Aerated Compost Tea Guide

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I've written this guide to help give an overview on how to make aerated compost teas properly using information that has been researched and microscope-tested, and based on my 10 years of knowledge in this industry.

Note: I will be updating this periodically in response to questions and new research.

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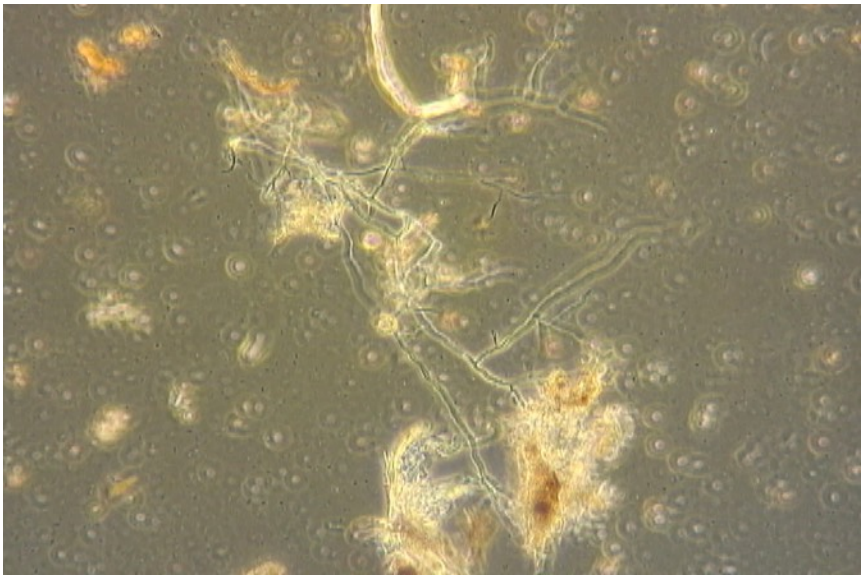
What Is Aerated Compost Tea?

AACT or ACT is a process which involves taking water, compost, and a food source in a container and adding oxygen via an air pump. The reason we make ACT is to increase the diversity and biomass of beneficial aerobic microorganisms in the soil and on the leaf surface of the plant.

All these components play key roles in creating optimal conditions for aerobic microorganisms.

I'll break down the necessary ingredients and explain the importance of each component in later sections.



Fungal hyphae under phase contrast microscope

Since the main benefit of ACT is to increase microbial life in your soils and on the leaf surface of your plants, it's a good idea to know a bit about the main players. Rather than to get into too much detail here, I will just state that what we want in ACT is good diversity and biomass across all sets of major organisms (bacteria/archaea, fungal hyphae, flagellates, with some ciliates and nematodes potentially), If you want to dive into learning more about these microorganisms, I highly recommend Jeff Lowenfels' book "Teaming with Microbes." If you are interested in microscopy, then I suggest starting here:
http://www.gardeningwithmicrobes.com/microscope.shtml
and
http://microbeorganics.com/

Benefits of Aerated Compost Tea

1. **Increases Nutrient Cycling** - This is the most important benefit of making ACT. Nutrient cycling is what helps make the nutrients and minerals in the soil into a form that is available for plants to uptake. When you apply organic fertilizer, you're not directly feeding the plant but rather the microorganisms in the soil that will then work to convert the nutrients into a plant-available (ionic) form.

2. **Creates Soil Structure** - Fungal hyphae helps in creating soil aggregates, and bacteria and archaea assist in breaking down organic matter and aerating the soil. Increasing biomass in your soil will also help with water holding capacity.

3. **Plant Protection from Pathogens** - While not a silver bullet in preventing all pests and diseases, by having more beneficial microorganisms on the leaf surface and around the roots, the goal is the beneficial microbes in ACT outcompete pathogens for that space on the plant so they can't get a foothold. This point is a bit controversial within the academic world so I don't typically stress it when talking about the benefits of ACT. I have had many anecdotal reports of disease suppression using ACT but it's not something I would rely on as a 100% solution.

4. **Beneficial Microorganisms** - In an ACT, you'll typically get good populations of nitrogen-fixing bacteria, nitrogen and phosphorus-solubilizing bacteria, and whole collection of other beneficial microorganisms, many of which have yet to be identified and fully understood in their role in soil health.

5. **You can use less compost**. If you have a large area to cover or a limited amount of good compost, this allows you to cover a larger surface area in less time and with less labor.

6. **It's portable.** Applying ACT is much easier than applying compost and will give you higher levels of active microorganisms than you would see in compost alone. It can be applied through the use of a sprayer.

Other Types of Teas

Different types of teas have been around since humans first began cultivating the earth. I think it's important to start with some basic definitions so you have a good foundation for what the key differences are.

