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Composting characteristics of cow manure with bulking Agent in a batch composter

Anisa Dhroso[1], Ilirjan Malollari[1], Hasime Manaj[1], Xhersika Saliko[1]
[1]*Department of Industrial Chemistry, Faculty of Natural Sciences, University of Tirana, Albania*

Abstract:- Cow manure manure was co-composted with straw in a batch anaerobic composter, to understand the effects of physical and chemical parameters on composting, for four weeks. Process was performed at temperature 37^{o}C. Properties of the material periodically monitored during the composting process were moisture content, temperature, pH, total nitrogen, total carbon, C/N ration, and total phosphorus and total potassium were examined at the end of composting. Moisture be maintained in higher level, than 70%. Carbon to nitrogen ratio of 30 :1 was experimented.

Keywords:- Composting, anaerobic, batch, dairy manure

I. INTRODUCTION

Composting is a biological treatment in which aerobic/anaerobic thermophilic and mesophilic microorganisms use organic matter as a substrate, the main products of this process being fully-mineralized materials and stabilized organic matter (mostly humic substances). Composting is one of the technologies of integrated waste management strategies, used for the recycling of organic materials into a useful product. The application of compost to agricultural land is a practice which is gaining importance particularly due to its beneficial properties in improving soil fertility and plant growth, and reducing the potential of erosion and desertification (Gigliotti, Valentini, Erriquens and Said-Pullicino 2005). Composting stabilizes organic wastes and destroys most parasites, pathogens, and viruses contained in the wastes (Tiquia et al., 2000). However, one of the most negative effects of composting animal manures is the loss of nitrogen (N) through ammonia (NH3) volatilization which reduces the fertilizer value of the manure, and constitutes an important economic loss. Hence, composting changes the nature of the waste and can affect its usefulness as a soil amendment (Tiquia and Tam, 2000). During composting, carbonaceous and nitrogenous compounds are transformed through the activities of successive microbial populations into more stable, complex organic forms, which chemically and biologically resemble humic substances (Bernal, Alburquerque and Moral 2009). The end product obtained from composting may have some fertilizer value but it should be strongly emphasized that compost is an excellent soil conditioning agent; reducing the odour emission by decreasing the concentration of volatile compounds (Smet, Van Langenhove and De Bo, 1999), the moisture content, the potential phytotoxicity and also contributes to the elimination of pathogens (Tchobanoglous, Kreith and Williams 2002). Measuring physical (temperature, humidity) and chemical (pH, organic matter content, electric conductivity) parameters to evaluate the progress of the composting process has become a necessary step to determine the suitability of compost for different uses (Senesi and Brunetti 1996; Adani *et al.* 1997; Outmane *et al.* 2000; Eggen and Vethe 2001). The most widely used parameter for composting is the C:N ratio of the initial composting material; high initial C:N ratio will cause a slower beginning of the process and the required composting time to be longer than usual, while low initial C:N ratio results in high emission of NH_3 (Tiquia and Tam, 2000). The pH is one determination employed to characterize compost and to follow the decomposition process. From the results of batch composting, reported that pH values near 8 are optimum for composting. The increases in costs of fertilizers and the need for soil conditioners with some unproductive infertile soils may also stimulate additional interest in composting (Barberis and Nappi 1996). Many studies on composting organic waste have been conducted to determine the optimum conditions for composting process. The aim of the present study was to measure the physical and chemical parameters during composting of preselected organic wastes (dairy manure and bulking agents), in anaerobic batch. Process was performed at temperature 37^{o}C. The anaerobic process is very slow, takes place at low temperature and produces odors. The raw materials, which we used for process, were animal wastes and straw. Cow manure is commonly applied to farmland directly; hence, it frequently causes environmental problems (air and water). It will be more valuable if it is converted into an organic fertilizer, applying composting process to its application on farm land.

II. MATERIAL AND METHOD

This study was conducted using laboratory scale batch composter. The external part of body and the perforated cover were insulated using cloth to minimize heat loss. The cow manure picked out in farm which

approximately 1 kg was. Bulking agent (absorbent material), such as straw from field was used for composting. The suitable mixing weight ratio of 2 parts of manure to 1 part bulking agent. Batch composter (Fig. 1) was a cylinder type (20 x 18 cm) with 1.4 cm thickness glass material. Batch composting unit had a loading capacity of around 0.5 kg. This laboratory scale composter was built from glass cylinder, which submerged into water bath. Water temperature was controlled heating equipment, such as temperature controller. Temperature on the composting process was measured by the continuous self recording thermometer. Temperature measurements were taken at two locations, 0.10 m from the top and 0.25 from the bottom.

