METHOD FOR COMPOSTING SPENT MUSHROOM COMPOST

The present invention relates to a method for composting spent mushroom compost, comprising of composting the spent mushroom compost under conditions for providing composted spent mushroom compost with a dry matter content of 45% to 90%, preferably of 55% to 75%. According to another aspect, the present invention relates to composted spent mushroom compost comprising a dry matter content of 45% to 75%, a nitrogen content of 1% to 3% by weight, a phosphorus pentoxide (P2O5) content of 0.5% to 3% by weight and/or a potassium oxide content of 1% to 5% by weight.
METHOD FOR COMPOSTING SPENT MUSHROOM COMPOST

Description

The present invention relates to a method for composting spent mushroom compost, also known as mushroom manure. According to another aspect, the present invention also relates to composted spent mushroom compost and to dried casing soil.

Spent mushroom compost, or mushroom manure, is the nutrient medium or substrate for cultivating mushrooms and is usually composed of manure, such as horse manure, with straw, chicken manure and chalk. The spent mushroom compost is full of mycelium. Generally placed above the spent mushroom compost is a layer of peat which serves as casing soil for the purpose of keeping the moisture content optimal during cultivation of the mushrooms. Spent mushroom compost is generally distinguished from compost in that spent mushroom compost comprises not only vegetable material as compost does, but also comprises horse manure and/or chicken manure.

In current practice spent mushroom compost, i.e. mushroom compost remaining after the cultivation of mushrooms, is disposed of as fertilizer, in general together with casing soil placed on the spent mushroom compost for the purpose of cultivating mushrooms. The drawback of disposing of spent mushroom compost as fertilizer is that the product has a limited added value and that transport costs are moreover considerable.

The present invention has for its object, among others, to provide a method for processing spent mushroom compost in order to thus make use of any added value of the spent mushroom compost.

This objective is achieved by composting spent mushroom compost in accordance with the appended claim 1.

This objective is more specifically achieved with a method for composting spent mushroom compost comprising of composting the spent mushroom compost, or used mushroom compost, preferably under conditions for providing composted spent mushroom compost with a dry matter content of 45% to 90%, preferably 55% to 75%. The present composted spent mushroom compost preferably has a dry matter content of 60 to 70%.

By composting spent mushroom compost a dry product is obtained with higher contents of N, P and K, and so a higher fertilizing value than the usual integral spent mushroom compost for marketing. The weight further decreases greatly due to drying, whereby the transport costs to market outlets are greatly decreased, as is the associated emission of C0₂.

The term 'composting' as referred to in the present context is understood to mean digestion of the spent mushroom compost under the influence of for instance bacteria and fungi, preferably under controlled conditions.
Calculations have moreover shown that there is so much residual heat released during the composting of the spent mushroom compost that it can provide for a considerable part of the heat requirement during the mushroom cultivation. Some of the heat can be made suitable for businesses in the vicinity such as a glass horticulturist/strawberry grower and asparagus grower.

In a preferred embodiment the present method therefore comprises a step for further use of heat obtained by composting the spent mushroom compost for cultivating mushrooms and/or crops or for other applications, optionally by heating a water circuit which can then be used to heat spaces for cultivating mushrooms and/or crops or for other applications. The present method therefore preferably comprises the use of heat obtained by composting the spent mushroom compost for the purpose of heating water and/or air via a heat exchanger, such as for instance an air/air heat exchanger.

In yet another preferred embodiment the hot air from the composting is mixed with air coming from outside the process, or fresh air, and circulated through the spent mushroom compost via perforations under the spent mushroom compost. This recirculation of heat from the composting process is advantageous for improving the efficiency of the composting of the spent mushroom compost.

In a preferred embodiment the present method comprises of adding a composting agent to the present spent mushroom compost during or prior to composting of the spent mushroom compost. The addition of composting agent provides the advantage that the composting process progresses more advantageously, wherein the composted spent mushroom compost also has improved properties such as increased concentrations of N, P and K. The term composting agent as used in the present context is understood to mean a composition which has a favourable effect on the process of composting spent mushroom compost.

In a further preferred embodiment the present ratio of spent mushroom compost and composting agent lies between 1:1 and 6:1, preferably between 1:1 and 3:1, such as between 2:1 and 3:1.

In a preferred embodiment said composting agent comprises manure or digestate, preferably a thick fraction of manure or digestate from a manure separator, such as for instance a thick fraction of pig manure.

