

**Process for Degrading Food and/or Organic Waste to Compost, In-line Waste
Treatment Assembly and Biomaterial For Use in Same**

5 The present invention relates to a process for degrading food and/or organic waste to compost. The invention also relates to an in-line waste treatment assembly suitable for use in such a process. The invention further relates to a biomaterial suitable for use in such a process.

10 In an ever-increasing consumer society, there is an ongoing and increasing need to find alternative means to deal with waste. This is evident through initiatives being taking to recycle waste and minimise the amount of waste being deposited into landfills.

15 In the particular area of food waste and other organic waste, efforts are being made to extract this waste from general non-organic wastes. However, much food and organic waste finds its way into landfill. Likewise, a substantial amount of food and organic waste is incinerated, leading to emissions into the atmosphere.

20 Some effort has been made to provide systems for the decomposition or degradation of food and organic wastes. These systems generally require a substantial amount of time to be effective and employ micro-organisms to achieve the decomposition of the waste. In many instances these methods are not particularly effective due to the variety of waste that may be present in the waste, particularly in the case of food waste. Also, it is generally necessary to replace the biomaterial used in the existing
25 methods after a relatively short time frame.

The present invention advantageously provides an alternative to existing food and organic waste disposal systems. The system according to certain embodiments of the invention may advantageously be used to degrade a wide variety of food and organic
30 wastes. Furthermore, the invention advantageously provides a system that may decompose food and organic waste in a relatively short time frame.

According to a first aspect of the invention there is provided a process for degrading food and/or organic waste to compost, the process including:

reducing the particle size of the waste to form a reduced waste having decreased volume;

dewatering the reduced waste to form a dry or semi-dry pulp;

introducing the pulp to a reactor preloaded with a biomaterial including a solid support inoculated with a pre-selected combination of micro-organisms; and

treating the pulp in the presence of the biomaterial to degrade the pulp to compost;

wherein treatment of the pulp is conducted at a temperature in the range of from 35 to 50°C and includes agitation phases during which the pulp is mixed with the biomaterial and non-agitation phases during which the pulp is allowed to stand.

It has been advantageously found that conducting treatment with agitation phases and non-agitation phases results in homogeneous mixing of the pulp with the biomaterial while facilitating rapid growth of the micro-organisms present. Rapid growth of the micro-organisms is also assisted through treatment of the pulp at a temperature in the range of from 35 to 50°C.

Still further, it has been found that the viability and quantity of the biomaterial may be advantageously maintained over an extended period of time compared with prior art methods. In particular, it has been found that the biomaterial may be advantageously maintained within the reactor for at least six months using the process of the invention.

According to the process of the invention, the pulp fed to the reactor is completely degraded to compost in one cycle, as discussed in more detail below. This advantageously results in minimal increase in solid volume within the reactor. Again, this has the advantage that the biomaterial may be left in the reactor without having to remove compost produced and without replenishment of the biomaterial for at least six months. At that time, the biomaterial may be removed, together with an end product of rich compost which may be useful as an organic fertilizer for soil conditioning.

As noted above, the process of the invention includes agitation and non-agitation phases during which the pulp is mixed with the biomaterial and let stand respectively.

This has been found effective in decomposing the pulp and also in reducing the time required for this process. Preferably, the pulp is treated for a period of from 3 to 5 hours, more preferably for a period of about 3 hours. During treatment in the reactor, the agitation phases are preferably from 3 to 5 minutes in duration and the non-
5 agitation phases are preferably from 1 to 2 minutes in duration. More preferably, the agitation phases are about 3 minutes in duration and the non-agitation phases are about 1 minute in duration. Each agitation phase is followed by a non-agitation phase, and so on, until the desired treatment period has elapsed.

10 The agitation and non-agitation phases are designed to encourage growth of micro-organisms within the biomaterial, thereby enhancing rapid digestion of the waste being treated. Preferably, agitation includes churning of the biomaterial and pulp, generally in a circular motion. This will advantageously ensure homogeneous mixing of the biomaterial and pulp. In a particularly preferred embodiment the agitation
15 includes homogeneous mixing of the biomaterial and pulp by churning that induces lateral translation of the biomaterial and pulp. For example, lateral translation from left to right to left.

The relative volumes of biomaterial, pulp and aerated space above the material in the
20 reactor is not particularly limited. Preferably, however, the ratio of waste over top space is 50:30:20. That is, for example, if a reactor is built for a 500 litre capacity, biomaterial takes up 50% or 250 litres, pulp takes up 30% or 150 litres and aerated space takes up 20% or 100 litres.

25 The temperature within the reactor is set to maximise rapid growth of the micro-organisms within the biomaterial and ensure rapid decomposition of the pulp. The more preferred temperature within the above range will be somewhat dependent on the micro-organisms being employed in the biomaterial. However, generally it will be preferred that the pulp is treated at a substantially constant temperature of about
30 40°C to 45°C. This will be dealt with in more detail below when considering the make-up of the biomaterial, in particular when considering the micro-organisms that are useful in the process of the invention and that are therefore desirable in the biomaterial.

