How to Recycle ALL Food Waste

back to the soil by the bokashi method

A lactic-yeast-phototrophic fermentation process

Fermenting food waste to prepare it for the soil

2 weeks to ferment
2 weeks in the soil
then plant

recycle**food**waste.org

Co-sponsors:

MoS Collective
(Masters of Succession Collective)
moscollective.net

SJC (Sustainable Jersey City)
sustainablejc.org

info@sustainablejc.org

Information:

recycle**food**waste.org

moscollective.net

sustainablejc.org

EM Research Organization, emrojapan.com

TeraGanix (U.S.), teraganix.com

Booklet written by Shig Matsukawa, shig@recyclefoodwaste.org
Artwork by Elizabeth Onorato

October 2012, November 2014, November 2015

Recycling Food Waste

There are different ways to recycle food waste, including composting (e.g., mesophilic composting, thermophilic composting), vermiculture (worm composting), using black soldier fly larvae, the bokashi method, and other methods.

The Bokashi Method of Recycling Food Waste

What is bokashi?

A Japanese term, bokashi means
'**fermented organic matter**' (mainly known by some farmers)
See section below on different uses and history of bokashi.

What is the bokashi method?

2-Step Process:

Step 1. Ferment ('pickle') the food waste

2 weeks to ferment.
Pretreats food waste to prepare it for step 2.
[How-To Step 1 is on page 8]

Step 2. Add to soil

2 weeks in soil, then plant.
Or, composted to be spread on soil.
[How-To Step 2 is on page 10]

In Step 1, think in terms of fermenting foods (sauerkraut, yogurt) since the same microbes are used to ferment the food waste. After fermentation, the food waste **will still look like food waste** (i.e., naturally preserved), **but will smell fermented** (vinegary, sour, pungent, fruity, pleasant or somewhat unpleasant, and/or other such smells or combination of smells—See Tips & Tricks section below).

In Step 2, you can think in terms of composting. The **fermented food waste** (**FFW**) will now be soft and ready to more quickly and safely break down in soil or compost pile.

The Bokashi Method In Relation To Composting

The bokashi method can be done on its own (standalone), or it can complement or supplement and be integrated with composting.

Standalone ways are where Step 2 include burying, trenching, and sandwiching between soil in pots and planters. The FFW can be seen as a soil amendment to be mixed in and covered with soil without having to compost.

Or **with composting**, ways to integrate include using the FFW as, or part of, the greens when creating or adding to an existing composting batch, or adding to a worm compost.

Step 1, the fermentation step, is not composting, but rather naturally preserves the food waste, which is why after step 1, it still looks like food waste. Step 2, the breakdown phase, is where the FFW would decompose, as in composting, whether composted or just mixed inside of soil.

Either way, the Step 1 of the process can be seen as a **pretreatment step**, dealing with food waste as follows:

- Done in **airtight containers** minimizing pest attraction, odors and rotting issues; if pail-size, easy to move & carry.
- Treats food waste **at the source** (at home/in the kitchen)
- Treats **all food waste**, including meats, bones, dairy, oils, raw, cooked, and non-waxed/non-writing-printing paper.
- Prevents, eliminates or **minimizes pathogens** (by pH 3.9, coenzymes, bacteriocins, antioxidants)
- Produces (cultures/grows) a **dense** batch of **diverse**, **beneficial microbes** for soil or compost pile.
- Makes the nutrients from the food waste **bioavailable** (useful—soluble, absorbable—by plants, other organisms)
- Makes the **food waste soft** for easier breakdown or composting (by microbial activity and their enzymes)

Makes the organic matter content microbe-dense, nutrient-dense, and a source of water (high moisture retention).

A Little Bit About Microorganisms

The following terms mean the same thing:
microorganisms = **microbes** = **microscopic organisms**

They refer to all of the separate and different kinds of the smallest of organisms, including bacteria, fungi (yeast, mold), archaea, algae, protozoa, microscopic plants and microscopic animals.

> **Pathogens** are disease-causing microbes that produce substances that are **toxic** or cause **cell damage**. Pathogens can be bacterial, fungal, viral, parasitic, or prionic (disease-causing protein). It's estimated that pathogenic microbes represent a fraction of 1% of all microbes.
>
> **Microbiome** refers to all of the microbes, including their environment or body or part of the [animal, human, etc.] body in which they inhabit.

Microbes are everywhere.

They're in our body, in almost every kind of environment on earth, and in extreme conditions: in the earth's crust; bottom of the ocean near volcanic vents; deep in the ice of the arctic and antarctic; high up in the stratosphere; traveling with dust, pollen, birds, insects, fishes, animals and humans.

