

APPARATUS FOR TREATING FOOD WASTE

Field of the Invention

The present invention relates to an apparatus and method for treating food waste by aerobic process. More particularly, the present invention relates to an apparatus and method which capable of converting food waste into useful end-product in a very short period of time, and removing harmful substances and odorous gases generated by the food waste.

Background of the Invention

Large amounts of food waste are generated daily by households and restaurants. These large amounts of food waste will cause various serious problems to us and our environment if they are not being handled and disposed properly.

A traditional method for disposing food waste is by burial of food waste in landfills. This method is not ideal as it causes both land pollution and air pollution. Another common method for disposing food waste is by processing food waste in composting facilities. Although this method has many benefits and reduces food waste to landfills, a large scale composting operation takes time and money to manage and maintain.

Another known method for disposing food waste is by decomposing food waste using microorganisms. Typically, this method is for large scale operation which is costly and complicated, requires many special tools to process food waste, and has a relatively long processing time (e.g. few days). Furthermore, in many situations, not all kinds of food waste can be treated by the system.

Thus, there remains a need to develop a way to treat food waste more efficiently and rapidly in a small scale operation.

Summary of the Invention

The above and other problems are solved and an advance in the art is made by the provision of an apparatus and method for treating food waste more rapidly and

efficiently in accordance with embodiments of the present invention. A first advantage is that the apparatus and method of the present invention are capable of treating all kinds of food waste in a very short period of time (less than 24 hours). A second advantage is that the apparatus and method of the present invention are capable of filtering and removing foul odour, harmful substances and toxic gases (e.g. pathogens, methane, hydrogen sulphide and nitrogen gases) generated by the food waste so as no pollutants emitted to the environment. A third advantage is that the apparatus and method of the present invention are capable of providing and maintaining an optimal environment condition for rapid treatment of the food waste by aerobic process. A fourth advantage is that the apparatus and method of the present invention are capable of converting food waste into a useful end-product which has high germination index (more than 75%), low carbon-to-nitrogen ratio (less than 23), high organic matters (more than 70%), and high nutrients (for plant growth), low moisture content (20% to 30%), and no offensive smell. A fifth advantage is that the apparatus and method of the present invention are capable of reducing the bulk of food waste to about 30% in the form of small particles with the particle size of less than 9 mm. A sixth advantage is that the apparatus of the present invention is economical, easy to use, portable and compact enough to be installed in the household.

In accordance with some embodiments of this invention, an apparatus is provided for treating food waste in the following manner. The apparatus comprises various components as follows. A main body that is portable so that it can be easily transported and installed in any desired location. A container installed within the main body for containing food waste and a composition of microorganisms to treat the food waste. The container has a first side, a second side opposite to the first side, and an upper portion having an opening for loading/unloading food waste. Heating means in contact with an outer surface of the container for heating the food waste in the container. An air inlet disposed at the upper portion of the container through which air is introduced into the container. An air outlet disposed at the upper portion of the container through which air is expelled from the container. An exhaust vent disposed at the main body through which air is discharged from the apparatus. Agitation means installed within the container for mixing the food waste. The agitation means comprises: a rotatable shaft extending from the first side to the second side of the container; a plurality of agitator arms extending from the rotatable shaft; and a paddle connected to each of the plurality of agitator arms and proximate an inner surface of the container. Deodorization means connected between the air outlet and the exhaust vent. The deodorization means comprises a 3-

stage filtering system includes: a first filtering unit having an ultraviolet lamp that produces ultraviolet light to sterilize air expelled from the container; a second filtering unit having a dehumidification heater that generates heat to remove moisture expelled from the container and a zeolite filter that absorbs odorous gas expelled from the container; and a third filtering unit having a carbon filter that absorbs harmful gas expelled from the container. A suction fan connected to the exhaust vent so as when the suction fan is activated, air in the container is sucked out of the container via the air outlet and external air is sucked into the container via the air inlet. The air expelled from the container channels through the deodorization means before discharged from the apparatus via the exhaust vent.