The first stage of the process involves reduction of the particle size of the waste. This may be achieved by any suitable means, such as for example by grinding, cutting and/or pulping. Preferably, the waste is subjected to grinding to reduce its particle size. The grinding process should be such that all food and/or organic waste fed into the grinder is reduced in particle size, be that vegetable waste or animal waste, including bone. This step results in a reduced waste that has a substantially smaller volume and mass than the initial waste to be treated. The degree of volume reduction may vary, but will generally be in the order of 80 to 90% based on the initial volume of the waste.

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Dewatering of the reduced waste may also be achieved by any suitable means. For example, water may be removed from the reduced waste by centrifuge or pressing of the reduced waste. Preferably, dewatering of the reduced waste is achieved by pressing the reduced waste. In that regard, water removed from the reduced waste may be recycled back to the particle size reduction step if desired. This will advantageously reduce the water required for the process of the invention and is therefore preferable.

It will be appreciated that there must be gases generated in the reactor during decomposition of the pulp. Therefore, there will be some exhaust gas emitted from the reactor. In that regard, it is preferred that fresh air be constantly drawn into the reactor by a blower which also acts as the exhaust that extracts stale air from the reactor. For environmental reasons, the exhaust gas from the reactor is preferably treated before being released into the atmosphere. In particular, the exhaust gas emitted from the reactor is preferably deodorized before being emitted. Deodorization may be achieved by any suitable means, for example using zeolites and/or activated carbon. Preferably, according to the process of the invention deodorization of the exhaust gas is achieved using a deodorizing unit including a preliminary treatment zone including a zeolite, a secondary treatment zone including an ozone generator and a tertiary treatment zone including activated carbon.

The particular designs of the units to be used in the process of the invention, including the waste reduction unit, dewatering unit, reactor and deodorizing unit, will be dealt with in more detail below with reference to another aspect of the invention.

5 The nature of the biomaterial may vary, depending on the make-up of the waste to be treated. This will be dealt with in particular detail below with reference to a further aspect of the invention. However, in each case, the biomaterial will include a solid support inoculated with a pre-selected combination of micro-organisms.

10 The solid support preferably includes a porous, water absorbing material that is resistant to microbial attack. For example, the solid support may include natural and/or synthetic materials. An example of a suitable synthetic material is polyurethane sponge. Preferably, however, the solid support is selected from rice husks, wood chips and/or saw dust. More preferably, the solid support includes rice husks, wood chips and saw dust in a defined ratio. In particular, the ratio of rice husks, wood chips and saw dust in the solid support is preferably 1:1:2.

15 The pre-selected combination of micro-organisms inoculated onto the solid support will again be dependent on the waste material being treated. Again, this will be dealt with in more detail below with reference to the aspect of the invention relating to the biomaterial. However, according to one embodiment the biomaterial includes a solid support inoculated with a pre-selected combination of micro-organisms selected from
20 *Brevibacillus brevis*, yeast *Candida krusei*, *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus pumilis*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus mycoides*, *Bacillus firmus* and/or *Pseudomonas alcaligenes*.

25 In a preferred embodiment, the pre-selected combination of micro-organisms includes at least *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus firmus* and *Pseudomonas alcaligenes*. In a more preferred embodiment, the biomaterial includes all ten of the micro-organisms described in the immediately preceding paragraph.

30 In order to maximise microbial growth, the solid support is preferably treated with a culture medium and subsequently inoculated with a pre-selected combination of micro-organisms. Again, the culture medium will be selected based on the make-up of the waste to be degraded. Examples of the culture medium are provided below with reference to the aspect of the invention relating to the biomaterial.

As mentioned above, it has been found that the process of the invention may increase the longevity of the biomaterial. In particular, it has been found that the biomaterial may remain in the reactor for as long as six months or more. As the biomaterial may be maintained in the reactor for a substantial length of time, preloading of the reactor will not be required for every treatment. Rather, the preloading of the reactor will only be required once every six months or so. Therefore, the step of preloading the reactor is not essential to the process of the invention. It is enough that the reactor be preloaded with the biomaterial before the pulp is introduced to the reactor.

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Having said that, when actual preloading is required (i.e. on initial loading of the biomaterial into the reactor, or on replacement of the biomaterial) preloading of the biomaterial into the reactor preferably includes:

- introducing the solid support to the reactor;
- 15 adding a culture medium to the solid support in the reactor such that the culture medium is absorbed into the solid support;
- adding cultures of the pre-selected combination of micro-organisms to the solid support in the reactor; and
- allowing the pre-selected combination of micro-organisms to grow in the
- 20 reactor.

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Further discussion on the preloading process, and in particular on the proportions and types of materials preferred for the solid support, culture medium and micro-organisms, is provided below with reference to the aspect of invention relating to the biomaterial.

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In order to simplify processing and avoid environmental risks, it is preferred that each of the steps, including waste reduction, dewatering, pulp treatment and optionally deodorization, is conducted in an in-line waste treatment assembly. This provides for a number of advantages, including reducing pollution that may be caused through transportation of the waste and reducing user handling of the waste.