The average human body has around 10 trillion human cells, but we have 10 times many more microbes, about 100 trillion microorganisms: in our gut, throughout our organs, on our skin and coursing through our veins. We need them not only to help us to digest and with other bodily functions, but also to keep our immune system healthy. Additionally, we now know (2015) that we have a microbial cloud surrounding the air around our body. It's due to microbial emissions constantly coming off our body, including biological particles (dead skin, breath, perspiration, etc.) they ride on.

Microbes are necessary for all of life, the cycle of life, including composting and fermentation.

They help break down dead plants and animals into humus—the organic parts of soil (the other solid part of soil being inorganic—mineral particles). The microbes help to make nutrients bioavailable (having effects on the plants and other organisms), transport nutrients to plant roots, and they themselves are the food stuff for much of life on earth: other microscopic organisms, insects, earthworms, shellfish, etc.

The microbes found in extreme conditions, the extremophiles, include those found in battery acid, in the coolant water of nuclear reactors, and in toxic lakes.

They can consume what we consider waste, pollutants, chemicals and toxins, and make them harmless or useful.

They terraformed our planet!

A Little bit About Fermentation

A definition of fermentation

where microbes break down complex molecules
into simpler ones.

Example: sugars/carbohydrates (complex molecules) into CO2/carbonation and alcohol (simpler molecules).

During fermentation, microbes become very active: eating, excreting, and multiplying quickly/exponentially.

Different kinds of fermentation

Lactic/yeast fermentation, includes the type of fermentation that produces fermented foods:

sauerkraut, pickles, pickled roots, olives, yogurt, cheese, kefir, dark chocolate, vanilla extract, kimchee, miso, certain sausages and hard salami, bread, etc.

and fermented beverages:

beer, wine, mead, (as well as vinegar—as a condiment or pickling juice), and fermentation is a pre-step to making many kinds of distilled alcohol (whisky, vodka, sake).

Methane fermentation, such as those used in anaerobic digesters where the main purpose is to produce methane gas as a source of energy. It's produced by a mixture including food waste, slurry/sewage sludge and/or manure. This is an *anaerobic fermentation* process, the same term used in other fermentation processes, as well as in the bokashi method.

However, the bokashi method is a lactic-yeast fermentation process, or more specifically a **lactic-yeast-phototrophic fermentation** process. There is no methane produced, specifically in the fermentation step (Step 1).

We've been **fermenting foods and beverages**
since ancient times **to feed our bodies**.

Now, we're **fermenting food waste**
to feed the soil and plants.

Microbial Relationship Between Composting and Bokashi

Composting is the managing of the conditions to **attract the microbes**, that already exists in the environment, that break down the organic matter.

The bokashi method **directly adds the microbes** that ferments and pretreats the organic matter.

What kinds of microbes are in the bokashi?

There are three groups of microbes that are used to make bokashi:

Lactic acid bacteria
the same ones that are found in fermented foods,
such as, yogurt, cheese, sauerkraut, etc.

Yeast
the same as those used in baking and brewing (beer).

Phototrophic bacteria
found in soil and water, as well as, in worm castings;
they are a natural detoxifier.

A professor of horticulture/agriculture, Teruo Higa (currently at Meio University, Okinawa Japan), discovered that by combining these three groups of microbes, they behave differently and more effectively than when they are just among their own kind. He needed to refer to this combination of microbes by a name, so he called the grouping **Effective Microorganisms (EM)**.

EM•1 Microbial Inoculant

While EM refers to the combination of those 3 groups of microbes, EM•1 refers to **the liquid** that contains the 3 groups of microbes.
See last pages for list of the exact species of microbes in EM•1 (USA version).

The ingredients for making bokashi consists of EM•1, blackstrap molasses, water, and an organic matter (example, wheat bran). See below section on How To Make Bokashi.

How To — Step 1. Ferment ('pickle') your food waste.

Start in the kitchen

What do you need?

- **Airtight containers** that's convenient for your kitchen
- The **bokashi** fermentation starter* (also referred to as the 'sprinkle' or 'bokashi starter') added to the food waste so that it will ferment instead of rot.

How to ferment food waste

First, add handful of bokashi to bottom of empty container.

Sprinkle bokashi every time you add food waste.
(ideal ratio 1:33, e.g., 1 Lb bokashi to 33 Lbs food waste)

Keep container closed **airtight** and at **room temperature**.

Okay to briefly open and close the container 3 or more times a day.

White mold (actinomycetes, a mold-like bacteria) is good if it appears.

Press down the food waste to make more room.
You can use a non-wax paper plate and leave it in the bucket, adding more food waste on top of that.

When container ('bokashi bucket') is full

Add a final layer (handful or two) of bokashi on top.

Let it sit for **2 weeks** minimum at room temperature.

Keep it **airtight**.

Keep it out of direct sunlight.

