Chapter 1

Why Bokashi?

Bokashi composting at its simplest is using microorganisms to anaerobically ferment organic matter in an acidic environment so it can then be rapidly assimilated into the soil by the soil biota. Bokashi composting is really a fermentation process, not a composting process. By definition, composting is an aerobic process that requires oxygen to properly compost (break down) organic matter. In traditional composting, anaerobic composting is bad and results in unfavorable by-products. With bokashi you can ferment food waste anaerobically and avoid unfavorable by-products by using a specifically selected group of microorganisms that neutralize harmful bacteria and encourage the proliferation of beneficial bacteria. Because you are fermenting organic matter anaerobically in a closed system, not composting it in the traditional sense of the word, you have numerous benefits:

- You can compost *all* types of food waste, including meat, cheese, dairy, and bread.

- You don't have to worry about mixing greens and browns in a specific ratio.
- No insect or rodent issues.
- No putrid odors.
- Minimal greenhouse gasses are produced.
- No loss of nutrients to the ground or the atmosphere.
- The finished product is full of beneficial microorganisms.
- Bokashi composting can be used on any scale.
- The organic waste doesn't have to be turned on a regular basis.
- Bokashi composting is much faster than traditional composting.

When you compost using bokashi you need to introduce beneficial microorganisms to the food waste to start the fermentation process. This can be done using a dry carrier such as an inoculated carbon source (e.g., wheat bran) or a liquid form via a microbial spray (e.g., activated EM). These microorganisms then go to work consuming sugars from the organic waste and the fermentation process begins. After two weeks of anaerobic fermentation, the fermented organic waste can then be applied directly to your garden soil or mixed with soil to be used as a potting mix. The simplicity of the whole process makes recycling kitchen waste very easy, and is just one of the reasons you should add bokashi to your eco tool belt.

Meat and dairy are OK

If you were to start adding meat and dairy to a traditional compost pile, you would most likely attract flies, rodents, or both. This may or may not be an issue for you and your location, but for most people it is a big issue — big enough that it can lead to neighbor complaints, stop people from composting, or even discourage them from starting.

Can you successfully compost meat and dairy in a traditional compost pile without any problems? Yes, it is definitely possible

and can be done very efficiently, but it requires careful attention and a well-built pile that is actively managed. If air stops getting introduced to the pile you run the risk of the meat going anaerobic; it will smell very bad as it putrefies, releasing hydrogen sulfide and other sulfur-containing organic compounds. This is one of the reasons why even the United States Environmental Protection Agency (EPA) advises against backyard/onsite composting of these materials: "this method should not be used to compost animal products or large quantities of food scraps". [1] Having an aerobic compost pile requires a fair amount of work, dedication and knowledge. A lot of people succeed, but many come up short.

Greens and browns and the C:N ratio

Anyone who has read anything about the traditional composting process may only know one thing: you need the right mixture of browns and greens or it won't work right. This is where eyes start glazing over and the confusion begins. What is brown, what is green, how brown is something compared to something else? Potential composters start thinking and realize that they have a lot of green stuff, but where do they get all of this brown stuff? They might not have a lot of trees in their yard to supply dried leaves, and more and more people are averse to using cardboard and newspaper in their composting systems, so they are constantly in search of dried stuff to use as a carbon source. For an aerobic composting process to work optimally and quickly, you need to get the carbon-to-nitrogen ratio right, approximately 30:1. Most people don't get the ratio right, and that is why a lot of traditional compost piles fail. If you have too much brown, the pile won't heat up and fungal organisms will take over, so the pile is slow to decompose. If you have too much green, you run the risk of the pile going anaerobic and stinking (think pile full of fresh-cut grass sitting in the sun). The C:N ratio is drilled into people's heads over

and over again, but it causes problems. Most people understand the concept but have problems sourcing all the right components.

When you compost using bokashi, none of that matters, because you do not need to worry about the C:N ratio. You can compost whatever you have, and what most people have are a lot of food scraps. These are ideally suited to be composted using bokashi. They are usually sized down already, and most are easy to ferment in a bokashi system because they contain a lot of sugars. You just need to collect the food scraps, add them to the bucket, inoculate them with bokashi bran, and wait. Once the food scraps are introduced into a bokashi system, the microorganisms will start fermenting the scraps immediately, the pH will drop, and no putrid odors will be generated.

