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ELABORATION OF AN ECOLOGICAL METHOD FOR UTILIZATION OF FUR ANIMAL EXCREMENTS*

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ABSTRACT

This work discusses utilization of excrements from fur animals as beds for earthworm culture and biohumus production.

The experiment was conducted using 5 beds of *Eisenia fetida* (Sav.) compost earthworm managed in field conditions. The beds differed in respect of the type of manure (rabbit, fox, raccoon dog, mink or cattle) and level of stratification.

The effects of earthworm culture were checked after three and five months to determine the earthworm numbers and changes in their biomass. Changes in the chemical composition of beds were also monitored.

Five months after the establishment of earthworm culture, vermicompost produced was sampled to make chemical analyses of pH and nutrient content. Amounts of the coprolith fertilizer produced were also determined.

The results of the experiment showed that:

* excrements from fur animals (foxes, raccoon dogs, mink and rabbits) after stratification and fresh rabbit manure (4 days after collection) can be used as beds for compost earthworm culture and biohumus production;

* the vermicompost produced contains large (above-minimum) amounts of elements such as N, P, K, Ca and Mg. They attest to a favourable rate of bed mineralization by compost earthworms.

INTRODUCTION

Commercial technologies used in other branches of animal production (such as pig and cattle production) have recently found their way into fur animal production. This resulted in a high and rhythmical production of slaughter rabbits and high-quality pelts as well as the production of large amounts of excrements.

The amount of biogens excreted by fur animals is much lower than on a large pig or cattle farm. Nevertheless, the problem is quite serious on a national scale, with 1000 fox farms (about 150,000 vixens of the foundation stock), 60 mink farms (10,000 females) and 35 raccoon dog farms (4,000 females) being operated in Poland (Slawon, 1996).

100 vixens or female raccoon dogs with their offspring are estimated to produce about 15-20 m^3 of dung per year, and 100 female mink about 10 m^3. 20 mln rabbits are estimated to produce about 1,200,000 tonnes of dung per year.

This creates the problem of how to utilize and store these excrements while minimizing environmental burdens (Slawon, 1996; Saba et al., 1996).

The aim of the present work was to test under Polish conditions the possibility of using excrements from fur animals (foxes, raccoon dogs, mink and rabbits) as beds for the culture of *Eisenia fetida* (Sav.) earthworm and for the production of coprolith fertilizer.

MATERIAL AND METHODS

Excrements (faeces) from carnivorous fur animals (foxes, raccoon dogs and mink), and manure from herbivorous fur animals (rabbits) and farmed cattle were the experimental material. They were utilized by compost earthworms *Eisenia fetida* (Sav.) for vermicompost production.

The earthworms were farmed in beds (2 m long x 1 m wide x 0.25 m high) containing a foundation layer of feed (manure) in which about 150 compost earthworms (adult, young and cocoons) were placed per dm^3.

Manure and straw for the construction of beds was stored in a clamp for the period of 6 months, separately for each species of animals. One month before the earthworms were introduced, the clamp was exposed to the stratification process, i.e it was intensively watered once daily for 7 days after the establishment of the clamp, and semi-intensively 1-2 times a week for the next 7 days. After two weeks, the clamp substrates were mixed, not forgetting the watering 1-2 time a week. One month after the beginning of startification, when the clamp temperature did not exceed 20 ^oC and pH was 6.8-7.5, the manure was found suitable for the establishment of beds and introduction of earthworms.

To such beds were introduced earthworms from a maternal herd, which had earlier been estimated for earthworm stocking density (Kasprzak, 1990). 60 dm^3 of earthworms and their habitat (i.e. manure in which they lived) were put into each bed. Then the habitat and earthworms were evently distributed over the bed area and watered with a small amount of water.

The beds created on concrete slabs in field conditions of the open air varied according to the type of manure and degree of stratification (composting):

1. Beds containing excrements from carnivorous fur animals (foxes, raccoon dogs and mink) after stratification;
2. Beds containing excrements from carnivorous fur animals and rabbits after stratification (1:1);
3. Beds containing fresh excrements (not older than 4 days) taken from rabbits;
4. Beds containing rabbit excrements after stratification;
5. Beds containing cattle manure after stratification.

The beds were supplemented with manure, first after 50 days from the establishment of *Eisenia fetida* culture and then at 15 day intervals. The beds were supplemented with manure layers which were spread 5 to 7 cm thick. The farming effects were checked at three and five months to analyse earthworm numbers and changes in their biomass as described by Kasprzak (1990) and changes in the chemical status of beds (pH, salinity and moisture).

Five months after the establishment of earthworm culture, vermicompost was sampled to make chemical analyses of pH and nutrient content using methods applied in Chemical and Agricultural Stations (Filipek, 1977; Strahl, 1983) and method AOAC (1990). In addition, the scale of coprolith fertilizer production was determined by weighing the bed's content (i.e. biohumus proper) and uneaten feed (straw, waste and inorganic particles).

The bed utilization rate was determined from the amount of raw biohumus obtained (biohumus proper plus uneaten feed) compared with the weight of manure used in beds (together with supplemental feeding) and expressed in percent.

RESULTS AND DISCUSSION

The chemical analyses of earthworm beds (manure) and vermicompost made it possible to determine the content of nutrients available to plants (nitrogen, phosphorus, potassium, calcium and magnesium) and the degree of bed mineralization (Table 1).

Almost all elements analysed showed varying concentration levels in coproliths compared to manure.

The content of organic carbon increased in all the coproliths produced. Likewise for phosphorus (P), ammonia (NH_3) and ammonium nitrogen (NH_4), their concentrations were found to increase many times compared to the manure from which they were produced.

