ASSESSMENT OF THE COMPOST FROM THE METHANE FERMENTATION OF LITTER FROM BROILER PRODUCTION WITH A VIEW TO ITS UTILIZATION IN ORGANIC PLANT PRODUCTION

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Introduction

In Bulgarian fowl production, broilers are bred on litter. There are various technologies for the utilization of the litter from broiler production. The essence of the technological solutions is either direct recycling /as a component of the ration of ruminants/ or indirect recycling /for the increase or soil fertility after composting, during which all pathogenic microorganisms die/. Our research up to now shows that the produced dung from 150 000 laying hens, bred in cage batteries, for one year is a source of energy, equal to the energy obtained from 91.25t oil /Baykov & Tyravska, 1991/. We have developed a technology for litter-based biogas production, which includes the following technological phases: 1) grinding up the litter to fine flour, 2) sieving, 3) mixing with water up to the necessary content of dry substance with a view to optimize the methane fermentation, 4) input in the fermentor /Baykov,2004/. During the last few years greater attention is paid to compost as a source of biogenic chemical elements in optimal proportions for plants. Among the admissible soil fertility products /in Ordinance №22/2001 of the Ministry of Agriculture and Forestry on organic production of plants/ is designated the product obtained after the methane fermentation of domestic organic waste which is known as compost in the United States and as bioslime in Europe.

The aim of the present research is to make an ecological assessment of the compost obtained from litter from broiler production /LBP/ according to the requirements of Ordinance №22/2001 for the MRL/Maximum Residue Level/ values of toxic elements and according to the Norms of the Canadian Ministry of Agriculture /2002/ with a view to its utilization in the organic production of plants. This research is necessary because, unlike broiler dung and domestic organic waste, LBP is heterogeneous in content and it includes different sources of cellulose / in Bulgaria hay is the most common as well as some part of the fodder/.

Material and methods

Research was carried out on LBP after broilers had vacated the production houses. The litter is dried at temperature of 60^0C until its weight remains constant. After that the litter is grinded in a laboratory grinder to fine flour, which is then sieved and kept at room temperature. The mixture is then treated with water - 7% is the dry substance in the suspension. The suspension is then placed in a microprocessor controlled laboratory fermentor, where a temperature of 33^0C is maintained and the fermentation time is 15 days as determined by the model of Chen & Hashimoto /described in details by Baykov & Tyravska, 1991/. The obtained compost is studied for the degree of degradation of the organic matter/which is determined by the quantity of the mineralized rest/ and for the content of biogenic and toxic chemical elements by applying the methods described by Jorchem /1993/ with AAS "Perkin-Elmer-4100". Table 1 indicates the results of 12 experiments on the methane fermentation of dung from laying hens.

Results

The results of the experiments are presented in Table 1. Our previous research indicated that diluting the substrate by 7% is rational with a view to optimizing the methane fermentation. 49.2% degradation of the organic substance is reached, i.e. a reserve of biogenic chemical elements in accessible/inorganic/ form and in organic compounds is obtained. This characteristic makes the long impact on soil fertility possible.

When discussing the results for the presence of biogenic chemical elements we should keep in mind our previous research /Baykov and research associates, 2003/, which demonstrates that compost could be used as a source for supplying 4 basic biogenic chemical macroelements, necessary for the autotrophs.

The conducted research allows us to make an ecological assessment of the content of toxic chemical elements in the compost. For 7 of these elements there are normative documents for the MRL values in Ordinance №22/2001. Only the content of lead in the compost is equal in value to the MRL value for this toxic element /45mg/kg/. The content of copper in the compost according to our research is 65 mg/kg, which is very close to the MRL value /70mg/kg/. Requirements do not exist in Ordinance №22/2001 for some toxic chemical elements which are important for soil fertility and for the proper function of soil biocenoses. According to Stancheva/2000/ the phytotoxicity of toxic elements is expressed in the following order: Cu>Ni>Co>Mn>Zn. There are no MRL values for cobalt in compost in Ordinance №22/2001. If we consider the requirements in the norms of the Ministry of

Agriculture in Canada, the MRL of cobalt in compost is 34mg/kg and according to our research the determined quantity is 1.64mg/kg.

