day in Bangladesh, the leather industry generate a large amount of solid waste one of which is chrome saving dust that is the by-product during leather processing. It is a matter of regret that the tanneries of Bangladesh are discharging their processing wastewater and solid waste into the green environment prior to proper treatment (Zahid, Balke, Hasan & Fleger, 2006). Solid waste from the leather industry is chrome saving dust, buffing dust, lime fleshing, raw skin trimming (Kanagaraj, Velappan, Chandra Babu & Sadulla, 2006). Leaching of toxic chemical and heavy metals from chrome saving dust affects the surrounding environments, groundwater as well as soil. So it is the major concern all over Bangladesh in the tannery sector, disposal of chrome saving dust without environment pollution as an environment-friendly substance.

Microorganisms (fungi and bacteria) and smaller animals (many types of worms, including earthworms, nematodes, beetles and other insects) turn waste materials into mature compost. Initial carbon to nitrogen ratio in the raw waste mixture is one of the important factors for microbial activity that helps in decomposition (Bertoldi, Vallini & Pera, 1983). It is suggested that an initial carbon to nitrogen ratio of 25-30 is appropriate for composting (Mathava, Yan-Liang & Jih-Gaw Lin, 2010). Composting helps to reduce the volume and moisture content, minimize potential odour, decrease pathogenic bacteria and increase potential nutrients of solid waste (Hasan, Sarker, Alamgir, Bari & Haedrich, 2012). Compost that can be applied to a cultivate land to improve the organic matter content in the soil, which will release nutrients upon decomposition and increase soil structure and cation exchange capacity (Contreras-Ramos, Alvarez-Bernal, Trujillo-Tapia & Dendooven, (2004). During composting various chemical reactions happened within the mixing raw waste material. At the period of composting, organic and inorganic compounds are transferred into more stable and complex organic substance by the successive activities of different kind of microbes (Ravindran & Sekaran, 2010). The end time and also quality of the compost differ according to the composition of the initial waste mixture being processed (Kaur, Singh, Vig, Dhaliwal & Rup, 2010).

Despite the huge potential to convert a significant portion of municipal solid waste of Bangladesh into compost, this sector suffers several setbacks. With the view of objectives, a suitable composting technology for the country, an aerobic compost plant was built. At the end of composting various physical and chemical properties of the final compost has been studied.

The main objective of this study is to make compost from leather shaving dust to reduce the tannery solid waste. The essential parameters e.g., temperature and moisture were monitored during compost. The nutrient of the compost is compared with standard.

2. MATERIALS AND METHODS

2.1 Sample collection

Chrome shaving dust was collected from SAF Industries Ltd, Nowapara, Khulna, Bangladesh just after the shaving operation in a sack and brought back to the laboratory immediately. Cow dung and chicken manure were collected from the local respective firm, Khulna, Bangladesh.

2.2 Mixing of composting ingredients

First of all, the moisture content of each ingredient was determined in order to make a homogenous mixture relative to its moisture content. The pH of the ingredients was determined using a pH (UPH-314, UNILAB, USA) meter. Table 1 shows the moisture content and pH of leather shaving dust, cow dung, and chicken manure.

Table 1: Initial moisture content and pH of ingredients

Ingredients	Moisture content (%)	pH
Leather shaving dust	38.67	3.6
Cow dung	79.11	7.2
Chicken manure	62.97	7.3

Figure 1: Mixed ingredients of leather shaving dust, cow dung and chicken manure

Figure 1 shows a mixed ingredient of composting material. The leather shaving dust (LSD), cow dung (CD) and chicken manure (CM) were mixed manually with a distinct ratio to maintain the carbon to nitrogen ratio (C/N=25-30:1) between 25-30 composting. Table 2 shows the amount of the LSD, cow CD and CM for each pile.

Table 2: Amount (kg) of ingredients of piles

Piles	LSD	CD	CM	Total Weight (kg)
Pile # 1	5	12	16	33
Pile # 2	5	15	10	30
Pile # 3	5	12	11	28

2.3 Determination of Moisture Content

About 5 g sample was weight in a conditioned crucible and placed in the drying oven at 105±5°C for 16 to 24 h. The sample was cooled in a desiccator and weighed. The procedure was repeated for extra 1 h or more until the mass of the sample remains constant. Using thermostatically controlled drying oven capable of operating to 105±3°C the sample was dried to constant weight.