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Accordingly, in another aspect the invention provides an in-line waste treatment assembly for degrading food and/or organic waste to compost, the waste treatment assembly including:

5 a waste reduction unit adapted to reduce the particle size of the waste to form a reduced waste having decreased volume;

a dewatering unit for removing water from the reduced waste to form a dry or semi-dry pulp;

a reactor for receiving the pulp and treating the pulp in the presence of a biomaterial preloaded in the reactor; and

10 a deodorizing unit adapted to receive and deodorize exhaust gas emitted from the reactor;

wherein the reactor is adapted to maintain a reaction temperature of from 35 to 50°C during treatment of the pulp and to provide agitation phases during which the pulp is mixed with the biomaterial and non-agitation phases during which the pulp is allowed
15 to stand.

The temperature within the reactor may be maintained at from 35 to 50°C, preferably substantially constant at about 40°C to 45°C, by any suitable means. In a preferred embodiment, however, the reactor includes a heater and a thermostat for controlling
20 the reaction temperature. As noted above, it is important that the temperature within the reactor be maintained within the desired range to maximise microbial growth in the reactor.

The reactor may be provided with any suitable means to effect agitation of the material within the reactor. For example, this may include any form of stirring or
25 mixing arrangement, or may be achieved through vibratory means. However, in a preferred embodiment the reactor includes a centrally mounted motor driven axle with a plurality of associated paddles for agitating the pulp and biomaterial in the reactor.

30 The form of the waste reduction unit is not particularly limited. This should, however, be capable of reducing all forms of food and organic waste to be treated. For example, in most instances the waste reduction unit should be capable of reducing not only vegetable matter, but should also be capable of reducing large hard bones, such as cow knuckles and the like. The waste reduction unit may, for example

include a grinding, cutting and/or pulping unit. Preferably, the waste reduction unit is a grinding unit.

5 It is also preferred that the waste reduction unit be incapable of reducing or destroying metal objects, such as silverware. In that regard, the waste reduction unit may be fitted with a magnetic sensor that protects the unit from metal articles that may have found their way into the unit.

10 For health and safety reasons, the waste reduction unit preferably includes a safety shut-off mechanism and/or is designed such that the unit will not operate until a lid that facilitates loading of the unit is closed.

15 In a particular embodiment, the waste reduction unit is a grinder of the type manufactured by In-Sink-Erator[®] under Model SS-500[™], Model SS-750[™] or Model SS-1000[™].

20 The dewatering unit may be any unit that facilitates removal of water from the reduced waste emitted from the waste reduction unit so as to form the dry or semi-dry pulp. For example, the dewatering unit may include a centrifuge. In a preferred embodiment, however, the dewatering unit includes a press for pressing the reduced waste to form the dry or semi-dry pulp. In a particular embodiment the dewatering unit is a pulper of the type manufactured by In-Sink-Erator[®] under Model WX-200[™] or Model WX-300[™].

25 It should be appreciated that the waste reduction unit and the dewatering unit are not limited to the above described In-Sink-Erator[®] models. Units produced by other manufacturers may be equally applicable for use in accordance with the invention.

30 In order to conserve water, the assembly preferably includes reticulation for reticulating water removed from the reduced waste in the dewatering unit to the waste reduction unit. This minimises the amount of water required for introduction to the waste reduction unit from a mains source. Generally, sufficient water is added to the system to facilitate reduction of the waste in the waste reduction unit. Spent water

may be flushed from the system when the waste to be treated is reduced to the reduced waste and dewatered to form the dry or semi-dry pulp.

5 The deodorizing unit may include any suitable arrangement for removing odours produced on decomposition of food and/or organic wastes. For example, the deodorizing unit may include zeolite treatments or activated carbon treatments or the like. In a preferred embodiment, the deodorizing unit is connected with an exhaust outlet of the reactor and includes a preliminary treatment zone including a zeolite treatment, a secondary treatment zone including an ozone generator and a tertiary
10 treatment zone including an activated carbon treatment.

The size of the in-line waste treatment assembly, and therefore each of the units forming the assembly, is not particularly limited. This will be somewhat dependent on the processing capacity desired for a particular instance. For example, when the
15 assembly is intended for domestic use, or for use in a restaurant, a relatively small assembly may be desirable. On an industrial scale, it may be more desirable to employ a larger assembly so as to satisfy higher throughput loads.

The in-line waste treatment assembly and the process for degrading food and/or
20 organic waste to compost utilize a biomaterial that is specifically designed for the purpose at hand. In particular, the biomaterial that is preloaded into the reactor before introducing the dry or semi-dry pulp produced from the initial waste is designed taking into account the make-up of the initial waste. In arriving at the inventions described above, significant developments have been made in relation to the
25 biomaterial used to decompose the waste. This has led to the further aspects of invention below and to the following more detailed description of the biomaterial.

