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"What Do You Need To Know To Get Started With Wood and Fish Waste Composting?"

A project leader for the Center for Forest Mycology Research, Dr. Micales has spent 15 years doing research into the fungal degradation of wood. Her current research includes using fungi to accelerate the decay of slash and woody debris in many of the Western States to reduce the fire hazard.

What are we going to do with all that wood waste?

Mountains and mountains of sawdust, hog fuel and wood chips have been generated by wood-processing mills and accumulated in large mountains in the past. But because of today's environmental constraints, simply accumulating waste in piles is no longer acceptable.

Landfilling may not be an option because of high tipping fees and the high costs of transportation to the landfill.

Wood waste can be used as a biomass fuel to generate energy and produce alcohol as a by-product. For simple incineration, new technology smokeless burners can operate with very little amounts of smoke. The heat can be used for mill tasks such as drying lumber or to generate electricity.

But you can also turn the wood waste into value-added products:

- Animal beds: usually the material has to be kept dry and in clean condition.
- Commercial mushroom-substrate: Especially for hard-wood wood waste. Most mushrooms dealt with in commercial production will not grow on coniferwaste.
- Mulch: Unprocessed wood chips, marketed in different sizes from discrete pieces of bark to near sawdust. Usually, mulch particles are of a generally uniform size. May be clean or aged. Aging gives a uniform grey look to the product. Several companies have been experimenting with dyed mulches to match the color of suburban houses, garages or driveways, but there have been reports of dye leaching out of the mulch and staining the driveway.

Mulch is a very high-value product.

To successfully market mulch, you must find your market. And costs, such as for bagging or for tramportation, must be factored in.

Now we get to compost

Unlike mulch, the wood waste in compost has actually been degraded by microorganisms into a humus-like structure.

Unlike mulch, where you can Pick out individual wood chips compost is more akin to what you might think of as organic soil.

But compost adds organic matter to the soil and this is very important for how the soil retains nutrients.

Using fish waste in conjunction with wood waste is an ancient technology. Native Americans used to plant fish with their corn seeds. The principles of using fish and wood waste together are well-understood and all that will be required is tinkering for the precise recipe for your particular ingredients.

Compost generation is really a microbial process – so all the efforts are trying to keep the microbes happy so that they will do their work

The production of compost reduces the volume of wood waste by 50 to 70 percent – so composting is valuable to save space, even if the compost is not used.

Why not use it? Compost makes a wonderful soil amendment, rich in nutrients. Be advised, though, that compost may not be as high in nutrients as commercial fertilizers.

Composting can be done for personal reasons, as a cottage industry or on a large industrial scale.

As with any large-scale operation, industrial composting would require investment in some expensive machinery. But a composting operation of an intermediate size could probably get by with not much more than a front-end loader.

Requirements for Compost

Compost requires a source of carbon and a source of nitrogen. The wood is the carbon and the fish is the nitrogen. Other nutrients are also required for living things to grow – phosphorus, calcium, magnesium.

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- Water – 60 percent water
- Oxygen is needed of at least 10 percent. As a note, the air is 20 percent oxygen.
- Temperature will self-generate in the pile.
- A pH of 6-8.5 is required. Not extremely acid or basic.
- Particle size of the stuff should be about 0.1 to 2.0 inches. Material that is larger than this will take a significant amount of time to break down. If the material is too fine, as in sawdust, the material will become compact, so there will not be enough air movement.
- Carbon and nitrogen – the basic building blocks of life – we are all made of carbon and nitrogen – as are all living creatures. Carbon provides energy and a source of structural material. Nitrogen is a major component of protein – both enzymatic and structural proteins, and also nucleic acids.
- The ideal ratio for composting – the ratio for bacteria to grow – is basically

25 to 35 parts carbon for every part of nitrogen. So we deal with carbon-nitrogen ratios of about 30 to 1.

Carbon-nitrogen ratios of components that go into compost mixtures

- Wood chips - 500-600:1, very low in nitrogen, which is characteristic of wood in general.
- Lumber mill residues - 200:1.
- Freshly-fallen leaves - 50: 1.
- Biosolids from sewage plant - 15:1.
- Fish waste - 4:1. It's still mostly carbon, but has a lot more nitrogen in relation to other materials.

So you want to mix a high source of carbon – wood waste – with a high source of nitrogen – fish waste. But you have to take into account the bioavailability of the carbon.