* **Bokashi Not Necessary** (Fruits & Veggies Only)

The bokashi, as a fermentation starter, is not necessary to ferment food waste in an airtight container.

However, you could then only do fruits and vegetables. This is because the microbes that can ferment these foods are already in and on the fruits and vegetables.

For example, the reason why it's relatively easy to turn cabbage into sauerkraut is because the bacteria that ferments it into sauerkraut are naturally in the cabbage. The way it works is you first chop up the cabbage and then press it in order to squeeze out the juices. The bacteria are in that juice. You then let the cabbage steep in its own juices (you can add salt, water and/or vinegar or other ingredients in the process) where it will ferment on its own. Another example, with grapes, the yeast are already on the skin of the grape. This is why it's not that difficult to turn grapes into wine, vinegar, etc.

So, without bokashi, you can ferment fruits and vegetable scraps in an airtight container, but it may take time and be inconsistent. To make it ferment better, you can mash the fruits and vegetable scraps to release and spread the microbes around.

After it's fermented in this way, it can be either buried and mixed in soil or added to a compost pile.

This method of recycling food scraps have been done by others and may be a very old method.

By Using Bokashi

On the other hand, **by using bokashi**, the fermentation would be quicker (2 weeks) and more consistent.

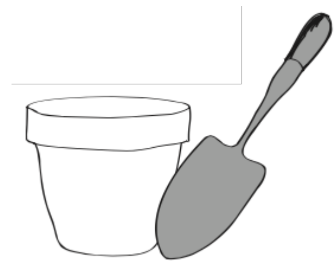
Not only that, with bokashi, you can then add all other types of food waste, including meats, bones, cooking oils, etc. This is because a wider variety of fermentative microbes are added.

How To — Step 2. Convert ('break down') the fermented food waste into the soil.

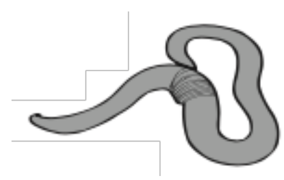
What to do after 2 weeks of fermentation.

Four ways to convert the fermented food waste (FFW)

1. **Burying In A Trench or Pit**
   - If in a trench, bury with about 6 inches of soil on top; can plant seeds right away, or seedlings after 2 weeks.
   - If in a pit, at least 1 foot away from existing plants and 3 feet away from trees; bury about 1 foot deep and cover with at least 6 inches of soil on top; can plant after 2 weeks, or let it be the nutrients for the surrounding plants.
2. **Into Pots or Planters**
   - First, add pebbles, small rocks or gravel with or without sand to the bottom of the pot or planter (about 1 inch) for drainage.
   - Add 1–2 inches of soil (or 1/4 height of the pot/planter)
   - Add FFW about 1/4 the height of the pot/planter, and mash and mix thoroughly with soil.
   - And fill to the top of the pot/planter with soil.
   - Can plant seeds right away; if planting seedlings, wait 2 weeks, but keep soil moist, do not water too much.



3. **Feed To Earthworms**
   If you have a worm bin or would like to start one, follow the general rules for vermiculture, except:
   - Add 1/3 FFW to 2/3 yard waste (leaves, clippings, etc.) and some soil.
   - No need to add earthworms since the worm eggs are in the soil and leaves.
   - Can feed FFW to worm bin every 2–3 weeks.



4. **Add To Compost**
   - Either add to an existing compost pile or bin, mix thoroughly,
   - Or start a new compost batch with FFW as 1/3 of the volume, that is, 1/3 greens (FFW) and 2/3 browns (leaves, wood chips, saw dust).
   - Compost ready sooner (1/3–2/3 sooner) with less turning.

What's Going On In Step 1

During fermentation of the food waste in the airtight container, "bokashi bucket," the following is happening:

- Nutrients from the food waste released by the microbes.
- Nutrients are made available and also useful (soluble, absorbable), that is, bioavailable.
- Microorganisms are exploding in population and diversity, creating a microbe-dense environment in the bokashi bucket.
- The microbes are producing (excreting) all sorts of metabolites (from their metabolism), including
  - Organic acids, creating acidic environment, pH 3.9 (pathogens generally can't survive where the pH is below 4.2)
  - Amino acids, protein building block, essential for life.
  - Enzymes, helps to break down the organic matter.
  - Coenzymes & bacteriocins, which are anti-pathogens.
  - Antioxidants, minimizes damaging oxidation (rotting) effects.
- It's the combination of these metabolites that makes it possible to treat all food waste.

The resulting fermented food waste:

- Of its **organic matter content**:
  - Pretreated so that it is stable and safer to use in step 2.
  - More ready to break down when added to soil or compost.
- Of its **nutrients**:
  - Made bioavailable (available + useful, soluble, absorbable—therefore, can have an effect on plant growth).
  - A source of both micronutrients and macronutrients.
- Of its **microorganisms**:
  - High degree of diversity (microbes from the bokashi & food waste)
  - Dense population of microbes due to the fermentation.