It should be noted, however, that the above described aspects of the invention are not to be construed as limited by the following discussion of the biomaterial.
30 Furthermore, although the following description of the biomaterial is generally framed in the context of use in the above described process and assembly, it should be appreciated that the biomaterials may equally be applicable to alternative processes and/or may be used in different assemblies as desired.

According to a further aspect of the invention, therefore, there is provided a biomaterial for use in a process for degrading food and/or organic waste to compost, and generally suitable for use in the above process of the invention, the biomaterial including a solid support treated with a culture medium and inoculated with a pre-
5 selected combination of micro-organisms including *Brevibacillus brevis*, yeast *Candida krusei*, *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus pumilis*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus mycoides*, *Bacillus firmus* and/or *Pseudomonas alcaligenes*.

10 Preferably, and generally, the biomaterial includes at least a combination of *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus firmus* and *Pseudomonas alcaligenes*. In a more preferred embodiment, the biomaterial includes all ten of the micro-organisms described in the immediately preceding paragraph.

15 *Brevibacillus brevis* is a skin and environment bacterium that grows at ambient temperature. Optimum temperature for growth of the bacterium is 30°C. The bacterium utilizes simple sugars (glucose, fructose, sucrose), molasses and malt extract rapidly, but is not able to digest starch.

20 Yeast *Candida krusei* was isolated from rotten vegetable matter. It grows at ambient temperature with an optimum temperature of 30°C. The yeast produces the digestive enzyme lignocellulase which degrades vegetable fibre. It is able to grow on simple sugars, molasses and malt extract, but not starch.

25 *Brevibacillus laterosporus* is a natural resident of soil, animal rumen and human skin. It grows at ambient temperature with an optimum temperature of 30°C. The bacterium produces protein (meat and vegetable proteins) degrading enzymes and is able to grow on simple sugars, molasses, malt extract and starch (rice, wheat, potato).

30 *Bacillus coagulans* is an environment bacterium. It is used in industry for the production of glucose isomerases, which converts to fructose. The bacterium grows at ambient temperature with an optimum temperature of 45°C. It produces spore at old age, and is therefore able to persist in food waste treatment systems with long waste

residence times. The bacterium produces lignocellulase, which degrades vegetable fibre, and is able to grow on simple sugars, molasses and malt extract, but not starch.

5 *Bacillus pumilis* is a soil and environment bacterium. It grows at ambient temperature with an optimum temperature of 30°C and produces spore at old age. It produces protein degrading enzyme and is able to grow on simple sugars, molasses and malt extract, but not starch.

10 *Bacillus licheniformis* was isolated from a plant surface. It grows at ambient temperature with an optimum temperature of 30°C. The bacterium produces alkaline protein degrading enzyme, and therefore works well in alkaline conditions. It is able to grow on simple sugars, molasses and malt extract, but not starch. It has been reported to produce the enzyme pentosanase, which is used to remove pentosan gum from wheat flour. It is also known to produce chitinase, chitobiase and citric acid.
15 The enzymes chitinase and chitobiase degrade the outer skeleton of crab, prawn and lobster. The citric acid helps to solubilise calcium skeletons.

20 *Streptomyces avermitilis* is a soil bacterium. It grows at ambient temperature with an optimum temperature of 30°C. It produces spore at old age and is therefore able to persist in waste treatment systems with relatively long waste residence times. It produces alkaline protein degrading enzyme and is able to grow on simple sugars, molasses, malt extract and starch.

25 *Bacillus mycoides* is a soil and environment bacterium. It grows at ambient temperature with an optimum temperature of 30°C. It produces spore at old age. It produces protein degrading enzyme and grows on simple sugars, molasses, malt extract and starch.

30 *Bacillus firmus* is a phosphate solubilising bacterium isolated from soil. It grows at ambient temperature with an optimum temperature of 30°C. It produces spore at old age. It produces oil and protein degrading enzymes. It grows on simple sugars, molasses, malt extract and starch.

Pseudomonas alcaligenes is a soil bacterium. It grows at ambient temperature with an optimum temperature of 30°C. It produces oil degrading enzyme and grows on organic matter such as citric acid, molasses and malt extract.

- 5 It should be noted at this stage that additional micro-organisms, bacteria and/or fungi may be added to the pre-selected combination of micro-organisms if desired. For example, additional constituents may be added based on their specific ability to digest a component of the food and/or organic waste to be treated.
- 10 The ratio of the micro-organisms in the biomaterial will be somewhat dependent on the type of culture medium used. Generally, the substrates included in the culture medium will be selected based on the make-up of the waste to be degraded. Preferably, substrates are chosen such that the proportion of each micro-organism in the biomaterial is relative to the proportion of material to be degraded by each micro-
- 15 organism in the waste. In general terms, however, it is preferred that an appropriate quantity of culture of each of the micro-organisms is added to the solid support to provide at least 10^9 live cells.

