THE COMPOSTING OF WASTES FROM LIVESTOCK PRODUCTION

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Abstract

The work purpose of this article was to find out the influence of aeration on waste composting on base of animal tissues and to find the course of their breakdown pursuant to different combination of substrates. The importance of waste composting from animal production and their stabilization is by reasons of effective carbon sequestration in the soil and by the possibilities of waste decontamination with their pertinent use at following fertilization. The experiments were realized in 50 l fermenters with six different raw material compositions of compost and with different aeration. It was found, that the enhancement of aeration has the influence on higher compost stability only in such compostable wastes and at compliance of further important parameters in compost raw material composition, especially in the optimal C/N ratio (30:1).

Key words: compost stabilization, compost maturity, carbon sequestration, animal tissues, compost aeration, phytotoxicity, bioassay

INTRODUCTION

On all states with higher ecological feeling happen in the last years the development of aerobic composting focused on biomass or communal biowaste. Today, with the prohibition of by-products from animal production in abroad for fodder use, it considers on their exploitation to produce aerobic stabilized compost. For order of European parliament and EC Council 1744/2002, which determines hygienic rules concerning above-mentioned hygienic by-products, allows the possibility to use materials elaborated on rendering plant destructor to beard-bone flour and rendering fats and in less risk material, it allows also composting of only mechanically modified and sterilized material.

In this work we want to judge the possibilities of waste aerobic composting on base of animal tissues in comparison with composting of vegetable wastes (Vana et al.; 2000) from views of product stability (Adani et al.; 2003) and other parameters (e.g. content of vegetable nutrients) decisive for agronomical fertilizer effectivity (Munoz et al.; 2000).

Hygiene in these procedures depends upon manners of animal tissue adjustment and on fermentative conditions of the experiment. The aerobic waste composting on base of animal tissue sticks out all series of problems, whose unambiguous solution is impossible find in scientific literature. The experimental works with composting of animal tissues are focused above all on completion of hygiene conditions less to achieve stable, inodorous organic fertilizer, which won't be have tendency to acidify, to liquefy and the growth of phytotoxicity (Vana, 1997).

Series of foreign authors at waste use on base of animal tissue prefer the production of meat-bone meal and similar flours also at the cost that will be necessary further use like fuel or to prepare for anaerobic digestion (Kern M., Sprick W. 1994; Weimer et al., 1997). From our present knowledge (Munoz, 2002) follows that at compliance of right composting practice (Kotoulova, Vana, 2001) and especially an optimal raw material composition of the compost, it can use also wastes of animal tissue for aerobic composting.

MATERIAL AND METHODS

This work deals with experimental finding of fundamental parameters for the course at aerobic substrate fermentation with a share of waste from animal tissue in comparison with aerobic substrate fermentation on base of plant biomass and animal feces. The experiment was realized in a system of heat-insulated 50 liters biofermenters aerated by wetting air (15 l/h per biofermenter) about temperatures of 30°C for the duration of 10 weeks.

At formation of raw material composition in fresh compost the outlines was the optimization of C:N ration to approx. 30:1. A correction was realized by the addition of ammonium sulfate. The water content had instilled by 50 % of volume compost porosity. Optimal humidity moves at weight intervals of 61.6 – 64 %. In the fermentative experiment was testing mechanically treated waste from animal tissues, whose parameters are in the table n. 1.

The monitoring of qualitative characters of tested wastes was focused not only on parameters influencing the course of compost maturity, but also on the content of risk elements, decisive for the use manner of the produced compost. In the control combination is the waste share from animal tissue replaced by fresh dung, whose qualitative characters are introduced as well in the tab. 1.

Tab.1: Quality characters of tested waste from animal origin.

