RESULTS OF THE STUDIES OF THE ORGANIC WASTE BIOTRANSFORMATION PROCESSES ON SATELLITES "BION-M" №1 AND "PHOTON-M" №4

The problem of utilization of organic waste in confined habitats

• The long terms of interplanetary expeditions and the operation of planetary bases require the creation of the most closed biological life support systems (BLSS).
• Recycling of organic waste is necessary in closed BLSS.
• The disposal of waste beyond the limits, for example the lunar or Martian base, is unacceptable due to the presence of planetary quarantine.
• Warehousing and storage of waste is unsafe in the sanitary-epidemiological aspect.
• Already, a significant proportion of waste accounted for the waste of personal hygiene.
Bioreactor developed by BioTechSis, Ltd. for fermentation in space flight conditions

### Analysis of Cellulolytic Activity

Analysis of cellulolytic activity after cultivation of Community No. 5 for 14 days at a temperature of 55 °C and 14 days at a temperature of 25 °C under conditions of orbital flight (Experiment) or on Earth (control, and repeated seeding of the culture), substrate - gauze.

<table>
<thead>
<tr>
<th>Probe</th>
<th>Decomposition of cellulose, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fragmenter with Bion M (experiment)</td>
<td>5,3</td>
</tr>
<tr>
<td>2. Fragmenter with Bion M, having reinoculated after the flight</td>
<td>32,9</td>
</tr>
<tr>
<td>3. Fragmenter control on Earth</td>
<td>29,9</td>
</tr>
<tr>
<td>4. Fragmenter control on Earth, having inoculated</td>
<td>50,3</td>
</tr>
<tr>
<td>5. Fragmenter control in glass</td>
<td>62,2</td>
</tr>
<tr>
<td>6. Fragmenter control in the glass, reinoculated.</td>
<td>28,5</td>
</tr>
</tbody>
</table>

### Analysis of the Content of Volatile Fatty Acids

Analysis of the content of volatile fatty acids in samples after cultivation of Community No. 5 for 14 days at a temperature of 55 °C and 14 days at a temperature of 25 °C, under conditions of orbital flight (Experiment) or on Earth (control, and repeated seeding), substrate - gauze fabric.

<table>
<thead>
<tr>
<th>Probe</th>
<th>Acetate</th>
<th>Propionate</th>
<th>Butyrate</th>
<th>Valeriat</th>
<th>Capronate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fragmenter with Bion M (experience)</td>
<td>3.714</td>
<td>0.177</td>
<td>1.334</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Fragmenter with Bion M, having reinoculated after the flight</td>
<td>46.716</td>
<td>0.283</td>
<td>17.184</td>
<td>0.102</td>
<td>0.156</td>
</tr>
<tr>
<td>3. Fragmenter control on Earth</td>
<td>31.861</td>
<td>0.882</td>
<td>25.494</td>
<td>0.106</td>
<td>0.030</td>
</tr>
<tr>
<td>4. Fragmenter control on Earth, having inoculated</td>
<td>47.127</td>
<td>1.293</td>
<td>14.233</td>
<td>0.036</td>
<td>-</td>
</tr>
<tr>
<td>5. Fragmenter control in glass</td>
<td>12.959</td>
<td>0.468</td>
<td>5.733</td>
<td>0.019</td>
<td>-</td>
</tr>
<tr>
<td>6. Fragmenter control in the glass, reinoculated.</td>
<td>40.703</td>
<td>0.717</td>
<td>22.265</td>
<td>0.067</td>
<td>0.019</td>
</tr>
</tbody>
</table>
The total molar mass of volatile organic compounds before and after post-treatment using culture Trichoderma viridae in space flight condition

Clostridium thermocellum
Trichoderma viridae

The total concentration of volatile organic compounds before and after post-treatment by Trichoderma viridae culture in space flight conditions

Clostridium thermocellum
Trichoderma viridae

Comparative value of the contamination coefficient of liquid media, formed before and after post-treatment by Trichoderma viridae culture in space flight conditions

Clostridium thermocellum
Trichoderma viridae
Functions of MFC containing activated sludge in the composition of the BLSS

- fermentation of organic substances
- removal of heavy metal ions
- removal of nitrogen oxides formed during the decomposition of proteins
- power generation
Changes in concentration of oxygen and carbon dioxide while long-term function of MFC
Electrical characteristics of MFC in spaceflight (A) and ground control (B)

Horizontal scale – time (days)
Vertical – voltage (mV)
Block diagram of treatment of disposed means of personal hygiene

- **The used means of personal hygiene**
  - Autoclave
  - The culture medium

- **Clostridium thermocellum 55 °C**
  - Biogas
  - Dry residue, 0 – 10%
  - Autolysation

- **Fungi monocultures 37 °C**
  - Fungi biomass
  - H₂O
  - The system of water regeneration from urine

- **Methane engines**
  - CO₂

- **Greenhouses**
The block scheme of utilization of plant wastes

- Fungi monocultures 37°C
  - Fungi biomass
  - Methane engines
  - Biogas
- Association of aerobic Bacteria, 29°C
  - pH=7.0
- Association of anaerobic Bacteria 37°C
  - pH < 7.0
  - Inedible vegetable waste
  - Dry residue, 5 – 20%
  - Autolysis
- CO₂
- Greenhouses
- H₂O
- The system of water regeneration from urine