In accordance with some embodiments of this invention, the apparatus further comprises controlling means for controlling the heating means, the agitation means, the suction fan, and the deodorization means so as to provide an optimal environment condition for aerobic treatment of the food waste.

In accordance with some embodiments of this invention, the microorganisms comprise *bacillus subtilis*, *bacillus licheniformis*, *bacillus amyloliquefaciens*, *bacillus atrophaeus*, and *bacillus circulans*.

In accordance with some embodiments of this invention, a method is provided for treating food waste using the apparatus as described above. The method comprises loading food waste into the container; adding a predetermined amount of the composition of microorganisms into the container, wherein the microorganisms comprise *bacillus subtilis*, *bacillus licheniformis*, *bacillus amyloliquefaciens*, *bacillus atrophaeus*, and *bacillus circulans*; and mixing the food waste and the microorganisms by the agitation means for a period of time sufficient for the food waste to be fully treated by the microorganisms.

In accordance with some embodiments, the period of time sufficient for the food waste to be fully treated by the method of this invention is less than 24 hours.

In accordance with some embodiments of this invention, the method further comprises maintaining an optimal environment condition for aerobic treatment of the food waste in the container by controlling the heating means, the agitation means, the suction fan, and the deodorization means.

In accordance with some embodiments of this invention, the optimal environment condition comprises a temperature within 70°C to 75°C.

In accordance with some embodiments of this invention, 10 grams of the composition of microorganisms is sufficient for treating up to 10 kilograms of the food waste.

In accordance with some embodiments of this invention, a kit is provided in the following manner. The kit comprises (a) an apparatus for treating food waste; and (b) an article having a composition of microorganisms comprises *bacillus subtilis*, *bacillus licheniformis*, *bacillus amyloliquefaciens*, *bacillus atropheus*, and *bacillus circulans*, wherein the composition of microorganisms is added into the apparatus to treat the food waste. In some embodiments, the article comprises 10 grams of the composition of microorganisms. The apparatus of the kit comprising:

- a main body that is portable;

- a container installed within the main body for containing food waste, the container having a first side, a second side opposite to the first side, and an upper portion having an opening for loading/unloading food waste;

- heating means in contact with an outer surface of the container for heating the food waste in the container;

- an air inlet disposed at the upper portion of the container through which air is introduced into the container;

- an air outlet disposed at the upper portion of the container through which air is expelled from the container

- an exhaust vent disposed at the main body through which air is discharged from the apparatus;

- agitation means installed within the container for mixing the food waste, the agitation means comprises:

 - a rotatable shaft extending from the first side to the second side of the container,

 - a plurality of agitator arms extending from the rotatable shaft, and

 - a paddle connected to each of the plurality of agitator arms and proximate an inner surface of the container;

- deodorization means connected between the air outlet and the exhaust vent, the deodorization means comprises a 3-stage filtering system includes:

a first filtering unit having an ultraviolet lamp that produces ultraviolet light to sterilize air expelled from the container,

a second filtering unit having a dehumidification heater that generates heat to remove moisture expelled from the container and a zeolite filter that absorbs odorous gas expelled from the container, and

a third filtering unit having a carbon filter that absorbs harmful gas expelled from the container; and

a suction fan connected to the exhaust vent so as when the suction fan is activated, air in the container is sucked out of the container via the air outlet and external air is sucked into the container via the air inlet, the air expelled from the container channels through the deodorization means before discharged from the apparatus via the exhaust vent.

Brief Description of Drawings

The above and other problems are solved by features and advantages of an apparatus and method for treating food waste in accordance with the present invention described in the detailed description and shown in the following drawings:

Fig. 1 is a front sectional view of an embodiment of an apparatus for treating food waste in accordance with the present invention;

Fig. 2 is a side sectional view of the apparatus as shown in Fig. 1;

Fig. 3 is a rear sectional view of the apparatus as shown in Fig. 1 where the deodorization means is depicted; and

Fig. 4 is a flowchart of a method for treating food waste using the apparatus as shown in Fig. 1.