Fig. 1 Composting proccess scheme

Raw material were composted in seven days and after curing for one month. Storage of produced compost was ambient temperature in a vinyl chloride envelope without cover. Physical and chemical parameters of compost were analyzed at an interval of seven days. Solid waste was preliminary treated with drying, grinding and screening, and then analytically examined. If the sample contains more than 15% moisture, it must drain to ensure compliance in subsequent analyses. The following chemical and physical properties were analyzed: a pH, conductivity, moisture, ash and total concentration of N, P, K. The moisture was calculated by sample weight loss at 105 C for a period of 24 h. The pH and the EC were measured from an aqueous extract. VS were calculated by sample weight loss at 575 C for 3–4 h. The organic nitrogen was evaluated using the Kjeldahl method. After components dilution, the solution is analyzed by atomic absorption spectrometer (K) and by spectrophotometer (P). All values were below the limits established by European Guidelines. The results of experiments performed for each organic waste, were within the range given for the preparation of compost.

III. RESULTS AND DISCUSSION

The compost process depends on many factors as discussed, especially carbon-to-nitrogen ratios, moisture content, temperature, pH, EC. The art of composting is balancing these factors to achieve the final product quality in the desired level. Physical and chemical characteristics of raw materials and analysis for individual ingredients of it are shown in Table 1.

Tabela 1 Chemical and physical characteristics of raw material

	Straw	**Caw manure**
Organic matter (%)	86.02	75.5
Ash content (%)	13.95	24.5
Organic carbon (%)	47.78	41.94
Total Nitrogen (%)	0.392	2.7
C/N ratio	121.91	15.53
Phosphate (%)	0.085	0.28
Potassium (%)	2.2	1.93
pH	7.65	6.40
KE (mS/cm)	1.840	4.8

Analyzed data for physical and chemical characteristics of admixtures are shown in the following graphics. The weekly samples were analyzed for moisture content, weight, pH, ash, carbon to nitrogen ratio. Optimal moisture condition for composting depends upon composition of the mixture. Moisture plays an

essential role in the metabolism of microorganisms and indirectly in the supply of oxygen. A moisture content of 40 to 60 percent provides adequate moisture. If moisture content falls below 40 percent, bacterial activity will slow down, and will cease entirely below 15 percent. When the moisture content exceeds 60 percent, nutrients are leached, air volume is reduced, odours are produced (due to anaerobic conditions), and decomposition is slowed. Adding dry material, such as straw can also remedy an excess moisture problem. If the materials are too wet, anaerobic conditions will dominate the composting process. In our case, the moisture content of the compost mass in anaerobic batch, remained 75 - 80% (w. B).

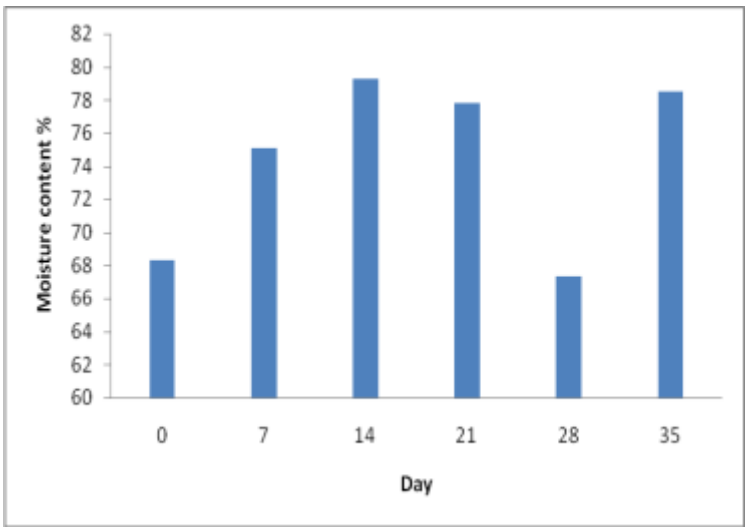

Fig. 2 Moisture content changes in compost

Determination of organic matter is a more routinely procedure for composts and provides an estimate of all substances containing organic carbon. The organic matter results obtained from batch composter are shown in figure 3. The experiment results showed a decrease in organic matter, but the composters should stay much more longer than twenty one days, to achive an optimal results, until organic matter result under 70%.