In a preferred embodiment the method comprises the step of separating the spent mushroom compost from a casing soil prior to composting of the spent mushroom compost. This has the advantage that the casing soil as such can be used for further applications without being contaminated with spent mushroom compost. The compost heat released during composting of the spent mushroom compost is preferably used to dry the used casing soil. This produces a product consisting substantially of and greatly resembling peat. It is surprising that, optionally following additional conversion, the mushroom remnants such as mushroom stems can hardly or no longer be
found in the resulting dried casing soil. The resulting dried casing soil can serve very well as peat substitute and thereby results in a considerable CO₂ reduction compared to the use of peat.

In a preferred embodiment the present method comprises of drying the casing soil for the purpose of providing dried casing soil with a dry matter content of 30% to 80%, preferably 40% to 60%. It has been found that the casing soil contracts much less than the starting material during drying, thereby greatly increasing suitability as potting compost ingredient.

In a preferred embodiment said spent mushroom compost is composted at a temperature of 30-85°C, preferably at a temperature of 40-65°C. Said spent mushroom compost is usually composted for a minimum period of time of 5 days, such as for instance of 5 to 15 days or of 6 or 7 to 12 days.

In a preferred embodiment the method comprises of supplying outside air to the space in which the composting takes place during composting of the spent mushroom compost, wherein the outside air is heated via a heat exchanger using heat obtained by composting the spent mushroom compost, so that efficient use can be made of the heat released during the composting, while the supplied air is meanwhile brought to process temperature.

Considering the favourable properties of the composted spent mushroom compost, the present invention also relates to composted spent mushroom compost obtainable with the present method. Considering the favourable properties of the separated casing soil, the present invention also relates to dried casing soil obtained with the present invention.

According to another aspect, the present invention relates to composted spent mushroom compost comprising a dry matter content of 45% to 75%, a nitrogen content of 1% to 3% by weight, a phosphorus pentoxide (P₂O₅) content of 0.5% to 3% by weight and/or a potassium oxide content of 1% to 5% by weight. In a preferred embodiment said composted spent mushroom compost also comprises composted casing soil and/or composting agent, such as for instance pig manure.

According to yet another aspect, the present invention relates to the use of said composted spent mushroom compost as manure concentrate.

According to yet another aspect, the present invention relates to the use of said dried casing soil as potting compost, for instance as substitute for peat.

The invention is further described on the basis of the following non-limitative example, in which reference is made to the figures. In these figures:

Figure 1 shows the measured energy generation in MJ/hour (upper graph line) and the water evaporation in the discharged process air in kg/hour (lower graph line) for a duration of 7 days;
Figure 2 shows the measured temperatures in degrees Celsius for the duration of 7 days, wherein the upper graph line shows the temperature of the composting spent mushroom compost, the middle graph line shows the temperature of the discharged process air and the lower graph line shows the temperature of the supplied inblown air.

**Example 1**

26000 kg of nutrient medium was separated after harvesting of mushrooms into 19760 kg of spent mushroom compost and 6240 kg of casing soil. The characteristics of the spent mushroom compost and casing soil are stated in table 1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Spent mushroom compost (19760 kg)</th>
<th>Casing soil (6240 kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (in kg)</td>
<td>6552</td>
<td>1248</td>
</tr>
<tr>
<td>Organic matter (in kg)</td>
<td>3604</td>
<td>998</td>
</tr>
<tr>
<td>Water (in kg)</td>
<td>13208</td>
<td>4992</td>
</tr>
<tr>
<td>Volume (in litres)</td>
<td>36808</td>
<td>7800</td>
</tr>
<tr>
<td>Nitrogen content (in gram/kg)</td>
<td>6.5</td>
<td>1.0</td>
</tr>
<tr>
<td>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt; (in gram/kg)</td>
<td>4.1</td>
<td>0.3</td>
</tr>
<tr>
<td>K&lt;sub&gt;2&lt;/sub&gt;O (in gram/kg)</td>
<td>11.2</td>
<td>0.8</td>
</tr>
</tbody>
</table>

The spent mushroom compost was composted for 10 days at a temperature of 40-65 °C. The heat released during the composting was used to dry the casing soil and also to heat outside air which was supplied to the composting process via an air/air heat exchanger.

