STUDY OF INFLUENCE OF CARBON/NITROGEN RATION ON COMPOST OF CELLULOSIC WASTE

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Abstract

Composting is an old and inexpensive method to converts organic waste into useful material (compost) that can be used as soil conditioner and organic fertilizer. Composting is a self-heating, aerobic, solid-phase biological accelerated natural process of biodegradation and mineralization of organic matter. Industrial composting is a controlled process. The main objectives of this process are to maximize the hygienization and biodegradation/mineralization. The C/N ratio is an important quality parameter when using compost as a soil amendment, because materials with a high C/N ratio can immobilize soil nitrogen by the on going decomposition of the carbonaceous substances once the compost has been applied to soil. The ratio decreases as composting progresses because of the conversion of organic C to CO_2. At the same time, part of the nitrogen can be lost in form of NH_3. C/N ratio can either be measured in the compost or in an aqueous extract. Normally, a C/N ratio of less than 20 in mature compost is thought to be desirable. However, C/N values measured in sufficiently stabilized composts varied between 5 and 20, depending on the type of raw material. In this paper was studied the influence of vegetal waste/pig slurry weight ration on the quality of compost. Moisture, temperature, pH values, volatile organic carbon, total organic carbon, Kjeldahl nitrogen and ash content were monitored for 63 days.

Keywords: aerobic process, biodegradation, composting, vegetable waste

I. INTRODUCTION

The composting process is an old and inexpensive (low cost) method that converts organic waste into useful material (compost) that can be used as soil conditioner and organic fertilizer (Chang J.I., 2006). During composting, the compounds that contained the carbon and nitrogen are transformed through the activities of successive microbial populations into more stable complex organic forms namely humus substances, (Haynes R.J., 1986). Carbon (C), nitrogen (N), phosphorus (P) and potassium (K) are the primary nutrients required by the microorganisms involved in composting. Nitrogen, phosphorus and potassium are also the primary nutrients for plants, so nutrient concentrations also influence the value of the compost, (Pare´ T., et al., 1998). Excessive or insufficient carbon or nitrogen will affect the process. Carbon provides microorganisms with both energy and growth; nitrogen is essential for protein and reproduction. Metabolic activity evolution is affected by the chemical composition of starting material, moisture, temperature, pH, the turning frequency, the oxygen input and the particle size. (Beffa T., et all., 1998).

The ratio of carbon to nitrogen, C/N of 25:1 to 35:1 are ideal for active composting, although initial ratios of 20:1 up to 40:1 consistently give good results, in general, biological organisms need about 25 times more carbon than nitrogen. (Haug, R. T., 1994);

Other parameter that influences the composting process is temperature. The composting process is based predominantly on microorganisms which grow in the temperature range from 25 to 60°C, mesophilic(<45°C) and moderately thermophilic (40 to 60°C)organisms. Elevated temperatures (>60°C) lead to inactivation of mesophilic microorganisms (Webley, D. M., 1947), destruction of pathogens, it reduces the level and activities of desired microorganisms that are important in the composting process, (Kiyohiko, N., and all., 1985).

The preferred pH is in the range of 5.5-8.0. pH does become a consideration with raw materials containing a high percentage of nitrogen. A high pH, above 8.5, encourages the conversion of nitrogen compounds to ammonia, (Zuccconi, F., and Bertoldi, M., 1987).

Growth and movement of microorganisms is only possible in an aqueous solution, in the water film that envelops the compost particles. As well, uptake of nutrients takes mainly place if they are dissolved in water. However, a water deficiency decrease the mobility of microorganisms and a water surplus can dilute the nutrients concentration. The moisture content in range 45-55% is sufficient to allow optimum activity without releasing leachates, (Beffa T., et all. 1997), but can be in range 50 and 70 % by ensuring adequate oxygen supply (over 15% O_2 concentration in the flue gas) (Bertoldi, M., and all., 1988; Miller, F.C., 1993),

The initial structure and the size of the composting mass to ensure an optimized aeration (passive or mechanical) required for an efficient aerobic degradation process. This rate is directly related to the type of waste and to the phase (initial, intermediary and terminal) of the composting process. The composting process will be not limited if 10 % interstitial oxygen is present. Thick water films in overly hydrated composts and small pore sizes will hinder the oxygen diffusion, (Beffa T., 2002). The particle size of mixture varied from 1.3 to 7.6 cm (Gray, K.R, 1971) and a minimal free air space of 30%, allowing the uniform air flow through (Haug R.T., 1993).

The present study was carried out in order to emphasize the effect of C/N ratio on the composting process of mixture between marc resulted from the distillation of fermented fruits distillery, sawdust and pig slurry. Marc resulting from of the fermented fruits (plum, apples, and peaches) distillery was selected as the one of composting materials. Mark has a high moisture content, 93.8%, and hasn't the porosity necessary so that the composting process is difficult. In order to reduce humidity and increase the porosity of mixture was used sawdust. To ensure a mixture a C/N ration in the optimal range was used pig manure, (Miller F.C., 1989).