No pest problems or putrid odors

When you compost meat, dairy, or any other food scraps with bokashi, you don't have to worry about putrid odors or attracting pests. All bokashi systems ferment the food waste anaerobically in a sealed container. So no smells can emanate from the food waste to attract pests. Even if ever-curious flies, rodents, or pets are in the area, they can't get at the food waste because it is sealed inside the bucket and they are stuck outside.

The fermentation process itself should not produce any putrid odors, though it will create a smell that the bucket will keep contained. Even though the fermentation process suppresses putrefaction and the rancid odors that accompany it, the process does produce a typically vinegar, pickle smell that is closer to pleasant that putrid. But again, the container is sealed shut so you can ferment your food waste inside your home or apartment and even the most sensitive noses won't be able to detect an odor. This is a huge advantage of using a closed system — the contents stays sealed away inside of a container while the microorganisms ferment the waste.

In addition to not giving off offensive odors, the microbes within the bokashi bran suppress putrefaction, pathogenic and methane-producing microbes, dramatically reducing the greenhouse gasses that are produced.

Minimal (if any) greenhouse gasses are produced

One of the dirty little secrets in the composting world is that traditional composting methods inherently generate greenhouse gasses (GHG). This is never mentioned in traditional composting circles, but is actually a pretty big problem. Methane, carbon dioxide, and nitrous oxide are all by-products of the traditional composting process, and all three are greenhouse gasses.

> Aerated composting (AC), one of the most common routes for recycling organic carbon into soil, has undeniable economical and ecological advantages, but also has some notable shortcomings. Its carbon recycling potential is 50 percent or less, the entire process is long (≥6 months), and its GHG footprint is very large. The main gas produced during AC is CO_2, but CH_4 (~25 times more potent as a GHG than CO_2) is also a notable by-product. Along with C mineralization, N is also released, mostly as amines, heterocyclic compounds, ammonia, nitrite, and nitrate. Suboxic, acidic, and organic-rich conditions can lead to incomplete denitrification with the formation of N_2O as well. The amount of N_2O emitted is small relative to CO_2, yet N_2O is ~300 times more powerful as a GHG than CO_2. There is furthermore clear evidence that unchecked N_2O produced during the turnover of carbon residues amended in soil can contribute GHG equivalents to the atmosphere which more than offset carbon savings due to aerated composting.
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> — Green and Popa,
> "Turnover of Carbohydrate-Rich Vegetal Matter"

So traditional (aerated) composting isn't as much of a free lunch as some would have you believe. When you compost organic matter aerobically using traditional methods, you will generate a high level of greenhouses gasses like methane and nitrous oxide, in addition to a lot of CO_2. That is why the compost pile gets measurably smaller — a lot of the carbon is volatized off into the atmosphere as the organic matter breaks down. For an eco-conscious person, that isn't good. It is MUCH better to have that carbon tied up in the soil matrix than it is to have it in the atmosphere.

Even under the best aerobic composting conditions, greenhouse gasses are emitted. But in reality most people don't maintain perfect aerobic compost piles; they let them go anaerobic, and that is a cause for concern. How many people start actively aerating a compost pile but then give up over time, leaving it untouched and anaerobic? A lot. When organic material composts anaerobically, nitrous oxide, ammonia, and hydrogen sulfide are produced. That is why anaerobic compost piles stink; the smell is a combination of these gasses. The ammonia not only smells but also leaches out of the pile into the ground, where it can potentially contaminate ground water. This also takes the nitrogen out of the compost, which is not what you want — you want nitrogen in your compost, where it will ultimately feed your plants. Methane is also produced in the pile when methane-producing microbes take over. These microbes prefer anaerobic conditions at a neutral pH; under those conditions, they can dominate the pile and multiply rapidly, producing a lot of methane. This is how they produce methane in bio-digesters, where it is harvested and used for fuel in industrial situations. The average home composter isn't harvesting the methane so the gas goes into the atmosphere. All of this GHG production can be avoided by fermenting food waste using bokashi instead of breaking it down in an oxidative process.