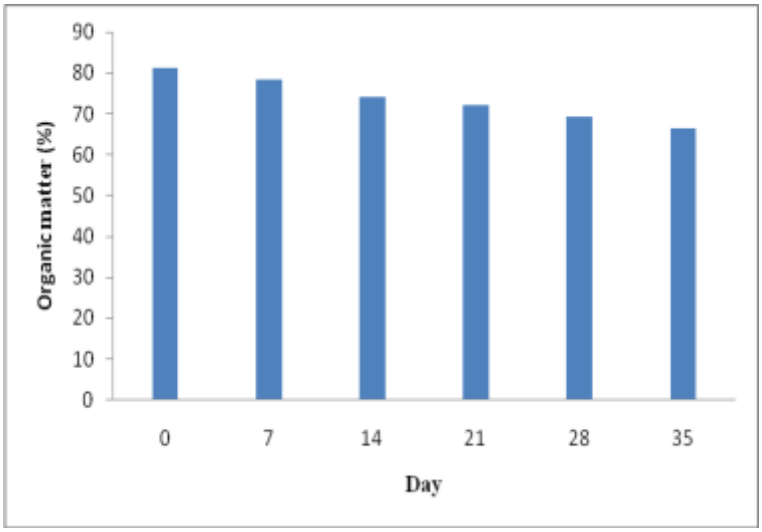

Fig. 3 Organic matter (%) results during composting process

The pH level of the composting mass typically varies with the passage of time. The initial pH of mixture during the composting process, was 7.67. The pH of the produced compost remained consistently close to 7 or 8 independent of the variations in pH for the initial mixtures. The studies carried out have shown that pH values near 8 are optimum for composting. pH values of straw was alkaline, hence compost mixture should be valuable as acid soil conditioner. pH values during composting process are presented in figure 4. In initial phase pH values reduced, due to increased amount of organic acids. Stabilization of pH values were done in the coming days.

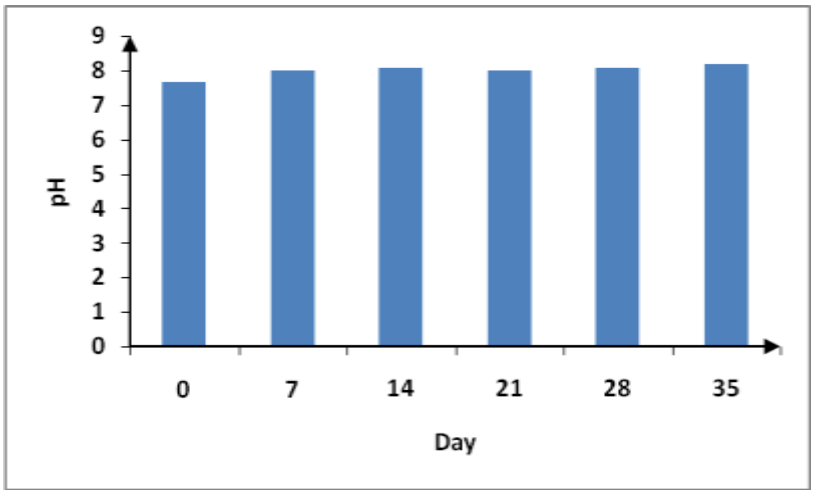

Fig. 4 pH of composting organic waste

Electrical conductivity affects the quality of compost because it reflects the suitability salinitetin and plant growth. This parameter is increased for some samples after the active phase, probably due to the release of soluble salts such as ammonia and phosphates, resulting from the decomposition of biodegradable organic subtrateve. Electrical conductivity results show that mixtures are within the allowable rate, and can be used for a wide range of plants (figure 5).