II. EXPERIMENTS

The organic mixtures composed from marc, sawdust and pig slurry were introduced in plastic recipients with 1L capacity. Recipients present small holes for a good aeration of composting mixture.

Table 1. The initial composting mixtures composition and characterization

Mixture	Mixture composition, dry weight			Mixture characterization		
	marc	sawdust	pig slurry	Moisture, %	C/N ratio	N, %
R	50	50	0	87.2	30	1.6
R0	50	25	5	89.4	21	2.1
R1	50	50	5	86.7	28	1.7
R2	50	75	5	84.2	35	1.5
R3	50	50	10	86.6	26	1.8
R4	50	50	20	85.5	23	2.0

The composting mixture were incubated at 45ºC, temperature that characterization the maximum biodegradation in composting system, the moisture was watered regularly to maintain moisture level between 50- 60%, (Beffa T., et all, 1997).

Every 7 days, for 63 days, the moisture, organic carbon, Kjeldahl nitrogen, pH and conductivity were determined contents from samples The carbon content was determined by combustion at 800ºC according to the standard RS 2505/2003, the Kjeldahl nitrogen method was determined according to RS 6417/1993, using a distillation unit, Velp Scientifica UDK 130D.

The wet samples taken from the reactor were extracted with bidistilled water (1g/10cm^3 sample to water ratio). After the solution had been allowed to equilibrate for 30 min with occasional stirring, a pH-meter (Jenway 370pH/mv) was used to measure the pH value and the conductivity was determined using a conductometer, Jenway 470. Aqueous compost extracts were prepared by placing 10 g of compost sample (dry weight) in a 250 cm^3 beaker filled with 100 cm^3 of distilled water, and shaking (125rot.min) for 2 h at room temperature.

III. RESULTS AND DISCUSSIONS

Initial the moisture content varied between 85-90% and the value decrease fast during the first 10 days for all composting mixtures. Thereafter, during the following days (10-63) the moisture content was maintained within 50-60%.

The profile of pH evolution and influence of sawdust and slurry shares are presented in figures 1 and 2 respectively. Increasing the share of sawdust and pig slurry in composting systems involves increasing the rate of composting and the pH value in the compost. The final pH values in composting systems are according the international standards, EPA 40 CFR 503 13

The composting process is finished after 49 of day in all system and starts the maturation process. The presence of pig slurry in the composting mixture determine the obtaining a compost with a higher pH.

Influence of sawdust and pig slurry weight on the C/N ratio evolution in time is showed in figures 3 and 4. The increasing of the sawdust weight in the composting systems involves the increase of C/N ration and the decrease the quality of the mature compost. For a initial C/N ration of 20.75 the final is 8.4 that characterization a compost from Class I according compost/ soil amendment classification of the EPA 40 CFR 503 13. If the initial C/N ration is 35 the final is 14.6 that are specifically for compost from a lower Class I to Class II. For obtaining high quality compost is necessary that the marc/sawdust dry weight ratio varied between 0.5-1.