As noted above, the culture medium affects the ratio of micro-organisms within the biomaterial. Which culture medium to employ is therefore a consideration dependent

20 on the waste to be digested. The following is an example of a culture medium suitable when the food and/or organic waste to be degraded is Asian food waste. It is able to support a bacterial concentration of about 10^8 cells/ml culture and the starch-degrader to non-starch-degrader ratio is about 7:3. For Western food waste, it is

25 preferred that the culture medium have a Starch-degrader to non-starch-degrader ratio of about 1:1.

The protein degraders are always present, for the sole nitrogen substrate in the culture medium is milk protein. Cooking oil is present to induce the production of oil

30 degrading enzymes.

Culture Medium Example 1 – Asian Food Waste

Rice Starch

5g

	Milk powder	4g
	Cooking oil	1g
	KH ₂ PO ₄	1g
	NaCl	1g
5	FeSO ₄ .7H ₂ O	3mg
	MgSO ₄ .7H ₂ O	0.7mg
	H ₂ O	1L

The pH of the culture medium is 7.0.

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It will be appreciated that the proportion and type of the carbon (starch, oil) substrates and nitrogen (protein) substrates can be modified to enhance the proportion of the desired micro-organisms, and therefore their production of food degrading enzymes. For example, fish meal could replace milk powder for fish-based waste. Potato or
 15 cereal starch could replace rice starch for Western food waste. Generally, higher starch content is desirable for Asian food waste, while higher protein content is desirable for Western food waste. This will be highlighted in the following examples. In each case, the pH of the culture medium is 7.0.

20 Culture Medium Example 2 - Seafood Restaurant Waste

	Rice Starch	5g
	Fish meal	4g
	Coconut oil	1g
25	KH ₂ PO ₄	1g
	NaCl	1g
	FeSO ₄ .7H ₂ O	3mg
	MgSO ₄ .7H ₂ O	0.7mg
	H ₂ O	1L

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Culture Medium Example 3 – Italian Restaurant Waste

	Wheat flour	6g
	Fish meal	3g

	Olive oil	1g
	KH ₂ PO ₄	1g
	NaCl	1g
	FeSO ₄ .7H ₂ O	3mg
5	MgSO ₄ .7H ₂ O	0.7mg
	H ₂ O	1L

Culture Medium Example 4 - Steak Restaurant Waste

10	Potato starch	3g
	Meat and bone meal	6g
	Corn oil	1g
	KH ₂ PO ₄	1g
	NaCl	1g
15	FeSO ₄ .7H ₂ O	3mg
	MgSO ₄ .7H ₂ O	0.7mg
	H ₂ O	1L

Once again, the solid support may include natural or synthetic materials. Preferably,
 20 as previously, the solid support includes rice husks, wood chips and saw dust in a ratio of 1:1:2.

According to yet another aspect of the invention there is provided a process for the preparation of a biomaterial including:

- 25 introducing a solid support to a reactor;
 adding a culture medium to the solid support in the reactor such that the culture medium is absorbed into the solid support;
 adding cultures of a pre-selected combination of micro-organisms to the solid support in the reactor; and
 30 allowing the pre-selected combination of micro-organisms to grow in the reactor;
 wherein the pre-selected combination of micro-organisms includes *Brevibacillus brevis*, yeast *Candida krusei*, *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus*

pumilis, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus mycoides*, *Bacillus firmus* and/or *Pseudomonas alcaligenes*.

Once again, the biomaterial will generally include a combination of at least
5 *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus firmus* and *Pseudomonas alcaligenes*. In a more preferred embodiment, the biomaterial includes all ten of the micro-organisms described in the immediately preceding paragraph.

10 As above, the solid support preferably includes rice husks, wood chips and saw dust mixed in a ratio of 1:1:2. The rice husks, wood chips and saw dust are preferably mixed until homogeneous, without addition of any heat.

The culture medium is preferably added to the solid support in a sufficient quantity to
15 provide the required nutrients to the micro-organisms of the biomaterial. More preferably, the culture medium is added to the solid support in an amount of about 2.5 litres per kilogram.

After the culture medium has been absorbed by the solid support, cultures of the
20 micro-organisms are added to the solid support, preferably with agitation to ensure dispersion of the cultures in the solid support. The cultures may, for example, be seed microbial cultures in dried powder form. Preferably, an appropriate quantity of culture of each of the micro-organisms is added to the solid support to provide at least 10^9 live cells.

25 In order to maximise growth of the micro-organisms, it is preferred that the temperature within the reactor be maintained at from 35 to 50°C over a period of at least 48 hours. Preferably, during growth of the micro-organisms, the biomaterial is mixed during agitation phases and allowed to stand in non-agitation phases. In that
30 regard, the agitation phases are preferably of about 3 minutes duration and the non-agitation phases are preferably of about 1 minute duration.

A preferred embodiment of the invention will now be described in further detail with reference to the accompanying drawing. It will be appreciated that the detailed

description is provided for exemplification only and should not be construed as limiting on the invention in any way.