Quality character	Unit	Mechanical fleshing	Tannic chippings	Piggy beards	Meat meal	Piggery sinew	Dung
Moisture	%	78.07	20.28	11.0	12.84	25.12	80.10
Combustible substances	% D.M.	83.23	93.96	94.04	95.12	96.05	82.10
C_{ox}	% D.M.	31.62	46.03	50.32	44.93	49.90	41.0
N_{tot}.	% D.M.	12.39	9.26	15.01	8.82	13.12	2.3
$P_{tot.}$	% D.M.	0.15	0.03	0.04	0.33	0.30	0.60
K_{tot}.	% D.M.	0.24	0.03	0.10	0.06	0.15	1.40
Cu_{tot}.	% D.M.	9.68	0.18	0.12	0.30	0.45	1.11
$Mg_{tot.}$	% D.M.	0.36	0.01	0.09	0.03	0.19	0.28
As	mg/kg D.M.	2.10	1.80	2.56	1.12	2.00	1.08
Cd	mg/kg D.M.	0.02	0.01	0.08	0.06	0.09	0.51
Cr	mg/kg D.M.	1.30	4.80	3.00	2.12	2.10	3.21
Cu	mg/kg D.M.	2.10	1.50	1.90	1.19	3.12	4.15
Hg	mg/kg D.M.	0.05	0.14	0.20	0.09	0.07	0.41
Mo	mg/kg D.M.	0.92	0.95	0.83	0.97	1.05	2.05
Ni	mg/kg D.M.	0.18	0.16	0.12	0.19	1.10	3.12
Pb	mg/kg D.M.	0.50	0.40	0.93	0.70	1.20	4.12
Zn	mg/kg D.M.	7.00	1.00	8.80	4.40	9.99	93.20

In the raw material composition of every combination with the content of animal tissue was safeguard also 15 % of share in seed-bed soil like a source of suitable microflora. In the control combination was added hot-bed earth only 5 %. In some combinations was provided also the correction of humidity with the addition of distilled water. Piggery sinews, mechanical fleshing and chippings were milling to size 12 mm. Raw material composition of particular combinations is cited in the tab. 2.

Tab. 2: Raw material composition of particular combinations in % of weight.

Waste	**Combinations**					
	1	**2**	**3**	**4**	**5**	**6**
Hammer-milled bark	60	60	60	60	60	30
Seed-bed soil	15	15	15	15	15	5
Mechanical fleshing	25	--	--	--	--	--
Tannic chippings	--	25	--	--	--	--
Piggy beards	--	--	25	--	--	--
Meat meal	--	--	--	25	--	--
Piggery sinew	--	--	--	--	25	--
Dung	--	--	--	--	--	65

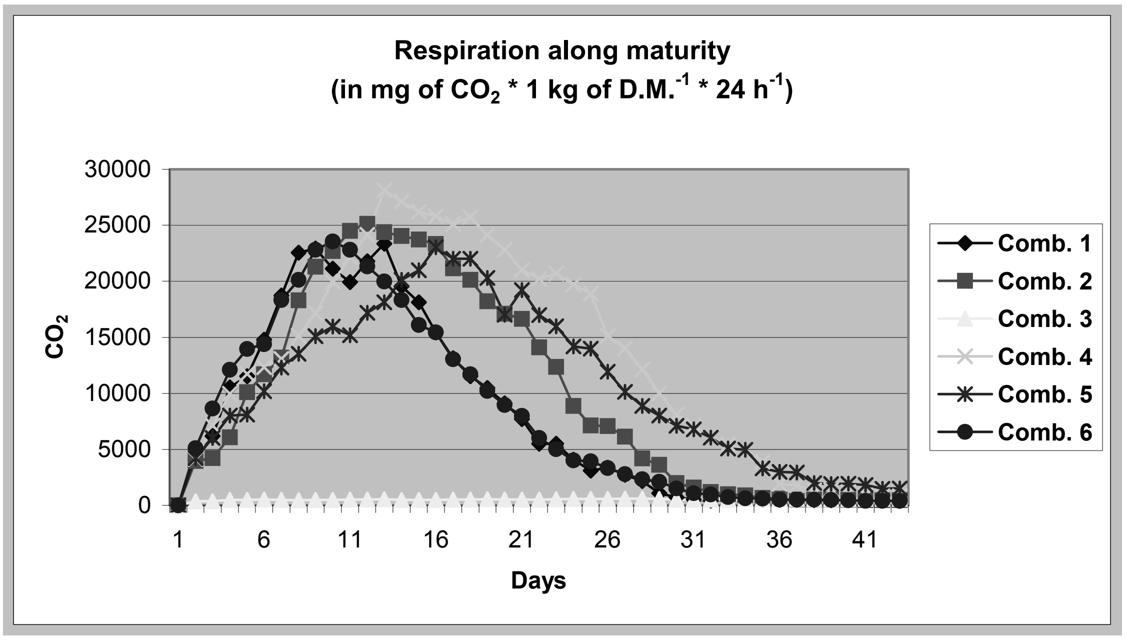
The charge of fresh substrate into each biofermenter constitutes 10 kg. Along fermentation was measured substrate temperature, deaeration variance and CO_2 content in deaeration arrangement Infralyt IV. From verified values is calculated CO_2 respiration in mg per kg of substrate dry matter under period of 24 hours.