Plant teas - This is where plants are soaked directly in water for an extended period of time. Compost is not involved, and any bacteria or fungi on the surface of the plant will be extracted. May contain some soluble nutrients. You can make your own “comfrey” tea or “nettle” tea by soaking the plant material in water and then applying the liquid to your soil.

Equisetum or “horsetail” is high in silica, an important plant element.

Non aerated compost teas - This is where compost is put into a container with water and foods are added for the microbes. The tea is then stirred occasionally or left to sit for a period of time. These teas may or may not produce beneficial results and could potentially harm your plants depending on the anaerobic organisms in your starting compost.

Commercially made microbial teas - These teas are typically advertised as "instant" compost teas. Specific organisms are cultured or extracted from compost and then put into a dormant state. Even with hundreds of different species, it won't contain even 1% of the diversity or quantities you would find in properly made aerated compost tea. These teas may be helpful in certain instances when you wish to combat certain diseases and know the proper microbe that has been documented to prevent or suppress it (eg. trichoderma).

Manure Tea - Typically manure is placed in a permeable bag (burlap) into a bucket or barrel and left to soak for an (# of days) extended period of time. Compost is not involved, and will be dominated by anaerobic organisms (bacteria and ciliates). Pathogens will be present in most instances, and excess nitrogen may burn the leaf surfaces of plants. These teas will contain some soluble nutrients, but may also contain antibiotics and growth hormones such as tetracycline, that are not broken down during the composting process. Oh, and it’s going to be super stinky!
Compost Extract - Compost extract is where the microorganisms are stripped from the soil aggregates

using water and extracted into a liquid form. This process will contain good biology for soil drenches, and can be made very quickly, as it does not require a brewing process. It does however require a large amount of compost relative to the final liquid product, and is primarily used in large commercial productions.

Compost Leachate - These teas is sometimes referred as "worm tea" as it is the liquid that leaches out of the base of worm bins or compost piles during the composting process. Leachates will consist primarily of soluble nutrients, but will contain some small amount of biology. This can serve as a good food substrate for the biology in your soil.

Nutrient teas - Nutrient teas are where a variety of different ingredients can be mixed together as a way of feeding the plant and microorganisms in the soil. Examples would be bat or seabird guanos, humic acids, seaweed extract powder, fish hydrolysate, molasses, etc…

5 gallon Nutrient Tea Brew

2 T. bat guano
1/2 tsp. SP-85 Humic Acid
3 tsp. Seaweed Extract Powder
2 T. Unsulfured Blackstrap Molasses
2 oz. Fish Hydrolysate

5 gallon ACT Tea Brew

1.25 cups of earthworm castings
1/2 cup of KIS Microbe Catalyst
1 T. organic alfalfa meal

The example on the left would be a Nutrient Tea as there is no compost (biology) in the brew. It can be mixed and applied without a brew cycle. The example on the right is an Aerated Compost Tea and should be brewed for 24-36 hours for optimal results. The example on the left would help feed the biology in the soil, while the example on the right would add more biology to the soil or leaf surface.

Brewing Equipment

There are 3 main components to successfully brewing aerated compost tea. I will discuss them all separately.

Compost Tea Brewer

The brewer is an important consideration when making ACT. After all, you could use the best microbial compost and food sources available, but if your brewer doesn't maintain adequate dissolved oxygen levels or thoroughly mix the liquid, then the quality of your tea will suffer.