The acquired results should be interpreted according to the normative documents of other countries, too. We point out the requirements in the normative documents of the Ministry of Agriculture in Canada, which are analogical to those in the United States. It is evident that the requirements for the content of toxic elements in compost are lower in these two countries in comparison with Bulgarian requirements. So if we produce organic plant production, on the basis of these requirements, the quantities of the 10 toxic elements in the compost are considerably below the MRL values.

Discussion

The research that was carried out indicates that, in the conditions of the used technology which parameters are determined by mathematical modeling preceded by laboratory experiments, a 49.27% degree of degradation of the organic matter is reached and all small molecules of organic compounds, which characterize the odor of dung, are mineralized. According to other research of ours it is determined that, at the same fermentation regime, all the pathogenic microorganisms and the eggs of helminthes are exterminated. The consistence of the manure also changes and this makes it possible to disperse it with machines used for the dispersion of fertilizers. Our results and the experiments of other countries /Al Seadi & Bo Holm – Nielsen, 2002/ are in the same direction: the utilization of dung for the production of biogas allows the resolution of the energy problems, but in the last few years the qualities of compost are of equal importance as well. According to our research, carried out for the first time in Bulgaria, it is determined that the compost, obtained from the methane fermentation of the laying hens' dung, contains lower quantities of toxic chemical elements than the MRL quantities mentioned in Ordinance №22/2001, that's why the compost can be used for obtaining organic plant production.

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References

1. *Al Seadi, T., Bo Holm Nielsen, Manure based biogas system – Danish experience. Organic Diversion Symp., Ontario vol.1, pp.1-15, 2002.*
2. *Baykov, B., Research on the production of biogas from laying hen's dung.1. Ecological assessment of the compost. Anniversary collection of the University of Forestry, 58-60, 2004.*
3. *Baykov, B., D. Tyravska, Ecological study on anthropogenic ecosystems. PAN, W-wa, 1991.*
4. *Jorhem, L., Determination of metals in foodstuffs by atomic absorbtion spectrophotometry after dry ashing. J. of AOAC International 76 /4/, 798-813, 1993.*
5. *Sheer, H., Personal notes from meetings in Goethe Institute. Sofia, September 2001 and February 2002.*
6. *Stancheva, J., Ecological foundations of agriculture. Sofia, Pensoft. 2000.*

Table 1 Biogenic and toxic elements in compost obtained from litter

№	Indices	Units of measurement	Value	MRL Ordinance №22/2001	Canadian Norms
1.	Level of mineralization	%	49,2		
2.	Dry substance content	%	7		
I. Biogenic elements					
1.	Potassium	mg / kg	34560 ± 1450	–	–
2.	Magnesium	mg / kg	1080,2 ± 140	–	–
3.	Sodium	mg / kg	28472 ± 400	–	–
4.	Calcium	mg / kg	1460 ± 980	–	–
II. Toxic elements					
1.	Arsenic	mg / kg	0,5 ± 0,1	–	13
2.	Cadmium	mg / kg	0,5 ± 0,2	0,7	3,0
3.	Chromium	mg / kg	60 ± 4,6	70	210,0
4.	Cobalt	mg / kg	1,64 ± 0,1	–	34,0
5.	Copper	mg / kg	65,0 ± 4,1	70	100,0
6.	Lead	mg / kg	45,0 ± 4,6	45	150,0
7.	Mercury	mg / kg	0,4 ± 0,1	–	5,0
8.	Molybdenum	mg / kg	0,2 ± 0,08	0,4	5,0
9.	Nickel	mg / kg	21,4 ± 1,2	25	62,0
10.	Zink	mg / kg	80,1 ± 9,0	200	500,0