Vermicomposting agricultural waste into value-added products: 30yr’s R & D in China

Zhenjun SUN

China Agricultural University
Beijing Vermitech Institute

Email: sun108@cau.edu.cn

College of Resources and Environmental Sciences, CAU
Total agricultural waste resources: **1 billion tons**, including
Crop straws: **0.7 billion tons**; livestock manures: **0.18 billion tons**
Ecological Utilization

Straw returning
Methane production
Edible fungi
Vermicomposting
Agriculture and livestock composting
Multiple integration

College of Resources and Environmental Sciences, CAU
High Quality Use

Commercialization and Marketization

**New products:**

- Biological preparation (Biological fertilizer, Biological pesticides, etc.)
- Biochemical preparation (Amino acids, Enzyme, Oligosaccharides, etc.)

*College of Resources and Environmental Sciences, CAU*
Comparison of the added value of the products developed from agricultural waste

College of Resources and Environmental Sciences, CAU
Vermiculture in China
Factors affecting vermiculture yield

- Materials
- Thickness
- Density
- Residuals → Earthworm
- Earthworm → Vermiculture
- Vermiculture → Vermicast
- Conditions
- Bed design
- Harvest

College of Resources and Environmental Sciences, CAU
Simple windrow system

College of Resources and Environmental Sciences, CAU
College of Resources and Environmental Sciences, CAU
Plastic Greenhouse System in North China
Composting pretreatment

College of Resources and Environmental Sciences, CAU
Cyprus conference, 2016
Intercropping system: vermiculture in field
Intercropping of vermicomposting and banana
使用过
“沃地龙蚯蚓菌肥”

未使用
Antibacterial peptides in earthworm *Eisenia Fetida*

Sun (1995) found an antibacterial peptide that was composed of forty amino acids from earthworm at first in the world.

<table>
<thead>
<tr>
<th>Name</th>
<th>Sequence of amino acid</th>
<th>Number of amino acid</th>
<th>Molecular weight</th>
<th>Antibacterial characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP1</td>
<td>/</td>
<td>40</td>
<td>4832</td>
<td>Bacteria and fungi resistance</td>
</tr>
<tr>
<td>EP2</td>
<td>Ac-Ala-Met-Val-Ser-Ser</td>
<td>6</td>
<td>535.27</td>
<td>Bacteria resistance</td>
</tr>
<tr>
<td>EP3</td>
<td>Ac-Ala-Met-Val-Gly-Thr</td>
<td>6</td>
<td>519.27</td>
<td>Bacteria resistance</td>
</tr>
<tr>
<td>EP4</td>
<td>/</td>
<td>/</td>
<td>About 20000</td>
<td>Bacteria resistance</td>
</tr>
<tr>
<td>ECP5-1</td>
<td>Ala-Cys-Ser-Ala-Gly</td>
<td>5</td>
<td>510.80</td>
<td>Bacteria resistance</td>
</tr>
</tbody>
</table>

The methods of earthworm peptide separation and purification have achieved the patent in 2004.
Sequence of amino acid in ECP$_5$-1

Ala-Cys-Ser-Ala-Gly
Influence of peptide on cancer cells

The resistance of $\text{EP}_2$ and $\text{EP}_3$ to MGC803 cell

Scanning electron microscopical observation on MGC803 cells which was untreated with antibacterial peptides

Scanning electron microscopical observation on MGC803 cells treated with $\text{EP}_2$ for 24h

Scanning electron microscopical observation on MGC803 cells treated with $\text{EP}_2$ for 48h

Scanning electron microscopical observation on MGC803 cells treated with $\text{EP}_3$ for 24h

College of Resources and Environmental Sciences, CAU
The character of earthworm antibacterial peptides

- The antibacterial peptide had stable physicochemical properties such as heat stability and wide pH scope. There was little influence of pH 3, 5, 7, 9, 11 on the antibacterial activities of antibacterial tetradecapeptide. And the antibacterial tetradecapeptide could keep when storing 180 days in home temperature.