Referring to Figure 1, the in-line waste treatment assembly 10 includes a waste reduction unit 11, a dewatering unit 12, a reactor 13 and a deodorizing unit 14. The waste reduction unit 11 includes a sink 15 for receiving waste to be treated and a grinder 16 located beneath the sink 15. The dewatering unit 12 is in the form of a pulper that is in communication with the grinder 16 by means of a conduit 17. Reticulation is also provided between the dewatering unit 12 and the waste reduction unit 11 for recycling water from the dewatering unit 12 back to the waste reduction unit 11.

As noted, waste that is introduced to the grinder 16 via the sink 15 is ground to a desired particle size and then fed to the dewatering unit 12, in the form of a pulper. In the pulper the reduced waste is pressed to remove substantially all of the water present in the reduced waste so as to form a dry or semi-dry pulp. The dry or semi-dry pulp formed after particle size reduction and dewatering represents a volume reduction of the initial waste of about 80-90%. Water that is removed from the reduced waste is pumped to the grinder 16 for recycling. On completion of the grinding and pulping process, spent water is emitted from the assembly via a water outlet 18.

The dry or semi-dry pulp may then be fed to the reactor 13, that is preloaded with a biomaterial and which includes a stirring mechanism 19 for agitating the pulp and biomaterial. The stirring mechanism 19 includes a plurality of stirring paddles 20 that extend from an axle 21 driven by a motor 22. The circular motion of the paddles 20 ensures homogeneous mixing of the material in the reactor 13 by lateral translation of the material in a left to right to left motion. The motor 22 is controlled so that agitation of the pulp is conducted in phases including agitation phases of 3 minutes and non-agitation phases of 1 minute. The motor 22 is set to automatically shut off after 3 hours of treatment of the pulp in the reactor 13.

The reactor 13 includes an outlet 23 in a bottom wall that may be opened to release used biomaterial. Advantageously, removal of spent biomaterial and replacement of that biomaterial is attended to every six months or so.

The reactor also includes an exhaust 24 for expelling gases produced in the reactor 13 during the decomposition of the waste. The exhaust is in communication with the deodorizing unit 14 that is adapted to remove odours from the gas emitted from the reactor 13. The deodorizing unit includes a preliminary treatment zone 25 including a zeolite treatment, a secondary treatment zone 26 including an ozone generator, and a tertiary treatment zone 27 including an activated carbon treatment. Clean air is emitted from the deodorizing unit 14 through outlet 28.

When preparing the assembly 10 for use, a mixture of rice husks, wood chips and saw dust in a ratio of 1:1:2 is fed into the reactor 13. This mixture, which will be the solid support for the biomaterial, is then mixed until homogeneous. To the homogeneously mixed solid support is added a culture medium that is selected depending on the waste material to be treated. The culture medium is added to the solid support in an amount of 2.5 litres of culture medium per kilogram of solid support. After the culture medium is completely absorbed by the solid support, a pre-selected combination of micro-organisms is added to the reactor 13. During addition of the pre-selected combination of micro-organisms, the solid support is agitated with the stirring mechanism 19 under a substantially constant temperature of about 40°C to 45°C.

The pre-selected combination of micro-organisms includes *Brevibacillus brevis*, yeast *Candida krusei*, *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus pumilis*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus mycoides*, *Bacillus firmus* and/or *Pseudomonas alcaligenes*. Each of the micro-organisms is chosen based on specific properties and effectiveness in digesting components in the waste being treated. As previously noted, however, the biomaterial will generally include a combination of at least *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus firmus* and *Pseudomonas alcaligenes*. In a more preferred embodiment, the biomaterial includes all ten of the micro-organisms described above.

During the addition of the micro-organisms, 20ml of each of the seed bacterial and yeast cultures is introduced to the reactor 13, this being sufficient to provide at least 10^9 live cells. The bacteria and yeast are allowed to grow in the reactor 13 for a

period of 48 hours with agitation phases of 3 minutes and non-agitation phases of 1 minute. As noted the temperature within the reactor 13 is kept substantially constant to maximise growth of the micro-organisms. The biomaterial formed within the reactor 13 is then ready for use in degrading food and/or organic waste to compost.

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The biomaterial may of course be formed off site and then introduced into the reactor 13. This may be determined on a case by case basis. It may be more likely that in an industrial context the biomaterial will be formed *in situ*, while in a domestic environment, the biomaterial will be formed off site.

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The protocol for digesting waste in the reactor 13 is relatively uncomplicated. To the biomaterial preloaded into the reactor 13 is added the waste to be treated. The waste , in the form of dry or semi-dry pulp, is added to the biomaterial at a ratio of 3:5 (pulp:biomaterial). That is, if 2.5kg of biomaterial is preloaded into the reactor 13, 1.5kg of pulp may be added to the biomaterial for digestion. The mixture in the reactor 13 is then treated for a period of 3 hours (one process cycle), during which time the pulp and biomaterial are agitated for a period of 3 minutes and let stand for a period of 1 minute, and this agitation/non-agitation process is repeated for the duration. The temperature in the reactor is maintained substantially constant at about 40°C to 45°C.