When you compost with bokashi, you are fermenting organic waste anaerobically at a low pH so greenhouse gas production is drastically reduced. Methane-producing microbes can't survive at a low pH, so very little methane gas is produced. But what about the other microbes involved — don't they generate gasses? Lactic acid bacteria are one of the primary constituents of the group of microorganisms used in bokashi bran to ferment food waste, and lactic acid fermentation is a process that does not generate any gasses. In a study, Dr. Lawrence Green found that:

> Organic waste processed by bokashi fermentation produces no measurable gas during the 7-day fermentation process and when then mixed with soil it is further degraded without evidence of any gasses being liberated. Based on these findings it appears that bokashi fermentation does not produce measurable gas emissions in its conversion of organic waste into a nutrient-rich end product that can be used to support plants and crops.
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> — Green, "A Pilot Study Comparing Gaseous Emissions"

Unscientific visual observation shows that no excess gas is produced when you compost using bokashi in an anaerobic container; the container doesn't swell, and there is no audible *poof* when it is opened after a two-week fermentation. This is clearly an area where more research is needed, but based on the science of the processes involved and the information available today, it seems that few if any greenhouse gasses are produced during the bokashi fermentation process.

No loss of nutrients — everything ends up where you want it, in the soil

Another benefit of fermenting organic matter inside a closed container is that all of the nutrients are retained in the process.

Nothing is lost through runoff or ground penetration. None of the nitrogen is lost to ammonia, and none of the carbon is oxidized off into the atmosphere. All of the amino acids, vitamins, enzymes, and nutrients generated or liberated from the organic wastes in the fermentation process stay contained within the bokashi bucket and ultimately end up exactly where you want them, in the soil.

A lot of carbon is lost in the traditional composting process when it is volatized off as carbon dioxide. In addition to being a greenhouse gas, it has been argued that this carbon is needed when the organic matter is added to the soil in order to ultimately produce polysaccharides, which help improve the soil structure. By fermenting waste in a closed container without producing CO_2, you are putting the carbon and other organic materials directly into the soil when you use the bokashi pre-compost. This may arguably benefit the soil structure more than the traditional method of applying already composted organic material, which is devoid of a lot of the original carbon.

The closed container also eliminates any evaporation, and thus the need to add additional water to the system. With water scarcity becoming more and more of an issue worldwide, this is a big advantage. The fermenting contents stay moist throughout the process, and the finished product is still wet when it is applied to the soil. This initially adds moisture to the soil where the bokashi pre-compost is applied while increasing the long-term water-holding capacity of the soil by supply organic matter that can be converted into humus by the soil biota. A lot of other soil amendments and composts are applied to the soil either dry or on the drier side, so they can act as a wick and draw moisture out of the surrounding soil during their initial application.

The final product is full of beneficial microbes

The microbes inoculated on the bokashi bran and used in the fermentation process aren't just valuable for fermenting food waste;

they are also valuable when they are introduced to the soil. The main microbes within the bokashi bran include lactic acid bacteria (LAB), yeast, and purple non-sulfur bacteria (PNSB). This group of microbes has the ability to perform a variety of beneficial functions including the breaking down of harmful chemicals and wastes and the ability to create bioactive substance and beneficial enzymes. All of the microbes in EM·1™ (the most common inoculant for bokashi bran) are derived from nature and occur naturally in soils and waterways around the world. These microbes were specifically selected by Dr. Teruo Higa for their ability to perform their own unique individual functions and function cooperatively in a consortium of beneficial microbes. The consortium of microorganisms have a lot of uses and real-world applications: they are used in sewage treatment plants because they have the ability to break down wastes and pollutants; on farms to help control manure odors; and to process food waste, which they are able to ferment, thereby speeding up its breakdown.

When you inoculate kitchen waste with bokashi bran, you are introducing these essential microorganisms to a food source. The microbes then start eating the sugars in the waste and begin to multiply and ferment the food waste. Some organisms also begin to feed on the waste of other organisms in the system. For example, the PNSB will feed on dead yeast and LAB bodies, and the LAB will consume some of the waste products of the PNSB.