- The antibacterial mechanism and character of the five earthworm peptides was also researched in our group.
Influence of *Escherichia coli* on the antibacterial function from *Eisenia fetida*

We have a new finding that fat from earthworm have the function of bacteria resistance.

*College of Resources and Environmental Sciences, CAU*
Vermicasts as function fertilizer

The resistance of vermicompost to anthracic of cucumber

College of Resources and Environmental Sciences, CAU
Two function microbes from vermicompost

- 0103A (*Streptomyces globisporus*)
- 0104A (*Streptomyces syringini*)

Fibrillae of 0103A spores  Spores of 0103A  Fibrillae of 0104A spores  Spores of 0104A

College of Resources and Environmental Sciences, CAU
Cyprus conference, 2016

Bioreactor for waste conversion

College of Resources and Environmental Sciences, CAU

A Chinese patent
Function liquid fertilizer

Earthworm Products
College of Resources and Environmental Sciences, CAU
Earthworm Products
College of Resources and Environmental Sciences, CAU
Some products developed in CAU

① products processed from earthworm
   - amino acid for animal nutrition
   - foliar fertilizer with amino acid
   - amino acid biopesticide

② vermicompost:
   - commercial fertilizers
   - soil less culture medium
amino acid processing from earthworm

Worm → hydrolyzing with enzyme
→ raw amino acid → adding microelement

→ AA additives
→ chelating → chelated AA → AA foliar fertilizer
→ AA pesticides
amino acid products: biochemical fertilizer

College of Resources and Environmental Sciences, CAU
Micro-ecological adjustant and function fertilizer

① Some effective antagonistic microorganisms were selected from vermicompost (Streptomyces spp)
② Micro-ecological adjust agent and soil conditioner plant rhizogenic agents
③ Antibacterial fertilizers and soil regeneration (Soil-borne disease of Cucumber seedlings)
④ Multi function fertilizers
Bacterium(0103A) from vermicast

mycelium

College of Resources and Environmental Sciences, CAU
Bacterium(0103A) from vermicast
Earthworm peptide and new pesticide-fertilizer

① 4 peptides extracted from earthworms
② effective methods for earthworm peptide processing （3 patents）
③ 3 producing lines in China for the new fertilizer
④ 2 nation certificates for new organic fertilizer
pesticide-fertilizer made of earthworm in China

College of Resources and Environmental Sciences, CAU
New products and Application of antibacterium fertilizers in China

1. Multi-function biological organic fertilizer:
   Vermicomost and effective microorganism
2. AA foliar fertilizer:
   Earthworm and microelements
3. Antibacterial peptide fertilizer:
   Biochemistry, earthworm
4. Vermicompost tea:
   Vermocompost and effective microorganism

College of Resources and Environmental Sciences, CAU
Antiblastic effect of vermicompost on some plant disease
prevention and cure effect on cucumber
Application on vegetable production
Cyprus conference, 2016

College of Resources and Environmental Sciences, CAU
Experiment of Earthworm AA additive on fish

College of Resources and Environmental Sciences, CAU
Experiment of Earthworm AA additive on pig

CK
College of Resources and Environmental Sciences, CAU

AA additive
Cyprus conference, 2016

Experiment of vermicompost as culture medium on vegetables (Shunyi, Beijing)

College of Resources and Environmental Sciences, CAU
Application of vermicompost on alone
(Tongzhou, Beijing)

College of Resources and Environmental Sciences, CAU
Wide foreground of vermiculture and vermicproducts in organic food production
Earthworm (cast) and products processing

- Organic waste → Vermicomposting
  - Earthworms
    - Vermicasts
      - Bio-organic fertilizer
      - Vermicompost tea
      - Deodorization
      - Vermiceuticals
      - Vermimeal
      - Amino acids
earthworm industrial chain

Earthworm

feedstuff
biomedicine
fertilizer
Health foods
cosmetics

College of Resources and Environmental Sciences, CAU
Medicine enzymes and Cosmetic products

College of Resources and Environmental Sciences, CAU
Medicine enzymes from earthworms
Cosmetic products made from earthworm
THANKS!