Detailed Description of the Invention

The present invention relates to an apparatus and method for treating food waste using a composition of microorganisms in an appropriate proportion and quantity. The treated food waste is a useful end-product which can be used as a soil amendment. The treated food waste has many desirable properties, including high germination index, low

carbon-to-nitrogen ratio, high organic matter, high nutrients, small particle size, no offensive smell, and free of harmful pathogens and contaminants. All kinds of food waste, including, but not limited to, raw and cooked food, hot and cold food, protein (animal and plant), fat (animal and plant), carbohydrates, starch, feathers and hairs, pectin, cellulose, bones, crustacean shells, vegetables, fruits, food with high salt content, shredded newspaper, tissue paper, and etc., can be fully treated by the apparatus and method of the present invention less than 24 hours. In some embodiments, food waste can be fully treated by the apparatus and method of the present invention within 16 hours.

In the present invention, only a small quantity of a composition of microorganisms is required to treat all kinds of food waste. Typically, 10 grams of the composition of microorganisms is sufficient to treat up to 10 kilograms of food waste. The microorganisms utilised comprise *Bacillus subtilis*, *Bacillus licheniformis*, *Bacillus amyloliquefaciens*, *Bacillus atrophaeus*, and *Bacillus circulans*. In some embodiments, any one or combinations of two or more of the afore-stated microorganisms can be used to treat food waste. An optimal environment condition is provided by the apparatus for rapid decomposition of the food waste by the microorganisms. All kinds of food waste can be fully treated by the microorganisms, leaving no untreated food waste.

Fig. 1 shows a sectional front view of apparatus 100 for treating food waste in accordance with an embodiment of the present invention. Figs. 2 and 3 show the sectional side view and rear view of apparatus 100. Apparatus 100 comprises main body 102 within which various components, such as container 110, agitation means 120 and deodorization means 130, are installed. Main body 102 should be portable and compact enough for ease of installation in any desired location, such as kitchen area where food waste is available. Main body 102 may be configured in any suitable sizes and shapes. For an example, main body 102 is rectangular as shown in Figs. 1 to 3, having dimensions of about 0.5 m (length) x 0.5 m (width) x 0.6 m (height).

Container 110 is installed within main body 102 for containing food waste and allowing food waste to be treated therein. Container 110 has first side 112, second side 114, a bottom portion of semi-circular shape 116 (viewing from first side 112 or second side 114, see Fig. 2), a top portion having opening 118 for loading and unloading food waste. Main body 102 has lid 104 which is a removable and hinged cover for closing opening 118. Apparatus 100 has a sensor for sensing lid 104 so that apparatus 100 only operates when lid 104 is completely closed. Handle 106 is mounted on lid 104 for

facilitating the opening and closing of container 110. Container 110 is integral to main body 102. Alternatively, container 110 is detachable to main body 102 so that container 110 can be detached and carried to any location to dispose the treated food waste. Also, the detachable feature allows a new container 110 to be replaced easily. Container 110 should be made of a material (e.g. stainless steel) which can withstand all kinds of food waste in various treatment conditions. Container 110 is capable of containing food waste of up to 10 kilograms. In another embodiment, container 110 can contain food waste of up to 20 kilograms. In some embodiments, stud-like structures (not shown) may be formed on first side 112 and/or second side 114 of container 110. Stud-like structures help to break the food waste and prevent unmixed food waste stuck at first side 112 and/or second side 114 of container 110 where agitator arms 124 are not reachable.

Agitation means 120 is installed within container 110 for agitating and mixing food waste. Agitation means 120 comprises rotatable shaft 122, a plurality of agitator arms 124 extending from shaft 122, and paddle 126 attached to each of agitator arms 124. Shaft 122 is horizontally attached to first side 112 and second side 114 of container 110 (see Fig. 1) and is rotatable clockwise and counter-clockwise. Shaft 122 may be integral to or detachable to container 110. A detachable shaft 122 allows it to be cleaned and replaced easily. The rotatable shaft 122 is driven by motor 140. The speed of shaft 122 is adjustable from 5 rpm to 30 rpm through a gearbox connected to motor 140.