Fermentation greatly increases the populations of these microbes. After two weeks of anaerobic fermentation, the process just doesn't suddenly stop because we said the time is up; the microbes continue to act on food waste. When you then combine this fermented food waste with soil, you introduce the microbes into the soil. Some of these microbes ultimately survive and multiply in the soil, where they have a beneficial influence, mainly through their ability to break down wastes and suppress pathogens, thereby improving soil quality. Introducing uninoculated

food waste to the soil won't have this same effect. In addition, raw food waste will release greenhouse gasses when it starts breaking down in the soil. Dr. Teruo Higa, the creator of EM, has stated that "kitchen refuse decomposes if simply buried in the soil, giving off offensive odors, evidence that degenerative microorganisms are at work. EM added to matter in this condition brings about a change in the microbiological equilibrium, causing dominance to shift away from degenerative to regenerative strains of microorganism. Under these conditions, organic matter no longer gives off offensive odors."[2]

Full scaleability: you can ferment a little or a lot

Bokashi composting can be scaled up or down in size depending on the needs of the end user without requiring any extra work or processing. In contrast, the effectiveness and work required for a traditional aerobic compost pile will vary with size.

A traditional compost pile needs to be about one cubic meter in size to work effectively. If it is any smaller than that, the pile won't build up enough heat to break down properly, and anything larger than one cubic meter will generate a lot of heat, requiring different, more energy-intensive management strategies. So traditional compost piles can be scaled up in size, but the tradeoff is more labor and/or more time required to get to a finished product. And they can't really be scaled down much smaller than a cubic meter without requiring more monitoring and time.

With bokashi composting, size is not an issue. The amount of mass being fermented has no effect on the final product; large amounts will ferment the same as small amounts. All bokashi systems need to be able to do two principal things, regardless of size: drain excess fluids from the system and maintain anaerobic conditions within the system. If both those conditions are met, it is possible to ferment one pound or ten thousand pounds of waste using the same process. As long as the environment is

maintained, then the steps are the exact same, regardless of size. No extra energy, equipment, or water is required to compensate for increased size.

No turning required and no extra water needed

In traditional composting, organic matter is broken down in an oxidation process, so you periodically have to turn the pile to introduce oxygen to other parts. Turning also moves the contents on the outside of the pile to the inside, where they can heat up and break down. Now, could you manage that same pile without turning it? Sure — but not without increasing the amount of time it will take to obtain finished product. A static, semi-aerobic compost pile may take up to a year to fully break down into finished compost. It also runs the risk of going to the bad side of anaerobic, because air isn't being constantly introduced to the center of the pile, and this could ultimately create odors.

Since traditional compost piles are usually exposed to the open air, you may have to add extra water to them throughout the process to maintain the proper moisture level, so they heat up and the contents are broken down properly. Some of that water will drain right through the pile into the ground, some will evaporate, and some more will be absorbed by the pile and used by the microorganisms that break down the organic waste. Regardless, additional water is required, some of which will leave the system in one form or another, so it has to be replaced somehow.

With bokashi, the system is closed, and the organic matter you add is generally at least 30 percent moisture, so you don't need to add any extra water regardless of your system's size. Some water will be removed when the bokashi leachate is drained from the vessel, but not enough to require the addition of any extra water.

Since the fermentation needs to take place anaerobically you do not want to add extra oxygen into the system by opening the vessel and turning the contents. This saves you a lot of work

compared to traditional composting. Once you have completely filled the system, all you have to do is drain off the leachate and wait for the fermentation process to run its course. And since the process is standardized regardless of size, you can ferment your food waste in any size vessel. This is a big advantage for people with limited space. People with small apartments, offices, or yards can compost their food waste in a corner of their garage, closet, or anyplace else, in spaces where they couldn't fit a traditional compost pile.

Bokashi composting is fast

Bokashi composting is much faster than traditional composting. With bokashi you can turn raw kitchen scraps into something you can plant into in 30 days. During those 30 days, you are just waiting most of the time, as the process requires little work.