What's Going On In Step 2

The pretreated food waste, the fermented food waste, can then be used directly or via composting as a soil amendment:

Inoculating the soil with a dense population and diversity of microorganisms.

Maintaining or increasing the organic matter content of the soil.

Adding to both macronutrient and micronutrient levels in the soil.

Providing bioavailable nutrients from the FFW

Making any inaccessible nutrients already in the soil bioavailable by the addition of the dense set of microbes.

The resulting amended soil would then have the following characteristics:

Greater diversity and population of **life in the soil** from native microbes to organisms that feed on the microbes (worms, insects, etc.)

Within 4 weeks, 90%–99% of the FFW should have broken down to become **part of the soil**. Whatever may be left (egg shells, avocado pits, mango pits, corn cobs, corn husks, bones, citrus peels, etc.) will take longer to break down, most within 2–4 months, and bones within about 9 months.

Improved soil structure: water retention, porosity, and nutrient and water carriers (mycorrhizae and microbial activities).

Greater long-term continuous **CO2 sequestration**.

Greater **water filtering** capacity (water retention & porosity)

Greater **soil-microbial-root** development (mycorrhizal/mycelial, rhizobial) — (improve soil structure, less prone to soil degradation such as erosion)

Bioremediating effects: breakdown of chemicals and toxins, potential reduction of heavy metals through either binding/chelation (making it non-bioavailable), as well as possibility of being carried away (gravitationally) through release (by at least temporary acidity) and rebinding—*need further studies*.

Relationship

composting	bokashi
How: create and manage the condition to **attract the microbes** that break down the organic matter	How: **directly adds the microbes** that ferments and treats the food waste
Setup: composting equipment, bins and/or tumblers	Setup: airtight containers and bokashi; optionally, use compost equip in step 2.
Ongoing needs: **greens** (food scraps, fresh cut plants, and such) & **browns** (leaves, yard waste, wood chips, and such), **space** (composting area) and **weekly management** (turning)	Ongoing needs: in step 1, food waste, **bokashi** fermentation starter (unless doing only fruits+veggies only*); in step 2, **places** (garden, yard, pots, planters) to use the FFW; browns would be very useful with some step 2 options
No pre-treatment necessary. The whole composting process is the treatment process itself.	**Pre-treatment**: fermenting ('pickling') food waste, stabilizing it by organic acids (acidity, pH<4.0), enzymes, coenzymes and antioxidants; if done at the source/in the kitchen, minimizes unhygienic, pathogen and pest issues.
Mainly fruits & veggies. However, **all** food waste & compostable plastics if by very high temperature, i.e., hyperthermophilic composting (above 162°F, 72°C)	**All food waste** including meats, bones, oils, raw, cooked, baked, sauces, juices, etc. However, **not** compostable plastics (which require high heat to break the bond that makes them rigid).
If by thermophilic composting (hot or high temperature composting), heats to above 141°F, 61°C; can lose over 40% of the mass	Room temperature (ambient temp.), stays under 100°F, 38°C Very little loss of mass in step 1.
Pathogens are dealt with mainly by heat.	Pathogens are dealt with by a combination of substances produced by the microbes during fermentation, including organic acids making the fermented food waste acidic (pH<4.0), coenzymes, bacteriocins and antioxidants.
How long to produce compost: 30 days – 2 years depending on composting method	How long for fermented food waste to break down in the soil: 2 weeks – 3 months; bones: 6–9 months. Entire process: 2 weeks to ferment, 2 weeks in soil, then plant.
If thermophilic composting, 8–12 weeks of turning, and 1 to 4 months of curing	Handling twice (fermenting + putting in soil) or 3 times (fermenting + feeding to worms + sifting worm compost)
End result is compost that's ready to use/apply/ spread or bagged for distribution	Two-step process: at end of step 1, still looks like food waste; but is now treated and ready for step 2: adding to soil or to worm bin or to compost
Bioavailable nutrients: more of micronutrients than macronutrients	Bioavailable nutrients: both micronutrients & macronutrients
[For both] Soil & environmental health: improves microbial life which feeds other soil life (worms, insects), adds nutrients, builds soil organic matter content/humus, water retention/filtration, soil bioremediation, long-term CO2 sequestration, etc.	

* If only fruits+veggies, can ferment without using bokashi. However, it may take longer and may be inconsistent. Mashing the fruits+veggies should help.