Carbon in wood occurs primarily in the form of cellulose, a polymer of simple sugar whose glucose units are linked together into long, thin threads. Cellulose is very digestible by microorganisms.

The problem is that the strands of cellulose in wood are imbedded in a matrix of lignin –which is a complex structure composed of rings of carbon molecules.

Lignin rings are of a non-repeating structure, which thwarts microorganisms' efforts to identify and digest the molecules. This limits the amount of carbon that is available. The amount of lignin affects the amount of carbon available. Lignin is not digested, but retains its structure into the finished compost.

Of all the microorganisms, the ones you most have to worry about keeping happy are the bacteria, since they do the bulk of the composting.

Another organism that eats fish and wood waste is earthworms, and so-called vermicomposting is a subscience of composting. Generally, earthworms are cultured in troughs. For vermiculture, temperatures must be maintained between 50 and 70 degrees F.

Vermiculture does not generate the high temperatures associated with regular composting.

Temperature is critical

Initially, when you mix compost it will be of ambient temperature and will stay that way for a few days. This is termed the "mesophi1ic" phase. But once decomposition begins, the temperature rises due to microbial growth. The compost will then attain a high temperature phase – 130-150 degree F. – termed the thermophilic phase. This phase may last for several weeks.

When the decomposition is completed, the compost cools and eventually returns to the ambient temperature.

One of the ways that you know compost is ready to use is that it has returned to the ambient temperature.

Decomposition of organic matter creates heat, and conversely, microbial growth generally occurs faster at higher temperatures.

As the compost pile heats up, it throws off moisture – and can lose up to 60 percent of its moisture volume that way.

It is vital to measure the moisture of the compost. Too wet a pile can retard microbial growth, resulting in lower temperatures.

Compost must be kept at 130 degree F. or higher for at

least three days to lull the pathogens and weed seeds in the compost pile. New research is showing that lower temperatures for a longer period of time also lull pathogens and seeds.

It is important to keep moisture and temperature levels consistent. Temperatures of 150-165 degrees F. will lull the microorganisms that do the composting.

Temperature is largely determined by the size and shape of the compost pile.

Too flat and wide a pile will result in temperatures too low for efficient decomposition. Too high and wide a pile can result in too hot a temperature, lulling microorganisms that do the composting. A critical mass of material is needed to self-sustain the composting process.

High temperature may also be related to the proportions used in the compost mixture – the addition of too much nitrogen may result in microbial growth erupting, causing temperatures to spike. Too little nitrogen may result in too little decomposition occurring, causing temperatures to remain too low to lull pathogens and weed seeds.

Moisture is another critical factor

The optimal level of hydration of a compost pile is 60 percent, which can be measured with a hydrometer. You can also check the compost manually – it should feel moist, but water should not drip out of your hand if you squeeze the material. Too much runoff can also mean leachate problems.

A compost pile that is too wet can become anaerobic, causing the growth of anaerobic organisms which cause extremely bad odors.

The oxygen level of the compost pile is also dependent on moisture, as well as the size of the particles being decomposed. Bacteria live in a thin film of water that surrounds compost particles. Too much water in the compost keeps the bacteria from diffusing oxygen through the thicker layer and results in the generation of bad odors from the anaerobic organisms.

It is important to keep the pile oxygenated. Start with a proper particle size, 0.1 to 2.0 inches. Too big a particle and decomposition takes too long. Too small a particle does not allow oxygenation.

Ammonia smell may be present under both aerobic and anaerobic conditions. The smell is caused by an excess of nitrogen. Fortunately, the ammonia smell is easily dispersed through the top of the pile. Many noxious odors are heavier than air and will linger at the bottom of the pile — where people's noses are.

The best odor control is to maintain the proper ratios of carbon and nitrogen, oxygen and water.

To remediate odors, there are commercial additives available. But a better method is the use of a biofilter. One way to form a simple biofilter is to place a layer of organic material on top of the pile. Other finished compost, peat moss, chips, brush, bark and also inert material can be used as a biofilter.

Leachate Issues

Control problems with leachate by keeping the proper amount of nitrogen in the mix, and protecting the pile from excess amounts of rainwater. Some operations use sawdust to blot up excess water and then

add the sawdust back into the composting pile. Others use catch basins, then re-use the water.