2.4 Determination of pH

The pH of the sample was determined by using the pH (UPH-314, UNILAB, USA) meter. Before measuring pH, the meter was calibrated with the standard solutions.

2.5 Determination of compost nutrient

The nutrient in the compost e.g., nitrogen (N), phosphorus (P), potassium (K), and sulphur (S) test was carried out by the help of the Soil Resource Development Institute, Regional Laboratory, Daulatpur, Khulna, Bangladesh. The micro-Kjeldahl method was used for the estimation of total nitrogen content in the sample as per the procedure suggested by AOAC (1995). The P content of the compost sample was estimated by a spectrophotometric molybdo-vanadate method. The K content in the compost was determined by extracting from the compost with neutral normal ammonium acetate solution and the S was estimated by the turbidimetric method.

2.6 Determination of Conductivity, Salinity, Total Dissolved Solids

The electrical conductivity (EC), salinity and total dissolved solids (TDS) were determined using the conductivity meter (CT-676, BOECEO, Germany). Before measuring, the meter was calibrated with the standard solution.

2.7 Pilling

After the homogeneous mixture of ingredients according to their ratio of the total of three piles were set up. Piles were covered with polythene sheet in order to protect piles from rainfall maintaining a necessary gap for sufficient aeration. With the aim of maintaining aerobic (open-air) condition during the process, the piles were turned manually every 7 days.

Table 3: Pile size of composting

Piles	Length× Width× Height (cm^3)
Pile#1	33×28×18
Pile#2	31×28×18
Pile#3	28×28×28

3. RESULTS AND DISCUSSION

3.1 Temperature of compost piles

The temperature of the compost piles was monitored regularly at the centre of the compost reactor with the help of digital thermometer. Figure 2 shows the compost piles temperature during composting. The heat is generated during the composting period due to the metabolic activity of the microbes. At a different range of temperature different types of microbes present.

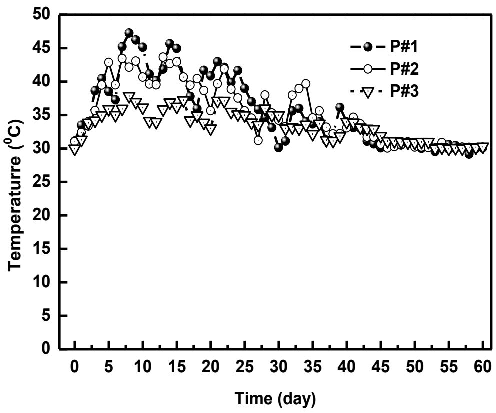

Figure 2: Change of temperature during the composting period

The temperature that carries the chemical reaction makes the remaining organic matter more stable and suitable for use as an organic fertilizer. The maximum temperature found in pile #1, pile #2 and pile #3 was 47.25°C, 43.66°C, 37.85°C on 8th, 13th and 8th days of composting, respectively. At the beginning of the compost, the temperature is almost equal to the day temperature. After a few days when sufficient microbes grew result in an increase in the temperature of the compost. From the beginning phase to intermediate phase when falling down the temperature, turning the pile usually increase the temperate of the compost. When decomposition is over, turning the pile can't increase the compost temperature. At the end of the 44th, 45th and 48th days of composting pile #1, pile #2 and pile #3 respectively balance the compost temperature with the place temperature.

3.2 Moisture of compost piles

The moisture of the sample was monitored every 10 days and measured during the following day that is depicted in Figure 2. During composting, the moisture content was adjusted with the help to sprinkling the tap water. Shyamala and Belagali (2012) reported that standard moisture content is 45%-65%. Because in composting period moisture is an important parameter for quicker degradation of organic materials, which turn into final compost. The initial moisture content in pile #1, pile #2 and pile #3 were 60.11%, 62.12% and 58.68%, respectively. It seems that gradually volume of the piles and moisture were reduced. On the 60th day, the moisture content in pile #1, pile #2 and pile #3 was 48.91%, 50.12% and 49.51% in, respectively.

