The effect of C/N ratio and fraction distribution on air demand of compost prisms during slaughtered waste composting

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Introduction

According to a change in the law forage products cannot be made of slaughtered wastes and perished animal products. The protein production technologies will be restricted to the disposal of hazardous wastes on animal health. The burning of the meal - made of valuable parts - in power plants is energetically not economical and hazardous on the environment. The composting of pretreated animal wastes is the most economical environment-sparing method, and fits in the natural cycle of the plant nutritients. At the same time there is no industrial composting technology of these kind of wastes which gives a stable, odourless product that appropriated to the animal health conditions.

During composting too main processes take place: the synthesis and degradation. Using the correct raw materials the optimal conditions of composting can be establishing, like C/N ratio, oxygen-balance, moisture content and temperature. The optimal nutrient content and grain distribution should be ensured during the chose of raw materials to determine the microbiological processes (Petróczki and Késmárki, 2003). The optimal C/N ratio can be modified with the rate of the mixed components. The aeration of the prism is determined by the grain size and fraction distribution.

The oxygen is an important factor during composting because of the following three reasons: the microbiological degradation; the depression of the moisture content and the temperature-control.

The microbes can use oxygen from two sources: from the air and from the oxygen content of the organic compounds (Haug, 1993).

During composting the first case is common. That process is called dry-rot. In this situation the aerob microbes oxygenate the organic compounds, carbon-dioxide and simpler compounds arose while heat disengages (Nakasaki and Othaki, 2002). For the thermofil organism 14-17% oxygen rate us optimal (Benedek, 1990). If this value decreases under 10%, the aerob microbiological processes stop.

The structure, the voidage is very important to settle the aerobic conditions and ensure the optimal aeration. This means that the material should be loose and should contain as much structuring material that ensures the continuous air-flow from the border of the prism to the core. If the air flow is low the system goes to anaerobic rot which is very harmful for the composting process.

Because of the effective oxidation it is important that the oxygen should go inside the particles. A concentration gradient evolves because of oxidation and effects and oxygen transport from the gas phase inside to the particles. The effectiveness of the transport is determined by the inner and outside partial pressure. The speed of composting depends on the degradation of the material and the speed of oxygen transport. Commonly, the oxygen transport is the limitation factor (Hamelers, 1995). During optimal degradation processes 30% of pore is required, which is reached by mixing structure-remedial materials (straw, wood clippings, green wastes, saw dust, etc.) (Alexa and Dér, 1998, Kocsis, 2005).

The continuous rotating and aeration inhibits the too large heat. Because of the higher temperature the evaporation starts up, which decreases the moisture content (Fazekas et al., 2000).

If there is not enough oxygen in the system during composting anaerobic conditions appear while the microbes uses reduction of the organic compounds to ensure the required oxygen. In this case odorous gases arose thanks to the ammonia, hydrogen sulphide and methane production (Simándi, 2007).

The aim of the study to analyze the affects of C/N ratio grain size distribution on oxygen-consumption. During the experiment we examined the intensive composting technologies of different mixtures of treated and non-treated slaughtered wastes with organic manure. We were following the oxygen consumption of the degradation, and determined the effect of fraction distribution on oxygen consumption.

Materials and Methods

The research was made on a composting plant near to Nyírbátor in northeast part of Hungary, which is the property of the Bátortrade Ltd. The plant is the larges intensive composting plant in Hungary which is supplied with oxygen-injection. The plant contains 14 composting silo. The volumetric capacity is 150 t for each room. The input material is covered with GORE™ folia, which does not allow the moisture to get inside and outside. The system is closed, no odorous gas emission. The produced gases are eliminated by vent hoods. The aeration is achieved by ventilators through the drainpipes under the compost rooms. The air flow of injection is 0,38 m^3/s. The air injection and the temperature is controlled with computers.

The composting plant is special because the larger part of the input materials are slaughtered wastes such as poultry feather, animal fur and preheated animal bones. Because of the low C/N ratio the wastes were mixed with straw dairy manure and poultry manure (*Table 1.*).

