Study on Chemical Properties and Organic Carbon Components of Vermicomposting

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Abstract. This article is to study the chemical property and organic material of the earthworm casts in three different places. The study shows that the earthworm casts contain plenty mineral elements, in which some toxic element still exist such as As, Cr, Cd, Pb etc. Besides, the earthworm cast is rich in organic material compared to common soil, which can over 60mg/L. What’s more it contains plenty amino acid especially Glu, Asp and Pro. Above all, the earthworm cast contains plenty mineral elements, organic material and amino acid. Thus can be fertilizer. But with some toxic element, it can make negative effect on environment.

1. Preface
It is a clean and environmental protection, no secondary pollution, simple technology and low cost biotechnology to use earthworm's life activities for harmless treatment of livestock waste. Besides, it can effectively solve the environmental pollution in urban and rural areas, and at the same time, it can obtain high-quality organic fertilizer and high-grade protein feed. Therefore, more and more attention has been paid to earthworm culture and earthworm waste disposal. Vermicomposting has a good adsorption effect [1], and its application in environmental protection is increasingly widespread. However, compared with the application research of vermicomposting, there are few related studies on its components, and more focus on biological components such as microbial types and functions [2].

2. Materials and methods
After natural fermentation of fresh cow dung at room temperature, a certain number of three kinds of earthworms were put into the fresh cow dung, and they were allowed to devour the cow dung freely. Due to the suitable environmental conditions for growth and development, earthworms propagated in large numbers, and all the cow dung was eaten by earthworms and excreted into odorless and porous black pellets, i.e. earthworm dung. The collected vermicomposting was gently peeled into small blocks with a diameter of about 10-12mm to remove small stones and other obvious organic substances such as weeds. During stripping, the vermicomposting mass should not be deformed by mechanical pressure, and then the sample should be placed on the paper and air dried for 2-3 days, until the sample is dry and used as the sample to be tested. The vermicomposting sample and water are mixed in a certain proportion. After a period of vibration, the soluble salt in the vermicomposting is extracted into the solution, and then the mixture is filtered. The filtrate can be used as the test solution...
for the determination of mineral elements in vermicomposting, and quartz sand is used for blank test in the whole process.

3. Results and discussion

3.1. Mineral element content of vermicomposting

It can be seen from table 1 that there are differences in the content of mineral elements in vermicomposting from three different sources, but the content differences among the elements are more obvious. The most mineral element in vermicomposting is Ti, the content is more than 3000 mg/L, the least element is Ag, the content is less than 0.1mg/L, the next is se, Ge, be, Sb, Ti, Bi.

It can be seen from table 2 that the content of mineral elements in vermicomposting from three different sources presents a common trend, Mn > Cu > Zn > Cr > Ni > Pb > As > Cd > Ag. Therefore, on the one hand, it can be used as an organic fertilizer to improve the poor soil environment and help the agricultural development. On the other hand, the toxic elements contained in vermicomposting, including heavy metals, may cause pollution to the environment.

The content of Mn is 577-744mg/L. The content of Cr is 16-77 mg/L, Pb is 23-30 mg/L, as and Cd are relatively low, as is 7-8 mg/L, Cd is about 1 mg/L.

According to the research of related literature, the fertility of vermicomposting is several times higher than that of common soil [3], and the mineral elements and nutrient elements in vermicomposting are very rich.

Table 1. The mineral elements in earthworm casts

| Mineral elements | NO.1       | NO.2       | NO.3       |
|------------------|------------|------------|------------|
| Li (mg/L)        | 33.095     | 36.434     | 41.199     |
| Be(mg/L)         | 1.698      | 1.928      | 2.021      |
| B (mg/L)         | 39.113     | 88.602     | 98.552     |
| Ti (mg/L)        | 3511.526   | 3621.597   | 3780.694   |
| V (mg/L)         | 90.837     | 97.724     | 97.416     |
| Co (mg/L)        | 9.491      | 8.917      | 9.312      |
| Ga (mg/L)        | 128.205    | 129.7578   | 129.851    |
| Ge (mg/L)        | 0.975      | 1.319      | 1.280      |
| Se (mg/L)        | 0.079      | 0.160      | 0.158      |
| Rb (mg/L)        | 33.225     | 145.788    | 155.102    |
| Sr (mg/L)        | 205.571    | 192.031    | 192.161    |
| Mo (mg/L)        | 1.230      | 1.062      | 1.231      |
| Ag (mg/L)        | 0.071      | 0.069      | 0.089      |
| Sn (mg/L)        | 2.855      | 2.771      | 2.895      |
| Sb (mg/L)        | 1.000      | 1.039      | 1.012      |
| Cs (mg/L)        | 15.961     | 17.490     | 16.203     |
| Ba (mg/L)        | 425.921    | 441.165    | 430.448    |
| W (mg/L)         | 1.445      | 1.477      | 1.497      |
| Th (mg/L)        | 0.532      | 0.454      | 0.524      |
| Bi (mg/L)        | 0.329      | 0.345      | 0.359      |
| U (mg/L)         | 2.201      | 2.093      | 2.277      |
Table 2. The main element in earthworm casts