6849 kg of composted spent mushroom compost and 2496 kg of dried casing soil were then obtained. The characteristics of the obtained products are shown in table 2.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Spent mushroom compost (6849 kg)</th>
<th>Casing soil (2496 kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (in kg)</td>
<td>4452</td>
<td>1248</td>
</tr>
<tr>
<td>Organic matter (in kg)</td>
<td>1504</td>
<td>998</td>
</tr>
<tr>
<td>Water (in kg)</td>
<td>2397</td>
<td>1248</td>
</tr>
<tr>
<td>Volume (in litres)</td>
<td>11415</td>
<td>4992</td>
</tr>
</tbody>
</table>
Example 2

In a test setup consisting of a composting tunnel of sea container size with all the necessary provisions for aeration and data recording the following test was performed:

8000 kg of spent mushroom compost was mixed with 3000 kg of thick pig manure and 2000 kg of graft material from a previous batch. Total input was 13000 kg. The dry matter content of the mixture was determined at the start to be about 30%. The duration of the composting was 7 days. During the composting the spent mushroom compost was provided with air by means of air circulation through a perforated floor, wherein the inflowing air consisted partially of process air discharged from the composting tunnel. Resulting at the end was about 8000 kg of material with a dry matter content well above 50%.

Figure 1 shows that the composting process has a positive energy production for 7 days, with a peak of over 125 MJ/hour. In addition, the drying capacity of the composting process was found to be favourable because the evaporation in kg/hour is positive for the whole duration. In short, spent mushroom compost can advantageously be used for composting processes because both the direct energy production (in MJ/hour) and the indirect energy production via the water vapour (in kg/hour) are favourable. Figure 2 shows that the temperature of the composting spent mushroom compost rises above 70°C. This is favourable because it achieves a sufficient degree of elimination of pathogens present in the spent mushroom compost. Figure 2 also shows that the temperature of the process air in the composting tunnel rises above 60°C. This is favourable because the heat present in this water vapour can be used to heat air and/or water via for instance a heat exchanger.

<table>
<thead>
<tr>
<th>Nitrogen content (in gram/kg)</th>
<th>18.8</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₂O₅ (in gram/kg)</td>
<td>11.9</td>
<td>0.8</td>
</tr>
<tr>
<td>K₂O (in gram/kg)</td>
<td>32.3</td>
<td>2.0</td>
</tr>
</tbody>
</table>
CLAIMS

1. Method for composting spent mushroom compost, comprising of composting the spent mushroom compost under conditions for providing composted spent mushroom compost with a dry matter content of 45% to 90%, preferably of 55% to 75%.

2. Method as claimed in claim 1, wherein a composting agent is added to the spent mushroom compost during or prior to composting of the spent mushroom compost.

3. Method as claimed in claim 1 or claim 2, wherein the ratio of spent mushroom compost and composting agent lies between 1:1 and 6:1, preferably between 1:1 and 3:1.

4. Method as claimed in claim 2 or claim 3, wherein the composting agent comprises manure or digestate, preferably a thick fraction of manure or digestate from a manure separator.

5. Method as claimed in any of the claims 1-4, further comprising a step of separating the spent mushroom compost from a casing soil prior to composting of the spent mushroom compost.

6. Method as claimed in claim 5, further comprising of drying the casing soil for the purpose of providing dried casing soil with a dry matter content of 30% to 80%, preferably 40% to 60%.

7. Method as claimed in claim 6, wherein the casing soil is dried using heat obtained by composting the spent mushroom compost.

8. Method as claimed in any of the claims 1-7, wherein heat obtained by composting the spent mushroom compost is further used for cultivating mushrooms and/or crops or for other applications.

9. Method as claimed in any of the claims 1-8, wherein during composting of the spent mushroom compost outside air is supplied to the space in which the composting takes place, wherein the outside air is heated via a heat exchanger using heat obtained by composting the spent mushroom compost.

10. Method as claimed in any of the claims 1-9, wherein heat obtained by composting the spent mushroom compost is further used for heating water via a heat exchanger.
11. Composted spent mushroom compost obtainable with the method as claimed in any of the claims 1-10.

12. Composted spent mushroom compost comprising a dry matter content of 45% to 75%, a nitrogen content of 1% to 3% by weight, a phosphorus pentoxide (P₂O₅) content of 0.5% to 3% by weight and/or a potassium oxide content of 1% to 5% by weight.

13. Dried casing soil obtainable with the method as claimed in any of the claims 5-10.

14. Use of the spent mushroom compost as claimed in claim 11 or claim 12 as manure concentrate.

15. Use of the casing soil as claimed in claim 13 as potting compost.