The losses of carbon after experiment finalization are compared by its original content in freshly charge. Along maturity is fixed substrate stability by the help of bioassay (Reichlova et al., 1996) based on phytotoxicity water leach verification.

Tab.3: Changes of Carbon along maturity period of particular combinations

Combination	Filling (g)	Dry Matter (g)	Combustible substances in D.M. (%)	Combustible substances in D.M. (g)	C (g)	Losses of CO_2 (g)	Losses of C (g)	Losses of C (%)
1	10,000	3600	74.5	2682	1341	336.98	91.6	6.83
2	10,000	3720	68.9	2563	1281	424.56	115.4	9.01
3	10,000	3650	80.1	2924	1462	21.89	5.95	0.41
4	10,000	3600	73.2	2635	1318	560.28	152.40	11.56
5	10,000	3590	75.1	2696	1348	458.68	124.76	9.25
6	10,000	3530	70.9	2503	1251	297.40	80.89	6.46

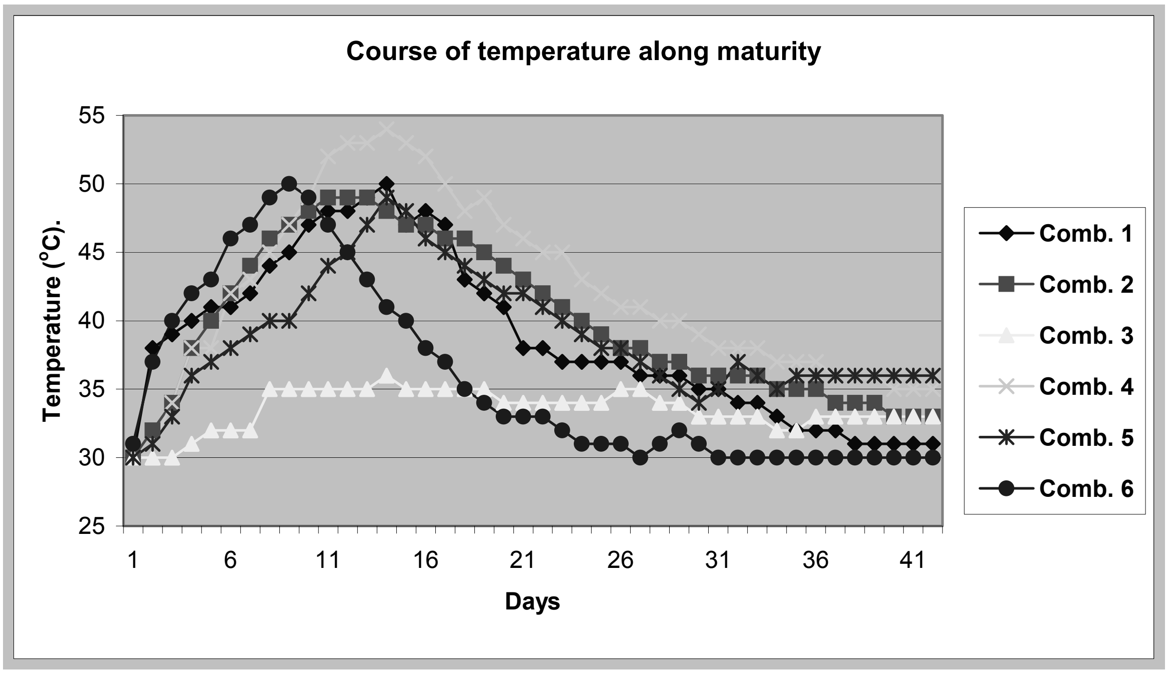
Fig.1: Respiration of compost along maturity (in mg of CO_2/1 kg of D.M. at 24 h).