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Water evaporated during the treatment process is channelled out of the reactor 13 as necessary. After the full cycle of 3 hours the pulp is completely composted into solid powder with minimal increase in the solids volume in the reactor 13. Furthermore, the nature of the biomaterial and the processing conditions contribute to the longevity of the biomaterial, making it necessary to replace the biomaterial only every six months or so.

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It is considered that the above aspects and embodiments of the present invention may find use in a number of environments, including the hotel industry, off-shore rigs and living quarters, restaurants, fast food outlets, hospital catering services and any other location requiring the disposal of food and/or organic wastes.

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Claims:

1. A process for degrading food and/or organic waste to compost, the process including:
 - 5 reducing the particle size of the waste to form a reduced waste having decreased volume;
 - dewatering the reduced waste to form a dry or semi-dry pulp;
 - introducing the pulp to a reactor preloaded with a biomaterial including a solid support inoculated with a pre-selected combination of micro-organisms; and
 - 10 treating the pulp in the presence of the biomaterial to degrade the pulp to compost;
 - wherein treatment of the pulp is conducted at a temperature in the range of from 35 to 50°C and includes agitation phases during which the pulp is mixed with the biomaterial and non-agitation phases during which the pulp is allowed to stand.
- 15 2. A process according to claim 1, wherein the pulp is treated for a period of from 3 to 5 hours and wherein the agitation phases are from 3 to 5 minutes in duration and the non-agitation phases are from 1 to 2 minutes in duration.
- 20 3. A process according to claim 2, wherein the pulp is treated for a period of about 3 hours and wherein the agitation phases are about 3 minutes in duration and the non-agitation phases are about 1 minute in duration.
4. A process according to claim 1, wherein the pulp is treated at a substantially
25 constant temperature of about 40°C to 45°C.
5. A process according to claim 1, wherein the particle size of the waste is reduced by grinding, cutting and/or pulping.
- 30 6. A process according to claim 1, wherein dewatering of the reduced waste is achieved by pressing the reduced waste.
7. A process according to claim 1, wherein the initial volume of the waste is reduced by 80 to 90% during the particle size reduction and dewatering steps.

8. A process according to claim 1, wherein the agitation phases include homogeneous mixing of the biomaterial and pulp by churning that induces lateral translation of the biomaterial and pulp.
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9. A process according to claim 1, wherein the ratio of waste over top space in the reactor is 50:30:20.
- 10
10. A process according to claim 1, wherein exhaust air emitted from the reactor is deodorized.
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11. A process according to claim 10, wherein deodorization of the exhaust air is achieved using a deodorizing unit including a preliminary treatment zone including a zeolite treatment, a secondary treatment zone including an ozone generator and a tertiary treatment zone including an activated carbon treatment.
- 20
12. A process according to claim 1, wherein the biomaterial includes a solid support selected from rice husks, wood chips and/or saw dust inoculated with a pre-selected combination of micro-organisms.
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13. A process according to claim 12, wherein the biomaterial includes a solid support of rice husks, wood chips and saw dust in a ratio of 1:1:2.
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14. A process according to claim 1, wherein the biomaterial includes a solid support inoculated with a pre-selected combination of micro-organisms including *Brevibacillus brevis*, yeast *Candida krusei*, *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus pumilis*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus mycoides*, *Bacillus firmus* and/or *Pseudomonas alcaligenes*.
15. A process according to claim 14, wherein the biomaterial includes a solid support inoculated with a pre-selected combination of micro-organisms including *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus firmus* and *Pseudomonas alcaligenes*.

16. A process according to claim 15, wherein the pre-selected combination of micro-organisms additionally includes *Brevibacillus brevis*, yeast *Candida krusei*, *Bacillus pumilis* and *Bacillus mycoides*.
- 5 17. A process according to claim 1, wherein the biomaterial includes a solid support treated with a culture medium and subsequently inoculated with a pre-selected combination of micro-organisms, wherein the culture medium and micro-organisms are selected based on the make-up of the waste to be degraded.
- 10 18. A process according to claim 1, wherein preloading of the biomaterial into the reactor includes:
- introducing the solid support to the reactor;
 - adding a culture medium to the solid support in the reactor such that the culture medium is absorbed into the solid support;
 - 15 adding cultures of the pre-selected combination of micro-organisms to the solid support in the reactor; and
 - allowing the pre-selected combination of micro-organisms to grow in the reactor.
- 20 19. A process according to claim 1, wherein each of the steps is conducted in an in-line waste treatment assembly.
20. An in-line waste treatment assembly for degrading food and/or organic waste to compost, the waste treatment assembly including:
- 25 a waste reduction unit adapted to reduce the particle size of the waste to form a reduced waste having decreased volume;
- a dewatering unit for removing water from the reduced waste to form a dry or semi-dry pulp;
 - a reactor for receiving the pulp and treating the pulp in the presence of a
 - 30 biomaterial preloaded in the reactor; and
 - a deodorizing unit adapted to receive and deodorize exhaust gas emitted from the reactor;
- wherein the reactor is adapted to maintain a reaction temperature of from 35 to 50°C during treatment of the pulp and to provide agitation phases during which the pulp is

mixed with the biomaterial and non-agitation phases during which the pulp is allowed to stand.