Agitator arms 124 extend from shaft 122 toward the inner wall of container 110 for crushing and mixing food waste (when shaft 122 is rotating) so as to enhance the treatment speed, where the area contact of the food waste with the microorganisms is maximised. Agitator arms 124 may be distributed in any suitable configurations along shaft 122 to maximise the mixing of food waste so as food waste can be mixed thoroughly and homogenously. For example, agitator arms 124 may be evenly spaced apart along the length of shaft 122 and/or along the circumferential surface of shaft 122. Agitator arms 124 may extend perpendicular from shaft 122 or at any suitable angle with respect to shaft 122. Two agitator arms 124 may offset from each other by a suitable angle (viewing from first side 112 or second side 114), such as 60° as shown in Fig. 2. Agitator arm 124 may have a rod-like shape or any other suitable shapes.

Paddle 126 can be attached to agitator arm 124 at any suitable positions for directing food waste in a desired direction. Preferably, paddle 126 is attached to an end portion of agitator arm 124 and adjacent to the inner wall of container 110 (see Fig. 2).

The close proximity of paddle 126 with the inner wall of container 110 allows food waste to be mixed thoroughly and prevents unmixed food waste to be accumulated on the inner wall of container 110, particularly the bottom portion of container 110. Paddle 126 may be in any suitable shapes and sizes, such as a rectangular planar blade as shown in Figs. 1 and 2. Paddle 126 may be attached at any suitable angle with respect to agitator arm 124. Preferably, paddle 126 is perpendicular to the longitudinal axis of agitator arm 124, forming a T-shape configuration as shown in Figs. 1 and 2. In some embodiments, two or more paddles 126 may be attached to one agitator arm 124.

Paddle 126 may be arranged to make an angle β (within 0° to 180°) with respect to the longitudinal axis of shaft 122. For example, paddle 126 is parallel to the longitudinal axis of shaft 122 when $\beta = 0^\circ$ or 180° ; and paddle 126 is perpendicular to the longitudinal axis of shaft 122 when $\beta = 90^\circ$. In some embodiments, each paddle 126 of agitator arm 124 may have an angle β which is different from other paddles 126 of agitator arms 124 extended from shaft 122. This allows food waste to be pushed to different directions when shaft 122 is rotated. In some other embodiments, a plurality of agitator arms 124 may have their paddles 126 arranged in different angles β from one another and running in a sequential order, such as 0° , 30° , 60° , 90° , 120° , 150° and 180° . This configuration allows food waste to be continuously pushed to travel along a path from one side to another side of container 110 without spilling out of container 110.

Heating means 150 is attached to the outer surface of container 110 for providing heat to container 110. The heat will transfer from container 110 to the food waste in container 110 so as the temperature of the food waste can be increased to an optimum condition for aerobic process by the microorganisms. Heating means 150 may be a piece of electrical conductor encapsulating the outer surface of container 110. An optional insulator covering heating means 150 may be provided to prevent heat loss. Sensors may be provided to sense the temperature of container 110 and the temperature of the food waste in container 110. Preferably, the temperature of heating means 150 is within 70°C to 75°C . The temperature of heating means 150 is adjustable from 60°C to 80°C by a controlling means in connection with heating means 150.

The upper portion of container 110 has air inlet 160 through which external air is introduced into container 110 and air outlet 162 through which internal air of container 110 is expelled from container 110. An optional air blower may be installed at the upper portion of container 110 for providing more external air into container 110 so that more

oxygen is supplied for aerobic process by the microorganisms. The air expelled from container 110 may contain harmful substances, toxic gases, offensive smell, and moisture, which will be filtered and removed by deodorization means 130 before discharged from apparatus 100 through exhaust vent 164 at main body 102.

