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Chemical Characteristics of Earthworm Vermicompost and Its Application Effects on Soil Properties to Produce Organic Vegetables

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Recently there are more and more worldwide interests about vermicomposts by earthworm in the soil evaluation for sustainable agriculture. Earthworm Casts have been recognized as eco-friendly fertilizer or soil conditioner, but earthworm breeding farms are operated on purpose of reprocessing the food wastes and organic sludges in South Korea, so vermicomposts produced at those farms should be strictly limited in the use of agricultural land (Notice of the Ministry of Environment). Therefore we collected various kinds of earthworm cast samples and analyzed the chemical properties, and conducted to test the application effects on some vegetables such as lettuce, Chinese cabbage, tomato, cucumber grown in greenhouse. We studied crop yields and chemical or microbiological changes in the soil by vermicompost treatments.

1. Chemical Properties of Earthworm Casts from each raw material feed
We collected 37 samples and analyzed chemical components in the various sludge sources for breeding earthworms. As a result, paper-manufacturing sludge had the highest content of CaO(5.1%), and the highest ratio of organic material/nitrogen(OM/N 42.2). Bakery sludge had the highest total nitrogen (5.4%), and the lowest ratio of OM/N(15.7). Organic matter contents of all sources were higher than 60%, the criterion in the compost material. We studied chemical characteristics of various earthworm cast products, which collected from domestic earthworm farms(9 kinds) and made in the United States(1 kind). As a result of analysis organic matter contents ranged from 27.4 to 75.8% and especially the cast made of paper sludge was lower than the other products. Plant nutritional contents were as follows ; total nitrogen 1.0 $\sim$ 4.3%, available phosphate 0.1 $\sim$ 4.0%, exchangeable K2O 0.2 $\sim$ 0.7%, CaO 1.3 $\sim$ 5.1%. So the earthworm casts were judged to be able to take full advantage of plant nutrients. Except for only one sample, the ratio of OM/N was less than 30, appropriate level and the compost maturity index by SolvitaR test was over 4 level in 8 kinds of them. In case of cast produced in the United States, especially organic matter and nitrogen content was relatively high, furthermore, sensory aspects of composting like color and smell seemed perfect.
As results of the toxic substances survey, salts of all of the samples were less than 0.44% compared to the composting process specifications 2%(RDA). Some heavy metals(like nickel, zinc, copper, and mercury) were exceeding above the composting process specification. Casts made of human faeces had a tendency of relative higher contents in Zn, Cu, and Hg than those of paper-manufacturing sludges. Mercury contents were about four times to the permit limit of hazard elements in the compost. Heavy metal amounts of the organic waste material were proportional to its earthworm casts.

2. The Effect of Earthworm Casts Application on Lettuce Cultivation
In lettuce cultivation we treated earthworm casts along with fertilizer based on soil analysis. 4 treatment were as follows ; Not N applied(control), recommended NPK(contrast), NPK +Livestock Manure Compost(LMC 440kg/10a), NPK + Vermicomposts (VC 1500kg/10a). pH decreased in LMC plot, but no difference for VC compared with control, and NH4-N contents were relatively high in the plot LMC and VC. The treatment of earthworm casts tended to increase soil fertility such as contents of organic matter, nitrate , available phosphate, exchangeable potassium and magnesium compared with NPK plot. For soil physical characteristics, significant difference was not found among treatments, but earthworm casts treatments had a tendency to increase in water-holding capacity.
The shoot growth of lettuce showed very good results in LMC plot, and leaf length, and leaf color in VC plot were comparable to NPK, but the number of leaves and harvest yield from VC application were higher than NPK. Vermicomposts are considered to substitute LMC. Lettuce yield harvested in VC plot decreased by approximately 22% compared with LMC, but 13% increased compared with chemical fertilizers alone. Significant difference was not found among amendment treatment in the sorption amount of nutrients. The utilization rate of nitrogen

was relatively low, indicating slow mineralization of vermicomposts.

3. Effect of Microbial Activity in greenhouse soil cultivated 3 vegetables
To examine the changes of microbiological activity in greenhouse soil, earthworm cast was applied to the three Korea's leading vegetable crops, such as chinese cabbages, tomatoes and cucumbers as follows ; No fertilization, NPK recommended, NPK+earthworm cast at a rate of 2 ton/ha. Casts increased the soil microbial biomass C.

In 2012 earthworm cast(vermicompost) was adopted as one of fertilizer items and official standard of products was established in South Korea. So we should use and feed clean raw materials in order to produce eco-friendly agricultural earthworm casts for resource reprocessing. For the future of organic farming, extensive research for quality maintenance of earthworm casts expansion and its regulations deserves to be conducted.