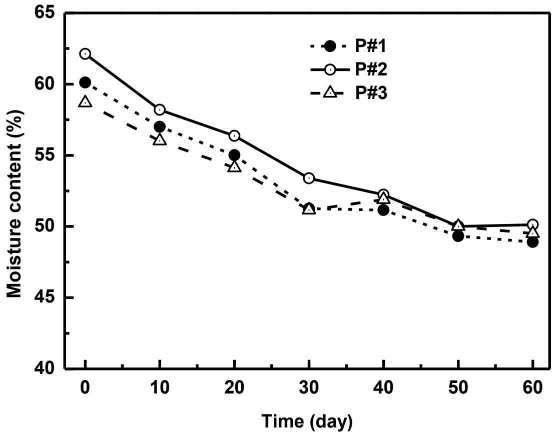

Figure 1: Moisture content during the composting period

All three final compost moisture content notify the compost standard level. If the moisture content is very low during composting that imply early dehydration of pile happened which inhibits the bacterial activity giving a physical stable but biologically unstable compost. Whereas the too high moisture content interface with the aeration by clogging the pores (Bertoldi, Vallini & Pera, 1983).

3.3 Characteristics of compost

Table 4 shows the nutrient content of the final compost in pile#1 as the nutrient N, P, K and S content were 0.50, 0.80%, 0.70% and 0.20%, respectively. All the nutrients for the pile#1 (compost ratio, LSD: CD: CM= 5:12:16) i.e. NPKS meet the standard value (N= 0.5-4.0%; P= 0.5-3.0%; K= 0.5-3.0% and S=0.1-0.5%) as declared by the Bangladesh Govt. Standard, 2013. The nutrient (NPKS) in pile#2, NPKS has ability to meet the standard value, as the values were 0.50%, 0.50%, 0.70% and 0.10%, respectively. However, the NPKS content of the pile#3 (N= 1.1%, P=1.1%, K=0.60% and S= 0.10%) compost satisfy the Bangladesh Govt. Standard, 2013 for compost. Among the three compost, the maximum N and P content were in pile#3 i.e. 1.1% and 1.1% respectively. The maximum NP content in pile#1 due to higher amount of chicken manure (CM) that is a rich source of NP content. The higher amount of S content was in pile#1. The higher the amount of P content in pile#3 and maximum amount of K content in pile#1 and pile#2.

Table 4: Physiochemical characteristics of the compost

Parameters	Pile#1	Pile#2	Pile#3	Standard	Unit
pH	7.13±0.21	6.86±0.4	6.76±0.7	6.0-8.5	-
Moisture Content	48.91±1.7	50.12±2.01	49.51±1.6	-	%
Temperature	30.56±1.8	29.94±1.5	29.41±1.2	-	°C
Conductivity	4.40±0.7	4.38±0.9	4.64±1.1	-	mS/cm
Salinity	2.56±0.6	2.46±0.7	2.53±0.4	-	Ppt
Total Dissolved Solids	2.31±0.3	2.31±0.2	2.22±0.6	-	g/L
Nitrogen (N)	0.50	0.50	1.1	0.5-4.0	%
Phosphorus (P_2O_5)	0.80	0.50	1.1	0.5-2.0	%
Potassium (K_2O)	0.70	0.70	0.60	0.5-3.0	%
Sulphur (S)	0.20	0.10	0.10	0.1-0.5	%

It might be the reason is that releasing of available P and K during decomposition of high content P and K organic substances. The minimum amount of N content was in the pile#1 and pile# 2 as the value of 0.50%. This decrease of nitrogen content might be due to the volatilization of gaseous ammonia during composting process proceeds. The earthworms known as the farmer’s friend can’t grow in a high range of pH (>9) even in the lower range of pH (<5). The optimum pH value was in the range of 6.00-9.00 (David, Roy, Edward & Michael, 1980). The pH for the pile#1, pile#2 and pile#31 was 7.13, 6.86 and 6.76 respectively. All the compost are suitable for growing earthworms.

3.1 NPKS assessment with standard

Table 4 depicts the NPKS content of the final compost. The NPKS values for the composts meet the standard value as declared by the Bangladesh Govt. Standard, 2013. The pH of the composts was within the standard level (6.0-8.5). The compost from leather shaving dust could be used as a soil conditioner.

4. CONCLUSIONS

This work is an initiative to use leather shaving dust as compost, which could be a solution to manage the solid waste in the tannery. It could be used as alternative chemical fertilizers avoiding any environmental interference. Prepared compost content the standard level of major nutrient NPKS, which is very important for plant growth. The tannery owner could take initiative to manage the leather shaving dust through to reduce the environmental load from the tannery.

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