In contrast, a well-built traditional compost pile can only turn organic matter into humus in about 30 days if it is extremely well made and actively managed. The average person won't be able to accomplish this for a number of reasons, the main ones being that you really have to know what you are doing and be willing to put a lot of work into the pile. I know from personal experience that most people don't want to go out and turn a compost pile every other day just to maximize efficiency. They just won't do it, it is too much work. So from a work requirement standpoint the 30-day goal of traditional aerobic composting makes it a bit of a long shot. Another key requirement to get good-quality compost in 30 days from a traditional pile is quantity and quality of ingredients. You need to have a cubic meter worth of compostables, and they need to be in the ideal 30:1 ratio of browns to greens; again, it is a difficult task for most people to achieve this on a consistent basis. Most people generate the bulk of their waste organic matter in the kitchen, and you can't just pile up kitchen waste and compost it without running into the problems discussed earlier.

Bokashi is a logical fit for this niche. You can add straight kitchen waste to the fermentation vessel as it is generated, apply some bokashi bran, walk away, and in 15–30 days you will have a finished product that you can put straight into the ground. Two weeks after that and you can plant directly into the finished bokashi compost. That is fast in compost timeline terms, especially considering there is little work and no mixing of ingredients required.

Bokashi gives you finished compost in 30–45 days all in, maybe even faster with some extra effort. The speed of the fermentation process is a big advantage. It also allows you to cycle organic waste faster by going straight from kitchen to fermentation to soil over and over again in small batches. You don't need to collect a critical mass of scraps to start with, so the fermentation process can start right away. You can also scale the fermentation vessel to the amount of scraps you are generating, so they go straight into the bokashi bucket as soon as you produce them.

Compared to traditional composting, this is a big advantage. You don't have to worry about what to do with kitchen scraps while you collect all of your other materials and amass enough volume to get started with your one-meter pile. I have heard of people freezing kitchen scraps until they have enough materials to assemble a full-size compost pile. That is a lot of extra work and room taken up in your freezer, and if you step back and think about it, it is kind of ridiculous. Feed the scraps to chickens or worms or compost them some other way like bokashi, but don't freeze them. Why go through all that trouble? It just isn't practical for everyone.

So now you have to add material collection time to the 30 days it takes to compost in the traditional method (at its fastest). Depending on the situation, that could be days or even weeks, so the 30-day time frame is out the window given that most people won't just have all of their scraps given to them on Day

One. And a lot of people will never generate enough scraps in a timely manner to build a one-cubic-meter compost pile, so they need a system that can break down food waste as it is generated, like bokashi. When you start comparing timelines, the amount of available organic waste, and the amount of work required, you can start to see that bokashi is more practical than traditional composting for homeowners who only deal with kitchen waste on a regular basis.

Conclusion

All in, bokashi composting requires less work than traditional aerobic composting, is easier, and may be more practical for some people looking to recycle their kitchen waste. Bokashi composting fills a niche. It takes away a lot of the reasons why the average person won't, or doesn't, compost their kitchen waste. You don't have to worry about moisture content, you don't have to worry about the C:N ratio, you don't have to spend time aerating the pile, and you can compost small (and large) volumes of food waste in a small space like an apartment. All of these factors can be difficult to manage and require a considerable amount of time and energy, sometimes more than the average person wants to spend. Even if you do all of these things you might end up waiting a month or more only to discover that you really don't have that great of a finished product anyway. Then most people give up and move on, saying, "Composting doesn't work for me."

Bokashi fills that niche and makes things easier and more predictable. Fermenting food waste with bokashi is faster, so you can cycle nutrients through the system more rapidly with more consistent results. Sure, you have to buy the inoculant or make it yourself, but it is relatively cheap and easy when you factor in the benefits. And the inoculant (and microbes) ultimately end up in the soil because everything is fermented in a closed system with no losses. The process yields a nutrient-dense, microbe-rich

finished product that is easily broken down by the soil biota. This finished product, called bokashi pre-compost, contains microorganisms that have the ability to suppress and outcompete pathogens and disease organisms in the soil. It also builds soil tilth and increases water-holding capacity by adding organic matter to the soil. And most importantly, it gives an eco-conscious person another tool for recycling their waste into an Earth-friendly finished product.