Tab. 4: Phytotoxicity index along compost ripeness in %.

Period of ripeness	1	2	3	4	5	6
Start	54.3	53.8	69.9	56.7	35.8	52.4
3 Weeks	30.2	29.6	66.7	28.8	28.9	32.1
6 Weeks	64.4	68.9	70.3	82.2	68.2	81.3

Fig. 2: Mean temperatures along maturity (in °C).



RESULTS AND DISCUSSION

The course of temperatures in particular variants denotes the intensity of aerobic fermentation. Maximal temperatures of 50.5°C was reached in the control combination n. 6 along 10 days and from the all tested variants the n. 1 achieved identical temperatures containing mechanically treated waste of mechanical fleshing, but as far as 15 day of maturity. With the exception of combination n. 3 containing piggish beard, where temperature only gently exceeds 35°C, achieved the other combinations maximal at intervals 47 - 49°C (fig.1). In days of achievement thermal maxima and in period of temperatures between 45 - 50°C was also the upper CO_2 respiration (fig. 2). Minimal CO_2 respiration in combination n. 3 containing beards testifies that the conversion of this waste along whole procedure was not initiated.

The measurement of this conversion can be valued by mean of Carbon losses in % under whole fermentative period. In combination n. 3 with piggery beards are these losses upper-most 0.41%. The major conversion get in combination n. 4 containing rendering fat-extracted meat flour, then follows with loss c. 9 % of combination n. 5 containing pork sinew and n. 2 containing tannic chippings and 6,8 % in the combination n. 1 with mechanical fleshing.

In comparison with the control combination with dung about 25 % and the addition of animal tissues in all cases, with the exception of the addition of piggery beards, the conversion of organic substances in the raw material compost composition increased.

Phytotoxicity index as indicator of organic substance stability was assessed three times, at the beginning of experiment, after 21 days and after 36 weeks of maturity. The low phytotoxicity index at the maturity beginning testifies the fast entrance of hydrolysis processes in all combinations with the exception of the combination n. 3 with the addition of piggery beards, which did not virtually change along the experiment. About the high intensity of hydrolysis processes in the other combinations recruit us into low values of phytotoxicity index after 3 weeks of maturity. Final values of phytotoxicity index testifies that the procedural conditions of aerobic composting was setting optimal for combination n. 4 with meat flour and for control combination n. 6 with dung. The values overlapping 81 % in these combinations testifies a high compost maturity. In control combination with dung comes on a temperature drop testifying about the finish of conversion already after 31 days after fermentation. In other combinations is necessary for the sake of achievement a stable and non-phytotoxic product to extend the time fermentation minimally about 7 - 14 days.

At present is the effort to compost some by-products from animal production, which today isn't possible to valorize like a component of feeding mixtures for veterinary hygienic reasons. We have experimentally proven, that is real and almost without problem from agrochemical views to use these products in composts, at compliance of all fundamentals in correct composting

(Vana, 1997). How had already been in our former works warned (Vana 2002), rendering meat and beard-bone flour accelerate and intensify the course of compost maturity and they would be possible use like accelerator of composting. The share of this waste must not essentially to low C:N ratio. It is valid also for other wastes on base of animal tissues with the exception of piggery beard, containing heavily biologically decomposable keratin. Practically, these had already been today regardless of right fundamentals in composting for animal waste neutralization, especially meat and beard-bone flour as far as with 25 % sharing raw material compost composition. Of such composting gives as a rule the development of bad smell gases, maturity time is disproportioned longer and the made product is phytotoxic.

CONCLUSION

It was experimentally certified, that wastes of animal tissue are compostable with the exception of waste containing keratin and in case the compliance of right fundamentals of composting, it can be reached for stable non-toxic product.

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