In beds no. 1, 2, 4 and 5, the coproliths produced were observed to have an increased content of calcium (Ca), while the Ca content of coproliths produced on fresh rabbit manure (3) was about 50% lower.

The coproliths in all beds were observed to have decreased contents of potassium (K), chloride (Cl) and sodium (Na).

Kolodziej and Kostecka (1994) suggested the following minimum contents of vermicompost as indicating favourable mineralization of bed by the compost earthworm: nitrogen (250 mg/NO_3/dm3), phosphorus (800 mg/P/dm^3), potassium (1400 mg/K/dm^3), calcium (1000 mg/Ca/dm^3) and magnesium (500 mg/Mg/dm^3). In our studies, vermicompost contained above-minimum levels of all nutrients except magnesium (Mg).

Salinity ranged from 18.60 to 19.80 g/NaCl/dm^3 in beds 1 and 2 and from 6.25 to 7.92 g/NaCl/dm^3 in beds 3, 4 and 5. The salinity of coproliths produced from manure was much lower, ranging from 3.84 to 6.35 g/Na/dm^3. According to Kostecka and Kolodziej (1994), the optimum salt content of vermicompost should not exceed 1 g NaCl/dm^3 to be conducive to plant growth.

The organic carbon to organic nitrogen ratio in beds (in manure) was found to range considerably from 16.55 to 59.45. The C/N ratio was found to be low in those beds which contained excrements from foxes, raccoon dogs and mink. By contrast, the C/N ratio was very high (from 45.53 to 59.45) in those beds where rabbit and cattle manure was used. According to Lac (1991), Kostecka (1994) and Kaplan et al. (1980), *Eisenia fetida* populations can develop well when the C/N ratio is about 20.

Table 2 presents the numbers of compost earthworms, cocoons (head/dm^3), biomass of 1 animal and coprolith production 5 months after the beginning of the experiment.

Table 2. Some parameters of vermiculture after a period of biological transformation frm April to October 1999.

Item	Bed no.				
	1	**2**	**3**	**4**	**5**
x pH of bed in October	7.11	7.48	7.86	7.93	7.40
x earthworm (adult and young) numbers per bed (head/dm^3)	87	65	39	32	52
x no. of cocoons (head/dm^3)	23	19	14	41	37
x biomass of 1 earthworm (g)	0.31	0.44	0.38	0.25	0.12
Earthworm density in bed m^3~('000 head)	87	65	39	32	52
Coprolith production (kg)	206	232	211	345	329
Bed utilization rate by earthworms (%)	34.3	38.6	35.1	57.5	54.8

In addition to earthworm numbers in beds and pH value, coprolith production could also be affected by temperature both in beds and outside. Air temperature was 15.4-5.5 ^{o}C (max.-min.) when the beds were set up in April 1999, 19.5-5.7 ^{o}C in May, 25.4-14.4 ^{o}C in July, and 12.6-5.5 ^{o}C in October respectively, while temperature of beds measured 15 cm above the concrete floor was 17.3, 18.2, 20.4 and 16.8 ^{o}C, respectively.

Beds containing a total of about 600 kg manure (including supplements) produced an average of 264.6 kg vermicompost. The low production of coproliths in beds 1 and 2, despite the highest stocking density, can be explained by the fact that about 45% of earthworms were young and thus had no effect on excrement production. The highest amounts of vermicompost were obtained from beds 4 and 5 which used rabbits manure after stratification (345 kg) and cattle manure (329 kg). Similar results were obtained in an experiment of Zajac et al. (1998) and slightly higher by Szczyglow (1990).

In summing up the results:

* fur animal excrements can be used as beds in compost earthworm culture and for biohumus production;
* the vermicompost produced contains large (above-minimum) amounts of elements such as N, P, K, Ca and Mg which attests to a favourable level of bed mineralization by compost earthworms.

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Table 1. Chemical characteristics of earthworm beds and vermicompost produced

No. of bed	Dry matter %	pH in H_2O	Salinity g/l in fresh matter	$N\text{-}NO_3$ mg/l in fresh matter	P mg/l in fresh matter	K mg/l in fresh matter	Ca mg/l in fresh matter	Mg mg/l in fresh matter	Cl mg/ l in fresh matter	Na mg/l in fresh matter	N total % in dry matter	Organic C % in dry matter	$N\text{-}NH_4$ % in fresh matter	C/N
1 a*	31.84	7.7	19.80	56	2750	2670	980	400	2000	910	1.40	27.92	0.67	19.92
1 b*	51.60	6.2	6.35	375	4180	2050	1660	400	724	660		36.71	1.26	
2 a	34.01	7.7	18.60	52	2800	2700	940	400	1800	890	1.43	24.20	0.35	16.92
2 b	22.90	6.6	4.82	175	3270	1795	1340	400	360	530		43.44	1.11	
3 a	24.92	7.1	7.92	42	1385	1720	3100	400	1600	450	0.56	25.53	0.21	45.53
3 b	28.22	6.4	3.66	311	2080	1100	1620	400	186	260		40.34	0.81	
4 a	23.04	7.1	7.85	36	1540	1850	1020	400	1000	450	0.67	24.61	0.21	36.71
4 b	26.80	6.8	3.59	171	2735	1335	1040	380	206	225		51.72	0.77	
5 a	19.11	7.2	6.25	30	925	1900	1380	380	1000	325	0.55	32.73	0.09	59.45
5 b	29.40	6.5	3.84	386	2165	1670	1420	400	280	300		42.15	0.90	

Note: a - chemical characteristics of earthworm bed, b - chemical characteristics of vermicompost produced