THE ENVIRONMENTAL IMPACT OF COMPOSTING MANURE

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Introduction

Poultry farms with a large concentration of birds produce not only considerable amounts of meat and eggs but also manure, which is a great environmental threat. Rational management of chicken manure, especially under the current EU legislation and environmental load standards in Poland, becomes a priority issue.

Uncontrolled use of poultry manure for fertilization has serious consequences for the natural environment, as it involves overfertilization of soil, nutrient leaching, the resulting contamination of ground waters, and eutrophication of surface waters (Aubert, 2001).

Because of the considerable biogenic potential of manure (27 kg N and 27 kg P_2O_5/1 ton), its improper use in crops may degrade the soil environment. Gaseous compounds and odours formed during the storage of chicken manure also adversely affect the natural environment (Schmidt and Bicudo, 2000). Ammonia, carbon dioxide and sulphur hydrogen are responsible, among other things, for the formation of acid rain and the greenhouse effect. The high concentration of these gases in air also has a negative effect on the health of humans and animals (Kirchmann and Lundvall, 1998), as confirmed by McGinn and Janzen (1998).

Out of the many ways of managing manure, composting is the cheapest and simplest. Adding manure to straw, which is cheap and widely available, is also appropriate because of the high C:N ratio, which is a decisive factor in the quality of compost produced. The unfavourable C:N ratio in manure results in the quick mineralization of the manure and weak retention of nitrogen in the soil sorption complex.

The aim of the present experiment was to determine the environmental impact of composting manure supplemented with straw.

Material and methods

Three types of compost mixtures, based on straw and mineral and organic modifiers, were prepared from the manure of caged Isa Brown chickens fed with DJ diets. The following modifiers were used:

- biosan,
- humokarbowit,
- earthworms (*Eisenia fetida*)

The control group was pure manure without straw, and the modifiers were biosan and humokarbowit. The living and environmental needs of the earthworms were the reason why no control group of pure manure and earthworms was formed. The experiment was carried out in two replications that covered the autumn-winter period (each time for 6 months).
The manure was mixed with straw and modifiers in a different weight ratio for each group. These proportions resulted from different initial values of carbon and nitrogen. Compost mixtures with supplements were placed in containers isolated thermally from the ground. The containers were placed in the open air in a special plastic tent adapted for gas measurements (Laville et al., 1997; Misselbrook et al., 2000; Hornig et al., 2001). Emissions of ammonia, carbon dioxide and methane were measured using the chamber method after 24 h accumulation, every 3 days, using a Multiwarn II electronic gas detector (Dräger).

During the experiment, composts were analysed quantitatively for N, P and K. Temperature, pH and moisture of the composted mixtures were also measured.

Results and discussion

Gas emissions are shown in Table 1.

The highest ammonia emission (90 g) was found in the mixture containing manure, straw and humokarbowit, and the lowest (70 g) in the mixture composed of manure, straw and earthworms. The intermediate emission was characteristic of the mixture of manure, straw and biosan.

Carbon dioxide emissions showed inverse correlations: the highest emission concerned the mixture of manure, straw and earthworms (3150 g), the lowest the mixture of manure, straw and humokarbowit (955 g), and the intermediate the mixture of manure, straw and biosan (2540 g). This allows a conclusion that the easily available carbon provided in straw as a source of metabolizable energy indicates the great biochemical potential of microflora in the compost mixtures.

Reduction of the biogenic potential of both elements (Table 2) was the highest for the mixture of manure, straw and humokarbowit (75.6% nitrogen and 20.0% phosphorus), but for phosphorus the highest reduction was characteristic of the mixture of manure, straw and biosan (25%), in which nitrogen reduction was the lowest (32%). In the mixture of manure, straw and earthworms, nitrogen reduction was 40.0% and phosphorus reduction was the lowest (7.5%).

It should be noted that the reduction of nitrogen (75.6%) corresponded with the highest ammonia emission (90 g) in the mixture of manure, straw and humokarbowit.

Methane emission remained low due to the oxygen conditions prevailing in the containers for most of the compost maturing period. This is evidence that the aeration of compost mixtures was efficient and there was no need to dig them over.

Gaseous emissions of ammonia and carbon dioxide were much lower in the experimental group than in the control group. For example, in the mixture of manure, straw and humokarbowit the emissions were 90 g for ammonia and 955 g for carbon dioxide compared to 300 g and 2220 g respectively in the control group without straw supplement. One exception was the mixture of manure, straw and biosan, in which carbon dioxide emission was 2540 g, being much higher than in the mixture of manure and biosan without straw (345 g).

Similar relationships concerned the reduction of biogenic potential, the values of which were higher in the experimental group, both for nitrogen and phosphorus.

The present results allow a conclusion that the supplement of straw increases the efficiency of composting chicken manure, reduces its biogenic potential and limits the emission of harmful gas admixtures such as ammonia and carbon dioxide. Composting manure with straw reduces the environmental load while increasing the possibility of managing and using chicken manure for fertilization. The high surplus of straw resulting from the profile of agricultural production in Poland and the price of straw are a strong argument for using it in the process of composting chicken manure.

Conclusions

The following conclusions on the composting of manure and straw can be drawn from the present study:

- the straw supplement increases the efficiency of composting chicken manure, reduces ammonia and carbon dioxide emissions, and increases the reduction of biogenic potential,

- the maximum reduction of nitrogen is not correlated with the maximum reduction of phosphorus. The content of both biogens is limited to the highest extent in different compositions of mixtures,
- the considerable reduction of both biogenic elements simultaneously can be obtained for some of the analysed components,
- the highest ammonia emission from the compost supplemented with straw is tantamount to the considerable reduction in nitrogen content,
- the biogenic potential of manure composted with straw and supplements can be considerably reduced when the level of ammonia emission is low,

The issue under discussion needs many further studies concerning the composition of microflora or the effect of temperature.

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Tab.1. Gaseous emission from the experimental compost mixtures in term of 100 kg of manure.

					Emission of gas		
					NH_3 (g)	CO_2 (g)	CH_4 (%)
Experimental group	Types of the supplements	***Waste with straw***	Types of the modificators	**Biosan**	80	2540	0,5
				Worm-Earth	70	3150	0,5
				Humokarbowit	90	955	0,5
Control group		Waste without straw		Biosan	150	345	0,5
				Humokarbowit	300	2220	0,5

Tab.2. Reduction of the biogenic potential in the compost mixtures.

					N			P	
					Initial (g)	Reduction %	Emission %	Initial (g)	Reduction %
Experime	Types of the	Waste with straw	Types of the	Bbiosan	500	32.0	42.5	400	25.0
				Worm-Earth	500	40.0	42.2	400	7.5
				Humokarbowit	780	75.6	40.0	550	20.0
Control		Waste without straw		**Biosan**	800	29.0	7.7	750	98.6
				Humokarbowit	2000	63.5	11.4	850	33.5