Note. All food waste can also be fermented by spraying Activated EM (the liquid mixture used in making bokashi, see How To Make Bokashi p. 20, but where the liquid is let to ferment on its own in an airtight bottle instead of mixing with a material, such as wheat bran, to ferment that material. While this method works, more of the EM-1 and molasses ingredients may be used compared to using bokashi, especially the wheat bran or rice bran bokashi.

Step 1. More Details Fermenting Food Waste—Tips & Tricks

If lots of food waste at once, slowly add food waste while sprinkling bokashi.

Add more bokashi if adding more meat or if adding already spoiling/spoiled food waste.

Add all food waste, including meats, dairy, bones, sea shells, egg shells, bread, citruses, etc., and especially oils (olive oil, cooking oil), salad dressings and sauces. Instead of rinsing plate under the faucet, use paper napkin (or utensil) to wipe sauces and dressing from plate into your bokashi bucket with the paper napkin (some paper is fine as long as bucket does not become too dry).

Also, add leftover juices, milk, soda, wine, beer, etc.

Avoid water or adding too much coffee (stick to adding only leftover coffee or tea if it has cream and/or sugar).

To balance out the liquid, add used paper napkins, brown paper bag (after tearing some of it up), and non-waxed paper plates.

Press down with a paper plate (which you can leave in there) to make more room and squeeze out some air.

When container is full, allow at least 2 weeks to ferment ("pickle") at room temperature.

If below room temperature, it will ferment, but more slowly. Prevent freezing or getting too hot (above 120°F, 49°C).

As long as container sits airtight, can leave it fermenting for many months until you are ready to use it.

The more vegetable scraps and especially fruit scraps mixed in, the better.

The microbes love the leftover sauces and salad dressings. Certain paper also helps.

Speed of Fermentation

- The ideal temperature for bokashi is between 80°F – 100°F (25°C – 40°C) — temperatures rounded for simplicity— fermentation can then take place within 7 to 10 days.
- At room temperature, between 60°F – 80°F (15°C – 25°C), fermentation can take place within 2 weeks.
- The longer the bokashi bucket is let sit (airtight) regardless of whether ideal temperature or room temperature, the more thorough the fermentation. Fermentation will continue until there's no more food for the microbes to digest. Since the bokashi fermentation is a lactic-yeast fermentation, similar to the "pickling" fermentation of pickles, sauerkraut, etc., the food waste is being naturally preserved.

- Harder materials, such as corn husks, bones, avocado pits, etc. may take longer to break down. While two weeks may be sufficient to get these materials exposed to the fermentation process, a longer fermentation process may shorten its break down period when placed in the soil.

Too Dry Bokashi Bucket

- There may not be any smell, or the smell is weak or mild indicating possible slow fermentation.
- May happen if too much dry materials, such as pasta, bread, baked goods, paper, etc.
- Need enough moisture for microbes to be active.
- Start adding liquids that would ordinarily be poured down the sink (cooking oils, spoiling milk, juices, soda, etc.)
- Generally, try to have a balance of wet (fruits, vegetables, sauces) and dry food waste mixed in.

Too Wet Bokashi Bucket

- May happen if too much food waste with lots of water content, such as eggplant, fruits (e.g., watermelon), or if you added too much liquids.
- The more watery and less oily, the more likely the liquid will oxidize (exposure to oxygen) and rot, especially if you can see the liquid pooling near the surface.
  - Oxidation happens on the surface area (both liquid and solid) where it is exposed to the air pocket when bucket lid is closed.
  - Therefore, sometimes when opening a bucket, the first smell may be somewhat foul, but after that initial smelly air clears, the bucket itself should smell fine (vinegary).
- Add dry materials to soak up the liquid, such as stale bread and paper (used paper napkin, paper plates, paper shopping bags, corrugated cardboard, etc.)—tear up the paper products; avoid waxy paper products.
- You can also add some oil (olive oil, cooking oil) which will float on the liquid and act as a buffer with the air preventing or delaying the oxidation and therefore smelly circumstance.
- Removing-the-liquid option, either by using a bucket with a spigot or with a cup or pouring it out.
  - The spigot option is recommended for those with experience and/or who wish to take advantage of the fermented food waste juice. The FFW juice can be used as a liquid fertilizer (1:5000 in water; 2–5 drops per quart of water) when watering plants,

or to pour down drains and toilets (microbes will clean the pipes). However, a bucket with a spigot also has a separator mesh towards the bottom to separate the liquid from the solid. This creates an air gap at the bottom of the bucket. If liquids aren't remove regularly (usually after the third day of starting the bucket), the air gap can oxidize the exposed liquid and cause a foul smell. The solid part is still good, but the smell may become inconvenient.

- A better option may be to pour or scoop out the fermented food waste juice. This way, you do not have to keep emptying the liquid (as in the spigot case).
- If you collect the juice in a bottle (where you can squeeze out the air), you may be able to keep it for several days. If the smell of the juice starts to go bad, use it right away (pour it down the drains and toilet, if you used what you could for your plants at 1:5000, 2–5 drops/quart, dilution rate in water).