Deodorization means 130 is connected between air outlet 162 and exhaust vent 164 by pipes 139 for deodorizing and purifying the air expelled from container 110 before discharging it out of apparatus 100. Deodorization means 130 comprises a three-stage filtering system includes three separated filtering units connected by pipes 139. First filtering unit 132 has an ultraviolet lamp which produces ultraviolet light to sterilize the air expelled from container 110. Second filtering unit 134 comprises dehumidification heater 135 and zeolite filter 136. Dehumidification heater 135 generates heat to remove moisture in the air expelled from container 110, and zeolite filter 136 absorbs odorous gases expelled from container 110. Dehumidification heater 135 is controllable by a controlling means mounted on main body 102. Third filtering unit 138 has a carbon filter that absorbs harmful substances and toxic gases expelled from container 110.

Suction fan 166 is connected to exhaust vent 164 for sucking air and creating a compulsorily airflow in container 110. When suction fan 166 is activated, internal air of container 110 and air in pipes 139 are sucked out and discharged from apparatus 100. Once internal air of container 110 is sucked out, external fresh air is forced to flow into container 110 via air inlet 160 due to low pressure in container 110. Therefore, external air can be continuously supplied into container 110 for aerobic process. The air expelled from container 110 will channel through deodorization means 130 for filtering and purifying before discharged from apparatus 100. Suction fan 166 may be continuously activated or periodically activated based on a predetermined setting. For example, suction fan 166 may be in a periodic cycle of activation for 10 minutes followed by deactivation for 30 minutes.

Apparatus 100 further comprises a controlling means in connection with various components of apparatus 100, including heating means 150, suction fan 166, agitation means 120, motor 140, deodorization means 130, temperature sensors, and etc., for controlling the respective components in order to provide and maintain an optimal environment condition for aerobic treatment of food waste. The controlling mean may be a control panel mounted on main body 102.

Fig. 4 shows a method for treating food waste using apparatus 100 as described above. Method 400 of this invention comprises the following steps. At step 402, food waste is loaded into container 110 of apparatus 100. At step 404, a predetermined amount of a composition of microorganisms is added to the food waste in container 110. The microorganisms utilised comprise *bacillus subtilis*, *bacillus licheniformis*, *bacillus amyloliquifaciens*, *bacillus atropheus*, and *bacillus circulans*. In some embodiments, any one or combinations of two or more of the afore-stated microorganisms can be used to treat food waste. At step 406, food waste and microorganisms are agitated and mixed by agitation means 120. The optimal environment condition within container 110 is provided and maintained in step 408 by controlling various components of apparatus 100, including heating means 150, suction fan 166, motor 140, deodorization means 130, and etc. The food waste can be fully treated less than 24 hours. In some embodiments, the food waste can be fully treated less than 16 hours.

While preferred embodiments of the present invention have been described and illustrated above, it is to be understood that they are exemplary of the invention and are not to be considered to be limiting. It is expected that those skilled in the art can and will design alternative embodiments that infringe this invention as set forth in the following claims.

CLAIMS

1. An apparatus for treating food waste, the apparatus comprising:
 - a main body that is portable;
 - a container installed within the main body for containing food waste and a composition of microorganisms to treat the food waste, the container having a first side, a second side opposite to the first side, and an upper portion having an opening for loading/unloading food waste;
 - heating means in contact with an outer surface of the container for heating the food waste in the container;
 - an air inlet disposed at the upper portion of the container through which air is introduced into the container;
 - an air outlet disposed at the upper portion of the container through which air is expelled from the container;
 - an exhaust vent disposed at the main body through which air is discharged from the apparatus;
 - agitation means installed within the container for mixing the food waste, the agitation means comprises:
 - a rotatable shaft extending from the first side to the second side of the container,
 - a plurality of agitator arms extending from the rotatable shaft, and
 - a paddle connected to each of the plurality of agitator arms and proximate an inner surface of the container;
 - deodorization means connected between the air outlet and the exhaust vent, the deodorization means comprises a 3-stage filtering system includes:
 - a first filtering unit having an ultraviolet lamp that produces ultraviolet light to sterilize air expelled from the container,
 - a second filtering unit having a dehumidification heater that generates heat to remove moisture expelled from the container and a zeolite filter that absorbs odorous gas expelled from the container, and
 - a third filtering unit having a carbon filter that absorbs harmful gas expelled from the container; and
 - a suction fan connected to the exhaust vent so as when the suction fan is activated, air in the container is sucked out of the container via the air outlet and external air is sucked into the container via the air inlet, the air expelled from the container