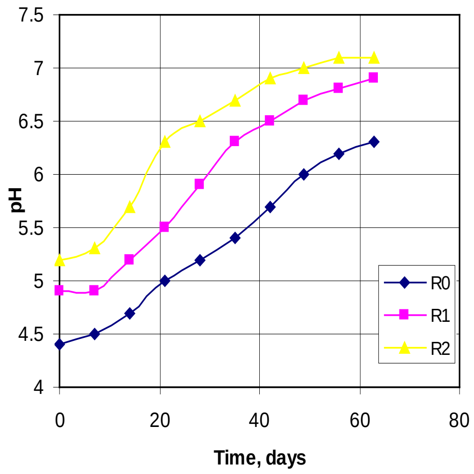

Figure 1 – Influence of sawdust ration on the pH variation in time

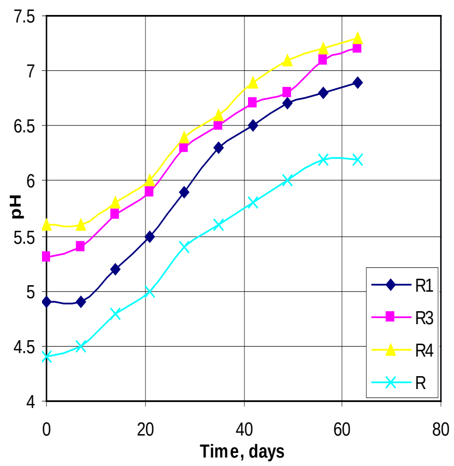

Figure 2 - Influence of pig slurry ratio on the pH variation in time

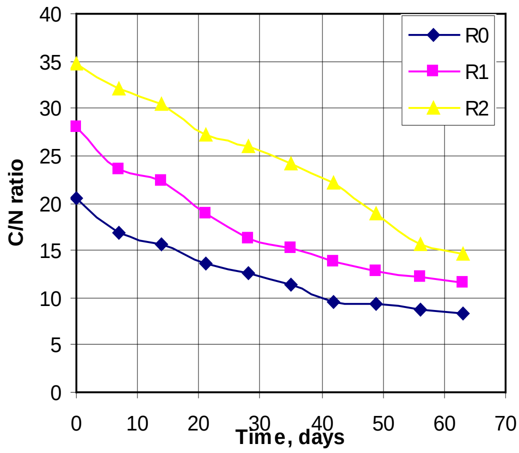

Figure 3 – Influence of sawdust weight on the C/N ratio variation in time

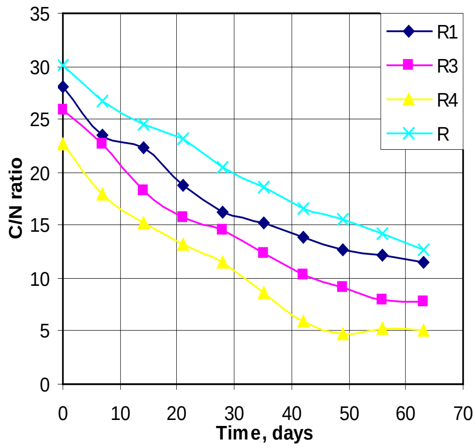

Figure 4. Influence of pig slurry weight on the C/N ratio variation in time

The increase of weight of pig slurry in the composting system involves de decrease of C/N ratio, if the initial ratio varied in range 30 to 22 the final varied in range 12 to 5 that characterizing the Class I of mature compost. In conclusion for obtaining the great quality for compost the dry weight ratio between marc and pig slurry can varied in range 2.5-10.

The conductivity variation in the composting systems was showed in figures 5 and 6 conductivity is a parameter that reveals the maturation degree. Because the values of conductivity are greater that the value characteristic for Class I reveals that the composting system didn't achieved the maturation stage. The increase of sawdust weight in system involves the increase of conductivity and decrease the quality of compost. Similar the increase of pig slurry weight involve the increase of conductivity and the time necessary for composting process increase.

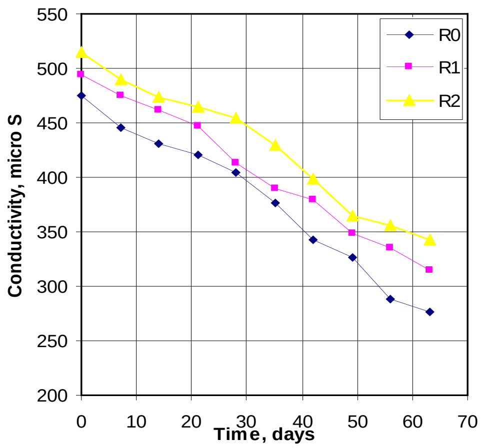

Figure 5. Influence of sawdust weight on the conductivity variation in time

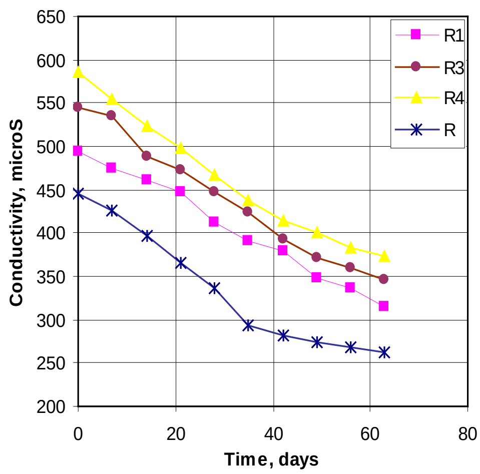

Figure 6. Influence of pig slurry weight on the conductivity variation in time

IV. CONCLUSIONS

Adding the sawdust and pig slurry at marc waste involve an increasing of compost quality. A higher quantity of sawdust and pig slurry determines the decreasing of compost quality.

Optimal ratios to mixing between marc/sawdust and marc/pig slurry in dry weight are 0.5-1 and 2.5-10 respectively when the composts obtained fall in Class I according Compost/ soil amendment classification of the EPA 40 CFR 503 13, Guidelines and procedures for production of compost in Colorado Department of Public Health and Environment.

After 49 days begins the maturation process in all composting systems.

The presence of pig slurry in the composting system involving a increase of composting rate and a increase of nitrogen compounds in a final compost composition.

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