Not Enough Food For The Microbes

- To help maintain a better smelling bokashi bucket, add all of your leftover/used salad dressing, oils, sauces, vinegar, gravy, etc. to the bokashi bucket (instead of rinsing them off in your sink). What also helps are leftover drinks (juices, wine, beer, soda, etc.)
  - These are rich in sugars/carbs, salts, minerals, etc. which the microbes love to eat.

Step 2. More Details Converting the Fermented Food Waste

Adding To Soil (Using fermented food waste as a soil amendment)

After 2 weeks (or longer), the fermented food waste (FFW), will still look like food waste.

It may be discolored and soft/mushy, but should smell fermented (vinegary, slight alcohol, etc.)

However, the fermentation process will have prepared the food waste for the next step: adding to soil.

Note. Any alcohol will likely be less than 1%, which evaporates quickly when taken out of the bokashi bucket. Any further production will very likely stop right away since conditions would been changed, especially when mixed in soil.

In the fermentation process, the microbes will release the nutrients from the food waste making them not only available, but also absorbable by the plants [bioavailability]. The microbe-rich bokashi bucket will also produce antioxidants and organic acids (helps preserve the food waste and deal with pathogens), as well as, produce a wide variety of enzymes to help break down the fibers, cellulose, lignin, chitin (what makes sea shells hard), etc.

How To Use The Fermented Food Waste (FFW)

You can use some of your FFW for your pots and planters at home (see below). Otherwise, you can bring your bokashi bucket to a compost site that will accept it.

The fermentation will have made the food waste soft making it easy to turn it into a paste by mashing it with a shovel or trowel (3-5 minutes of mashing is enough). This will help the FFW to break down faster (in 2-4 weeks) in the soil. It also helps to mix in soil, leaves, garden clippings, or wood chips/shavings.

The fermented food waste can be used in many different ways:

Buried in a pit or trench in yard, garden, etc.; at least 1 foot away from existing plants and 3 feet away from shrubs and trees (avoid close contact with roots); cover with 4–6 inches of soil; can bury deep and add more of your next batch of FFW on top of the previous batch—can do so almost immediately.

Sandwiched between soil in pots and planters (or mixed 1 part FFW, 2 parts soil/potting mix, and covered with a couple of inches of soil)

After burying or mixing in soil, allow 2 weeks before planting. Or allow at least 1 month before digging up to spread amended soil to other areas, for example, where plants already exists, or to nourish areas where burying/trenching is difficult.

Added to inside a worm bin (vermicompost). Mash into a paste before feeding earthworms.

Added to inside a compost pile (less turning, may help break down the compost pile quicker).

Mixed in to a closed vessel, such as an Urban Tumbler. (Will not need to be turned as much, and in cooler seasons, will become a worm composting vessel.)

If you cannot use your fermented food waste (some or all), then make sure that your local community garden or community compost site will accept it (there may be, or start a local 'home bokashi bucket program,' with a community garden).

Bokashi Uses And History

Bokashi is used as a fermentation starter or as a microbe and nutrient-rich carrier for various purposes, as well as, for providing organic content matter to the soil.

Uses of Bokashi

Technically, fermented food waste (FFW) can also be referred to as bokashi (fermented organic matter). However, to avoid confusion, distinctions are sometimes made: the bokashi that's used to ferment the food waste is referred to as the fermentation starter or the bokashi starter. It is also referred to as the sprinkle.

Below uses of bokashi are of the non-FFW type (the ways to use FFW is in step 2 above).

- Used to directly **enrich soils** (adding microbe-rich, nutrient-rich, organic content matter). Example ingredients of such direct-use bokashi includes combining rice bran, fish meal and oil cake.
- Added to **animal feed** (1% to 5% or more) as a probiotic supplement.
- Added to **cat litter** (1–2 cups of bokashi) to help reduce odors.
- Added to **bath water** (in a pouch with a ceramic or stone weight) to soften the water.
- Treating **dog waste** (similar to bokashi bucket, but adding about 1-to-1 bokashi to dog poop).
- Used in **humanure** (compost toilet, human waste) by adding bokashi instead of, or in addition to, sawdust or other fibrous organic material.

Bokashi and **FFW** Are **Not Fertilizers** By Definition

A fertilizer can be defined in various ways, but is usually defined by its NPK (Nitrogen, Phosphorous, Potassium) values.