| Mineral elements | NO.1       | NO.2       | NO.3       |
|------------------|------------|------------|------------|
| Mn (mg/L)        | 744.662    | 718.538    | 577.056    |
| Cu (ppm)         | 110.558    | 239.891    | 118.836    |
| Zn (mg/L)        | 99.050     | 97.491     | 101.644    |
| Cr (ppm)         | 77.579     | 16.421     | 46.070     |
| Ni (mg/L)        | 37.814     | 39.393     | 46.993     |
| Pb (ppm)         | 30.635     | 23.647     | 23.950     |
| As (ppm)         | 7.036      | 8.524      | 7.052      |
| Cd (mg/L)        | 1.224      | 0.890      | 1.011      |
| Ag (mg/L)        | 0.071      | 0.069      | 0.089      |

3.2. Content of organic matter in vermicomposting

Table 3. The organic material of different earthworm casts

| sample | TOC(g/kg) | HFOC(g/kg) | LFOC(g/kg) |
|--------|-----------|------------|------------|
| NO.1   | 40.73     | 4.66       | 0.06       |
| NO.2   | 61.95     | 4.37       | 0.07       |
| NO.3   | 59.42     | 4.50       | 0.04       |

It can be seen from Table 3 that there are significant differences in the content of organic carbon among the three kinds of vermicomposting. The TOC content of the first vermicomposting was 40.73g/kg, that of the second was 61.95g/kg, and that of the third was 59.42g/kg. The organic carbon content of the same earthworm dung is different, because the earthworm species in different places are different, the living habits and adaptability of different earthworm species are different, and the chemical composition and properties of the produced earthworm dung are also different. Wang Bin and others also reached this conclusion when studying the chemical composition and properties of earthworm feces of different life forms [4]. In terms of HFOC and LFOC [5], the contents of LFOC and HFOC in the three kinds of vermicomposting have little difference. On the whole, the contents of LFOC and HFOC in the vermicomposting are relatively low, and the proportion of LFOC in the total organic carbon is very low. When dangyaaai [6] and others studied the distribution characteristics of organic carbon physical components in the film soil profile of the Loess Plateau, they also reached similar conclusions.
### 3.3. Amino acid content of vermicomposting

Table 4. The amino acid of the earthworm casts

| Types of amino acids | NO.1  | NO.2  | NO.3  |
|----------------------|-------|-------|-------|
| Asp                  | 0.638 | 0.655 | 0.621 |
| Thr                  | 0.373 | 0.382 | 0.373 |
| Ser                  | 0.343 | 0.349 | 0.328 |
| Glu                  | 0.851 | 0.871 | 0.810 |
| Gly                  | 0.466 | 0.481 | 0.461 |
| Ala                  | 0.445 | 0.445 | 0.424 |
| Cys                  | 0.059 | 0.078 | 0.070 |
| Val                  | 0.280 | 0.291 | 0.273 |
| Met                  | 0.492 | 0.492 | 0.460 |
| Ile                  | 0.336 | 0.349 | 0.329 |
| Leu                  | 0.556 | 0.572 | 0.535 |
| Tyr                  | 0.242 | 0.268 | 0.240 |
| Phe                  | 0.327 | 0.327 | 0.321 |
| Lys                  | 0.278 | 0.289 | 0.257 |
| NH₃                   | 0.219 | 0.240 | 0.221 |
| His                  | 0.107 | 0.111 | 0.097 |
| Arg                  | 0.265 | 0.276 | 0.248 |
| Pro                  | 0.627 | 0.681 | 0.599 |

According to table 4, the contents of amino acids in three kinds of vermicomposting are slightly different, but roughly balanced, showing a common rule: the highest content of amino acids in vermicomposting is glutamic acid (Glu), which is about 0.8ppm. The latter is aspartic acid (Asp), phenylalanine (pro), Leu, methionine (Met), etc. Methionine (Cys) and histidine (His) were the lowest, and their contents were lower than 0.1 mg/L. According to Chen Baoshu, Chen benjian and others' research on the nutritional composition of earthworm feces [7], there are many essential amino acids in earthworm feces, but the contents of arginine, cystine and methionine are less. In a word, the rich amino acids in vermicomposting can improve the soil fertility [8].

### 4. Conclusion

In this study, there are many kinds of mineral elements in vermicomposting, but there are also some toxic elements such as arsenic, chromium, cadmium, lead and so on.

The content of organic matter in vermicomposting is higher than the average level of common soil, and the content of total organic carbon is 40-60mg/L.

There are many kinds of amino acids in vermicomposting, among which glutamic acid is rich. Vermicomposting is rich in mineral elements, organic matter and amino acids, so it can be used as biological fertilizer and has a good prospect in agricultural application. However, due to the presence of trace toxic elements, we should pay attention to the appropriate amount of application. In addition, although there are rich amino acids in vermicomposting, the contents of arginine, cysteine and methionine are less, so we should pay attention to the application of these amino acids alone.

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