Compost pile leachate has a high organic content, so you would not want to flush it into a river or down a storm drain. If you have a very wet nitrogen source (fish) you may want to use a drier carbon source – (drier wood waste.)

Getting the Right Mix

The basic mixture is 3 parts carbon to 1 part nitrogen – assuming a proper moisture content. Three or four parts wood waste to one part fish waste by volume is a good start.

Excellent spreadsheets are available at *httn://www.cfe.cornell.edu/compost/download.html* *and* *httn://www.cfe.cornell.edu/compost/calc/1a.html.*

Unusual materials, such as crab legs or sea urchins may need a slightly different mixture.

Mixing the Compost

How much material do you have? Gardensized amounts or massive amounts? How are you going to aerate?

In static piles, air just approaches from the sides and then is diffused through the pile. Another passive method is to insert drainage perforated pipes into the pile. For a more active method, air can be blown through the pipes. The airflow can be maintained with exhaust fans for negative pressure, as well as blowing air in for positive pressure.

The shape of your compost pile is vital to success.

Windrows is the term used for long, tall piles of compost – one of the most common methods.

Fully containerized systems are available, but are capital intensive. Container systems may be fully automated, through – with raw material coming in one end and processed, finished compost emerging from the other. This processed compost generally still requires an extensive curing period.

Start your compost pile with a somewhat fluffy base layer, that should be about 1 foot deep. This will help the pile drain, provide aeration and intercept leachate. Could be peat moss or bark.

Then comes the compost layers. Some people also add finished compost to the active layers. One recipe is 3 parts wood waste, 1 part fish and then a layer of finished compost.

Large-scale mixing is often done on a concrete pad, using a front-end loader. They will then add the cover layer, composed of 6 to 12 inches of wood chips, recycled compost, peat, etc. to act as a biofilter. This will intercept odors and act as a barrier against flies and vermin.

While dimensions of the compost pile are variable, about 10 cubic feet (3 feet x 3 feet x 3 feet) is considered the absolutely minimum critical mass need for successful decomposition.

The base of windrows are often about 8 feet across. Height is often about nine to 10 feet, although some operations will go up as high as 14 feet. A lot depends on the kind of machinery you have.

After the first period of decomposition, piles may be turned to aerate and bring fresh nitrogenous material against fresh nitrogenous carbon material. The amount you need to turn depends on the shape and size of your pile and the amount of moisture. There are several types of commercial turners. There are expensive self-contained units or ones that attach to an external power head.

Another composting strategy for aeration is passive – taking PVC pipe and putting holes in it and placing it in the base. This can be done length or width depending on the size and shape of the pile. As heat is emitted from the top of the pile, new air is pulled in on the sides and bottom.

An active system can be rigged with sensors, so if the pile gets too hot, it can be cooled down by fans throwing air through the pile. An active system using negative pressure is often coupled with a biofilter.

Fish waste will decompose in two weeks under proper conditions. All that will be left are the gill plates. A 36 lb salmon would decompose to nothing but gill plates in two weeks.

Carbon sources are much slower to decompose, and can take one to two years, so particle size is important.

Curing

Just because compost has dropped in temperature doesn't mean you are ready to put it on plants. It must first be cured, which results in certain organic acids and other chemicals breaking down. If the compost is used too early, these chemicals can be harmful to plants.

Compost maturity can be judged by its return to ambient temperature.

The carbon to nitrogen ratio in finished compost would be about 15:1, and it would contain no pathogens, and no toxic chemicals

To determine if the compost is ready, look at it. Do you notice odors or not? Does the compost still have a sulfury or ammonia smell? You can also order or perform a chemical analysis.

A good check is to throw a handful or radish or cabbage seeds onto a small pile of compost and see if they grow and if they appear healthy.

Financial Considerations

Is composting going to pay? Profitability depends on your strategy in producing compost. Are you just using compost for waste reduction or disposal? To take care of your wood waste or fish waste? Are you trying to make a profit from composting?

To make money, there is a whole range of considerations.

Do you want to do it on a large scale or a small scale?

Do you want to become a central place where people bring you their waste and you charge them to take it?

A market analysis is a great idea before beginning a commercial composting enterprise. Different markets may require modifications in the product – uniformity of particle size, for instance, or the size of the bag.

Transportation will be the major expense.

Wood 'N Fish Composting:

Small Industry Waste Management in Alaska

A Workshop on Utilization Opportunities for Fish and Wood Waste
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