While the FFW may sometimes contain more nutrients than compost, both **micronutrients** (essential nutrients necessary in trace amounts for normal/healthy growth, including Cl, Fe, B, Mn, Zn, Cu, Mo, Ni) and **macronutrients** (essential nutrients necessary in larger quantities, i.e., N, P, K, Ca, Mg, S), FFW is not technically a fertilizer because:

- Its NPK values are not evaluated and cannot be evaluated consistently.
- The NPK values are difficult to evaluate because the source, the food waste, that contributes to the FFW's nutrients, is always changing. The food waste may be comprised of either lots of different kinds of food waste, or only a small variety, and everywhere in between. Whether it be meats, vegetables, fruits, coffee ground, bread, rice, pasta, etc., from batch to batch, the quantity of each may be from zero to being most or all of it. Such fluctuations make it difficult to establish NPK values without having to separate the different types and recombining to get the desired nutrient (NPK) levels. Even so, there's no guarantee that the resulting NPK values will be within an acceptable error of margin.

FFW is therefore viewed instead as a **soil amendment**.

Soil Amendment (Soil Additive)

Amends the soil in various ways, including by one or more or combination of the following:

Soil structure—organic matter content, water retention, water porosity, level of compaction, erosion.

Nutrient levels—absorption, retention, supply, mobility.

Microbial life—factor in nutrient flow, bioavailability; microbial excretions bind soil particles; attract/feed other life that helps with soil health (earthworms, insects, etc.)

History of Bokashi

It is not clear when bokashi was first used by farmers. Some say bokashi has been used by farmers since the 1940's while others say that it may have been around since during the early Edo period (mid 1600's) in Japan. The practice of making and using some form of fermented organic matter may have also been used in other cultures throughout the world in ancient to recent past.

Bokashi was made by farmers by collecting several different kinds of organic matter (in which were the main source of the microbes), mainly mountain soil, or soil and moss from pristine valleys and forests or wooded areas, and some say by placing rice balls under a layer of leaves in the mountain.

The farmers would then mix the collected materials with their post-harvest residue and other plant waste materials (cut grass, weeds, and leaves), and keep them under a covering in order for the mix to ferment. From there, there may be various methods to manage the mix in terms of moisture and temperature. After the material has fermented, the farmers would then use it as a soil amendment to add nutrients and organic content matter to their farm. What they may not have known was that it also added beneficial microorganisms to their farm soil.

With the discovery of EM (Effective Microorganisms), it became easier to make bokashi and make it consistently (no question on whether the collected material together comprised enough of a microbial source and diversity for proper fermentation). So the term "EM Bokashi" is also used and would mean bokashi fermented with EM.

EM, Effective Microorganisms, is a combination of naturally existing microbes, mainly lactic acid bacteria, yeast and phototrophic bacteria. The combination made it potent as a microbial inoculant for improving soil microbial health and as a fermentation starter. That combination was discovered by Teruo Higa, professor horticulture, now at Meio University.

How To Make Bokashi

Preparation

a. Water — 1 cup of water per pound of wheat bran.
Place water in a large enough bowl or bucket.
Examples for 10 lbs, 25 lbs and 50 lbs.
10 lbs - 10 cups of water (80 fl oz, or 2.5 quarts)
25 lbs - 25 cups (200 fl oz, or 6.25 qts, or 1 gal 2 qts 1 cup)
50 lbs - 50 cups (400 fl oz, or 12.5 qts, or 3 gal 2 cups)

b. Measuring cup(s) or measuring spoon(s).
Have ready the right size measuring cup or spoon for the molasses and EM-1.
Examples
10 cups of water – 80 fl oz ÷ 100 = **0.8 fl oz** (1.6 tablespoon, or 24 mL)
25 cups of water – 200 fl oz ÷ 100 = **2 fl oz** (4 tablespoon, or 60 mL)
50 cups of water – 400 fl oz ÷ 100 = **4 fl oz** (8 tablespoon, or 118.3 mL)

Mixing

1. Fill mixing tub to about 3/4 full with wheat bran.
2. Mix the liquid ingredients (water, molasses, EM-1):
   a. Add the molasses first. Fully dissolve the molasses in the water. Use a clean hand or hot water to help dissolve the molasses quickly.
   b. Add the EM-1.
3. Slowly add the liquid mix to the wheat bran (do not add all of the liquid at once — it may be too much depending on pre-moisture content of the wheat bran).
   a. Thoroughly mix the liquid and wheat bran (with clean hands).
   b. Keep adding the liquid while mixing.
   Avoid clumping. Look for too dry spots and too wet spots (liquid may go straight to the bottom).
   Suggest using a circular pressing motion, as if wiping.
   c. Moisture target of about 30%. Test by squeezing a hand full where it should easily stick into a ball, but easily fall apart when touched. If it drips when squeezed, it is too wet—add more dry wheat bran in this case.
4. Put the mixed wheat bran into an airtight bucket or double-bag in trash bags.
   Press down and squeeze out the air as much as possible.
   For better anaerobic (less air exposure) conditions, place a plastic sheet or plastic bag over the wheat bran before closing the bucket (not necessary if double-bagging in trash bags).
5. Label the bucket(s) or trash bags as follows: ➜
6. Keep the fermenting wheat bran (bokashi) at room temperature, airtight. Keep away from direct sun light.
7. After two weeks, the bokashi is ready to use. The bokashi could be let to continue to ferment for up