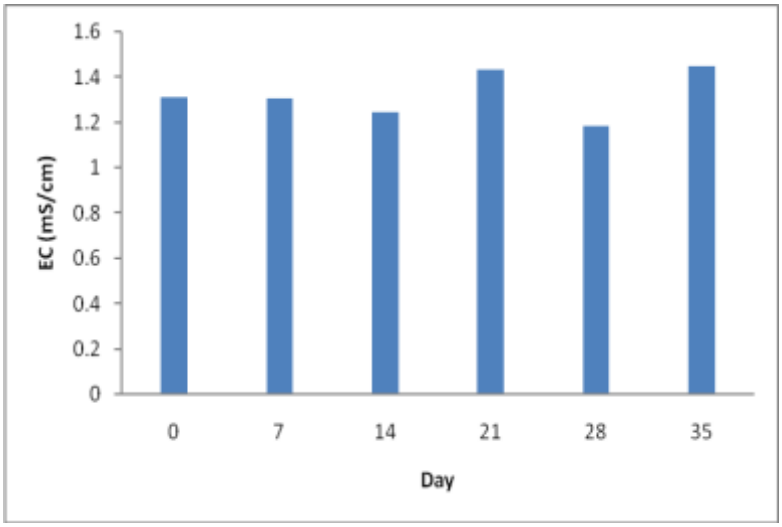

Fig. 5 EC of composting organic waste

Carbon and nitrogen compounds are important components in composting process, excessive or insufficient amounts depends in material. Microorganisms in compost digest (oxidize) carbon as an energy source, and ingest nitrogen for protein synthesis. The proportion of these two elements should approximate 30 parts carbon to 1 part nitrogen by weight. C:N ratios within the range of 25:1 to 40:1 result in an efficient process. Straw is good sources of carbon. Cow manure is a good source of nitrogen. The mixed straw compost contained 1.5 to 3.2 percent nitrogen. The initial C/N ratio of raw material was 15 for caw manure and 122 for straw, and also produced compost of it was 21 – 31. This may have been due to vigorous NH_3 volatilization during composting. At the initial C/N ratio was to high, for this reason composting was delayed. Reduction in C/N ratio of composting material is presented in Figure 6.

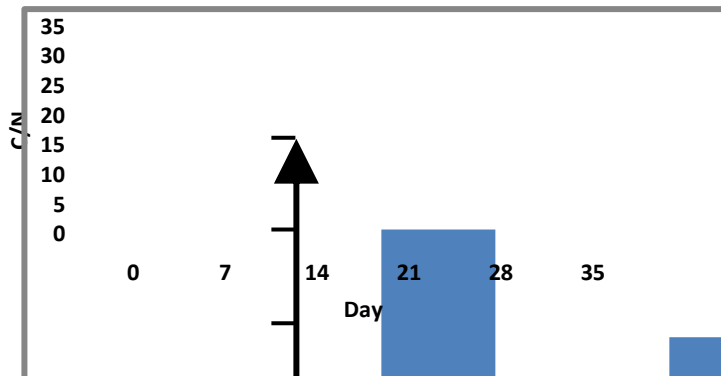

Fig. 6 C/N ratio analyses of compost

IV. CONCLUSIONS

Dairy manure is one of organic amendments that can improve the physical, chemical and biological characteristics of the soils This study was initiated to investigated the effect of initial condition about moisture content, pH value, C/N ratio, during the anaerobic composting process , mixed dairy manure with bulking agents. Degree of composting should be affected by physical factors. Dairy manure can be composted in a batch composter in around four weeks. Mixing weight ratio was of dairy manure to bulking agent successfully composted was 2 parts of manure to 1 part bulking agent. Favorable moisture content of initial condition was ranged from 60-65 % (w. b.), during the process was maintained 70-85%. It could not be composted satisfactory due to the initial low pH value. The pH of the produced compost remained consistently close to 7 or 8 independent of the variations in pH for the initial mixtures. The influence of the nitrogen component on the decomposition was very important. The carbon-to-nitrogen ratio (C:N) is a major nutrient factor. Adequate levels of phosphorus and potassium are also important in the composting process and are normally present in farm organic material such as manure. Concentration of macro and micro nutrients such a nitrogen, phosphorus and potassium in finished compost was higher than that of initial compost. Initial phosphorus content was 0.173, and in the end was 0.201; and potassium content 1.13 to 1.41.

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