Table 1. Parameters of the used input materials

Input material	C (mg/kg)	N (mg/kg)	C/N ratio	Bulk density
Poultry feather	8,57	2,61	3,3	0,483
Animal fur	41,59	15,19	2,74	0,206
Preheated bones	17,28	5,4	3,2	0,72
Dairy manure	45,6	2,4	19	0,8616
Poultry manure	37,8	2,7	14	0,5124
Straw	44,3	2,06	21,5	0,295

Results and discussion

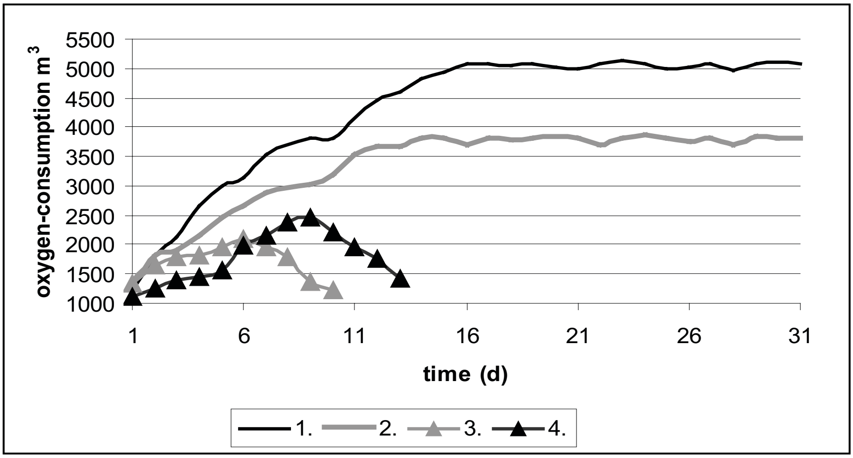
During the experiment 4 different compost recipes were implemented. The different mixing rates are shown in *Table 2*.

Table 2. The used input materials and the mixing rates of the installed experiments

No.	Dairy	Straw (t)	Feather (t) manure (t)	Poultry manure (t)	Fur (t)	Preheated bone (t)	C/N ratio
1.	72	19	36				15,7
2.		203	40			3,2	16
3.	54,4		32	20,8		16	4,3
4.		11,8	15		3	18	6

The values pf C/N ratio were different at each compost mixtures (*Table 2.*). in the first 2 cases the ratio was optimal, while during experiment 3 and 4 the C/N ratio was disadvantageous. In experiment 1 the huge amount of dairy manure and straw could compensate the low C/N ratio of poultry feather. In the recipe 2 also the effect of straw was determinative. In experiment 3 the dairy and poultry manure could not correct the effects of feather and bones because the rate of slaughter wastes was too large. In experiment 4 the amount of puffer materials was very small compared with the slaughter wastes. During the experiment 3 and 4 anaerobic conditions were realized, the mixture started to rot. The oxygen-balance of the prism was not optimal neither of the continuous rotation.

Figure 1, The oxygen consumption of the different mixtures



The necessary air flow was also different in each case (*Figure 1.*). In mixture 3 and 4 the oxygen consumption in the beginning was the same as it was in the cases where the C/N ratio was optimal. In the second part of the process the oxygen consumption decreased because of the low C/N ratio. The experience was stopped because the degradation moved to anaerobic way. The difference in oxygen consumption in the first two cases was caused by the different particle size distribution.

The smallest grain size belonged to the dairy and poultry manure because the crushing did not forestall the utilization of slaughter wastes. Because of the smaller particle size the oxygen reached the core of the grains so the degradation was effective in the mixtures where manure was used.

Comparing the different slaughter wastes the smallest grain sized belonged to the animal bone because it was preheated, so the difficult organic compounds went to smaller and simpler pieces. The grain size of the animal fur is small, but it is clotting and has a large resistant ability. The poultry feather has a large surface, very flexible so it cannot be utilized for composting just after crushing or pretreatments. The large keratin content also limits the utilization of the feather.

Conclusions

During the determination of the input materials we should endeavor to establish optimal C/N ratio. The disadvantageous slaughter wastes, with low C/N ratio, can only be utilized effectively for composting with large amount of puffer materials. The low C/N ratio decrease the effectiveness of degradation and may cause anaerobic conditions.

The establishment of the particle size also influences the degradation through the oxygen consumption. The grain size of the untreated slaughter wastes is unfavorable so some kind of pretreatment should be utilized before composting.

The 135°C heat-treatment can give a solution for this problem for bones but for poultry feather and animal fur a more effective treatment should be used. Crushing cannot be implemented because the feather and fur is very flexible wrap around the parts of the crusher. The more advantageous is the heat and pretreatment with bacteria species, which leads to simpler structures with the degradation of the sulphide-bridges.

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