Fermenting
bokashi
9/7/15
Ready: 9/21/15

Example label for bucket of fermenting bokashi to about a month before it can go bad. Under perfectly airtight conditions, the bokashi can be let as is, without opening, for over a year, depending on various factors (quality of the ingredients, especially the organic matter).

So, between two to four weeks of fermenting the bran, you can start using it, as is. It will be damp and as long as you store it airtight, the undried fermented bran (the bokashi), should be good for up to a month or so.

a. Air dry the bokashi if not using all of the bokashi within 2-4 weeks. Can use the bokashi as you dry it.

Drying Your Fermented Bran (the bokashi) after 2 weeks

To prevent mold (green or black mold) from forming on the damp bokashi, and especially if it will not be all used within a month, then it should be dried.

How To Dry The Bokashi

Spread it out thinly over a flat surface (over a tarp or newspaper or cloth or shallow bins or trays).

- If drying indoors, it can take 2 - 3 days to dry completely (crunchy dry feel). If in close quarters, the smell may be strong for some people. Air flow would be good.
- If drying outdoors, in direct sunlight, dries in less than 3 hours. Otherwise, it will depend on humidity, wind flow and temperature. So, during cooler seasons when not enough sunlight, not too dry air, then it may take more than a day (in which case, make sure to put the not-yet-completely-dry bokashi in a bag or container overnight to prevent any moisture, such as the morning dew, from making it wet again.

Use trays if possible. Even if you spread it out thinly, it will go faster if every now and then you use your fingers to stir it to let it air out and dry faster.

After drying, keep in a bag or container to keep out moisture.

A very well dried bokashi can have a long shelf-life (over a year, and as long as 3 years or longer).

Keep the bokashi dry and away from moisture.

When added to food waste, the moisture in the food waste will help to activate the microbes.

You can use the bokashi as it is drying.

The microbes in EM•1

EM•1 ingredients (U.S. version as of May 2010).
EM•1 Microbial Inoculant (full name), is OMRI Listed (Organic Materials Review Institute), omri.org, and can be used by certified organic operations.

ACTIVE INGREDIENTS:
Microorganisms: 1 million colony forming units/cc (units/ml), 1%: *Lactobacillus plantarum*, *Lactobacillus casei*, *Lactobacillus fermentum*, *Lactobacillus delbrueckii*, *Bacillus subtilis*, *Saccharomyces cerevisiae*, *Rhodopseudomonas palustris*
INACTIVE INGREDIENTS:
96% Water and 3% Molasses

Lactic Acid Bacteria
L. plantarum - in saliva (first isolated); liquefies gelatin
[foods found in: sauerkraut, pickles, brined olives, kimchi, Nigerian ogi, sourdough, cheeses, fermented sausages, stockfish]
L. casei - in human intestine and mouth; known to improve digestion and reduce lactose deficiency and constipation; complements growth of *L. acidophilus*
[foods found in: cheddar cheese, green olives]
L. fermentum
[foods found in: sourdough]
L. delbrueckii
[foods found in: yogurt, mozzarella cheese, pizza cheese, Hartkäse, Berg-Alpkäse, Bleu de Bresse, Bleu de Gex, Fourme d'Ambert]

Bacillus subtilis - commonly found in soil; can survive extreme heat; natural fungicidal activity; used in alternative medicine; can convert explosives into harmless compounds; used in safe radionuclide waste; produces amylase enzyme (present in saliva; breaks down starch into sugar)
[foods found in: Japanese natto (fermented soy beans), Korean cheonggukjang (fermented soybean paste)]

Yeast
Saccharomyces cerevisiae - brewing and baking, top-fermenting yeast (ale)
[foods found in: baked breads, coffeecakes, pastries, croissants] [beverages found in: beer, wine, mead, cider, vinegar]

Phototrophic Bacteria
Rhodopseudomonas palustris - naturally found in soil and water, a food source for small organisms (zooplanktons, small crustacea); a natural detoxifier; degrades odors in agricultural and industrial waste; stimulates growth of actinomycetes (white 'mold') which suppresses the growth of pathogenic fungi, improves soil structure, humus formation, helps soil retain water, and breaks down tough plant materials; benefits growth of certain crops and fruits; also found in earthworm droppings, swine waste lagoons, marine coastal sediments, pond water. [foods found in: Swiss cheese]