21. An assembly according to claim 20, wherein the reactor includes a heater and
5 a thermostat for controlling the reaction temperature.

22. An assembly according to claim 20, wherein the reactor includes a centrally
mounted motor driven axle with a plurality of associated paddles for agitating the pulp
and biomaterial in the reactor.

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23. An assembly according to claim 20, wherein the waste reduction unit includes
a grinding, cutting and/or pulping unit.

24. An assembly according to claim 20, wherein the dewatering unit includes a
15 press for pressing the reduced waste to form the dry or semi-dry pulp.

25. An assembly according to claim 20, wherein the deodorizing unit is connected
with an exhaust outlet of the reactor and includes a preliminary treatment zone
including a zeolite treatment, a secondary treatment zone including an ozone
20 generator and a tertiary treatment zone including an activated carbon treatment.

26. An assembly according to claim 20, including reticulation for reticulating
water removed from the reduced waste in the dewatering unit to the waste reduction
unit.

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27. A biomaterial for use in a process for degrading food and/or organic waste to
compost, the biomaterial including a solid support treated with a culture medium and
inoculated with a pre-selected combination of micro-organisms including
Brevibacillus brevis, yeast *Candida krusei*, *Brevibacillus laterosporus*, *Bacillus*
30 *coagulans*, *Bacillus pumilis*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus*
mycoides, *Bacillus firmus* and/or *Pseudomonas alcaligenes*.

28. A biomaterial according to claim 27, wherein the biomaterial includes a solid
support inoculated with a pre-selected combination of micro-organisms including

Brevibacillus laterosporus, *Bacillus coagulans*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus firmus* and *Pseudomonas alcaligenes*.

29. A biomaterial according to claim 28, wherein the pre-selected combination of micro-organisms additionally includes *Brevibacillus brevis*, yeast *Candida krusei*, *Bacillus pumilis* and *Bacillus mycoides*.

30. A biomaterial according to claim 27, wherein an appropriate quantity of culture of each of the micro-organisms is added to the solid support to provide at least 10^9 live cells.

31. A biomaterial according to claim 27, wherein substrates in the culture medium are selected based on the make-up of the waste to be degraded such that the proportion of each micro-organism in the biomaterial is relative to the proportion of material to be degraded by each micro-organism in the waste.

32. A biomaterial according to claim 27, wherein the food and/or organic waste to be degraded is Asian food waste and the culture medium has a starch-degrader to non-starch-degrader ratio of about 7:3.

33. A biomaterial according to claim 27, wherein the food and/or organic waste to be degraded is Western food waste and the culture medium has a starch-degrader to non-starch-degrader ratio of about 1:1.

34. A biomaterial according to claim 27, wherein the solid support includes rice husks, wood chips and saw dust in a ratio of 1:1:2.

35. A process for the preparation of a biomaterial including:
introducing a solid support to a reactor;
adding a culture medium to the solid support in the reactor such that the culture medium is absorbed into the solid support;
adding cultures of a pre-selected combination of micro-organisms to the solid support in the reactor; and

allowing the pre-selected combination of micro-organisms to grow in the reactor;

wherein the pre-selected combination of micro-organisms includes *Brevibacillus brevis*, yeast *Candida krusei*, *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus pumilis*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus mycoides*, *Bacillus firmus* and/or *Pseudomonas alcaligenes*.

36. A process according to claim 35, wherein the biomaterial includes a solid support inoculated with a pre-selected combination of micro-organisms including *Brevibacillus laterosporus*, *Bacillus coagulans*, *Bacillus licheniformis*, *Streptomyces avermitilis*, *Bacillus firmus* and *Pseudomonas alcaligenes*.

37. A process according to claim 36, wherein the pre-selected combination of micro-organisms additionally includes *Brevibacillus brevis*, yeast *Candida krusei*, *Bacillus pumilis* and *Bacillus mycoides*.

38. A process according to claim 35, wherein the solid includes rice husks, wood chips and saw dust mixed in a ratio of 1:1:2.

39. A process according to claim 35, wherein the culture medium is added to the solid support in an amount of about 2.5 litres per kilogram.

40. A process according to claim 35, wherein the cultures of the micro-organisms are added to the solid support with agitation to ensure dispersion of the cultures in the solid support.

41. A process according to claim 35, wherein the cultures are seed microbial cultures in dried powder form.

42. A process according to claim 35, wherein an appropriate quantity of culture of each of the micro-organisms is added to the solid support to provide at least 10^9 live cells.

43. A process according to claim 35, wherein growth of the micro-organisms is assisted by maintaining a temperature of from 35 to 50°C within the reactor over a period of at least 48 hours.

5 44. A process according to claim 43, wherein during growth of the micro-organisms, the biomaterial is mixed during agitation phases and allowed to stand in non-agitation phases.

10 45. A process according to claim 44, wherein the agitation phases are of about 3 to 5 minutes duration and the non-agitation phases are of about 1 to 2 minutes duration.

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