channels through the deodorization means before discharged from the apparatus via the exhaust vent.

2. The apparatus of claim 1, further comprising:

controlling means for controlling the heating means, the agitation means, the suction fan, and the deodorization means so as to provide an optimal environment condition for aerobic treatment of the food waste.

3. The apparatus according to any one of the preceding claims, wherein the microorganisms comprise bacillus subtilis, bacillus licheniformis, bacillus amyloliquidfaciens, bacillus atrophaeus, and bacillus circulans.

4. A method for treating food waste using the apparatus of claim 1, the method comprising:

loading food waste into the container;

adding a predetermined amount of the composition of microorganisms into the container, wherein the microorganisms comprise bacillus subtilis, bacillus licheniformis, bacillus amyloliquidfaciens, bacillus atrophaeus, and bacillus circulans; and

mixing the food waste and the microorganisms by the agitation means for a period of time sufficient for the food waste to be fully treated by the microorganisms.

5. The method of claim 4, wherein the period of time is less than 24 hours.

6. The method of claim 4 or claim 5, further comprising:

maintaining an optimal environment condition for aerobic treatment of the food waste in the container by controlling the heating means, the agitation means, the suction fan, and the deodorization means.

7. The method of claim 6, wherein the optimal environment condition comprises a temperature within 70°C to 75°C.

8. The method according to any one of the claims 4 to 7, wherein 10 grams of the composition of microorganisms is sufficient for treating up to 10 kilograms of the food waste.

9. A kit comprising:
- (a) an apparatus for treating food waste, the apparatus comprising:
 - a main body that is portable;
 - a container installed within the main body for containing food waste, the container having a first side, a second side opposite to the first side, and an upper portion having an opening for loading/unloading food waste;
 - heating means in contact with an outer surface of the container for heating the food waste in the container;
 - an air inlet disposed at the upper portion of the container through which air is introduced into the container;
 - an air outlet disposed at the upper portion of the container through which air is expelled from the container;
 - an exhaust vent disposed at the main body through which air is discharged from the apparatus;
 - agitation means installed within the container for mixing the food waste, the agitation means comprises:
 - a rotatable shaft extending from the first side to the second side of the container,
 - a plurality of agitator arms extending from the rotatable shaft, and
 - a paddle connected to each of the plurality of agitator arms and proximate an inner surface of the container;
 - deodorization means connected between the air outlet and the exhaust vent, the deodorization means comprises a 3-stage filtering system includes:
 - a first filtering unit having an ultraviolet lamp that produces ultraviolet light to sterilize air expelled from the container,
 - a second filtering unit having a dehumidification heater that generates heat to remove moisture expelled from the container and a zeolite filter that absorbs odorous gas expelled from the container, and
 - a third filtering unit having a carbon filter that absorbs harmful gas expelled from the container; and
 - a suction fan connected to the exhaust vent so as when the suction fan is activated, air in the container is sucked out of the container via the air outlet and external air is sucked into the container via the air inlet, the air expelled from the container channels through the deodorization means before discharged from the apparatus via the exhaust vent; and

(b) an article having a composition of microorganisms comprises *bacillus subtilis*, *bacillus licheniformis*, *bacillus amyloliquefaciens*, *bacillus atrophaeus*, and *bacillus circulans*, wherein the composition of microorganisms is added into the apparatus to treat the food waste.