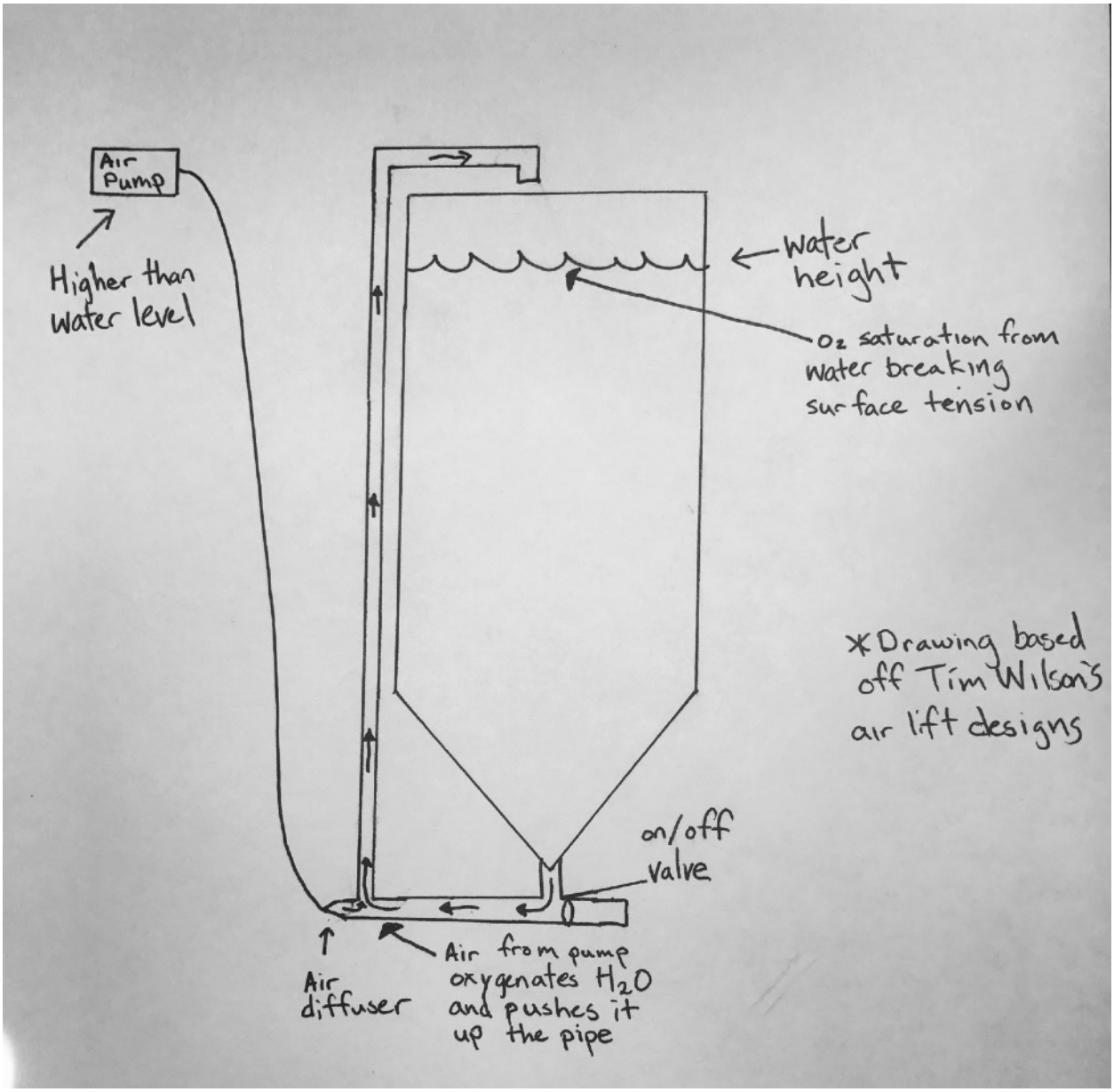
Brewer Design

There are many different designs on the market for both DIY and commercial models. Some are much better than others. Some of the original designs we saw actually incorporated motors than blended up the fungal hyphae or didn't maintain adequate dissolved oxygen levels. We carry two of the most common designs on the market, an air coil diffuser attached to an air pump, and an air lift brewer.

The air coil diffuser works well because it allows for even distribution of air bubbles throughout the entire brewer, which keeps material from settling in "dead zones," which can create anaerobic pockets or not allow for full extraction of the microbes from the compost particulate.

Here's a link to our KIS 5 gallon Compost Tea Brewing System. It was one of the original systems in the United States and was featured in "Teaming with Microbes" by Jeff Lowenfels and Dr. Ingham's "Compost Tea Brewing Manual."

Another popular design is the air lift, which infuses oxygen into the tea as it is pushed up a water column (pipe) to the top of the brewer and then splashed back down on to the surface of the water. This allows for optimal gas exchange, raising dissolved oxygen levels much higher while using a smaller air pump.



Here's links to our 5 gallon Mini-Microbulator and 50 gallon Microbulator air lift brewers.These are the most affordable, microscope-tested brewers on the market.

As a general rule, you want .05-.08 cfm per gallon of water when selecting an air pump*. Our 5 gallon system well exceeds this and you typically can't use too much air. The microbes won't mind the agitation, short of bubbling them right out of the bucket!

DIY Designs:

Oregon State Extension Service has a design for a 25 gallon Compost Tea Brewer, though the air pump they recommend is not large enough. You would want to source a 1.25 - 2 cfm air pump to get proper aeration. I always err on the side of adding too much air since it's not going to hurt anything.

Compost, Vermicompost, or Earthworm Castings

Even the best compost tea brewer won't make a good tea if you don't start with good compost. This is where your beneficial microorganisms come from, so it's a vital part of the process. There's so much that goes into making good compost that it would be an entire book unto itself. That being said, here's some good guidelines for compost.

1. Without a microscope, it's very difficult to determine the quality of compost. Typically, I avoid municipal composts and commercial composts because they are made too quickly (good compost takes time) and they tend to be highly bacterial. As a general rule, earthworm castings or vermicompost tend to be better than thermal composts IF you have no way to evaluate the material.

    A. If you are buying a commercial compost, here's the variables to consider:

    1. Do they have any lab tests or biological testing they can share with you?
    2. What sorts of inputs did they use in the compost?
    3. How long is the compost typically composted prior to bagging or selling?
    4. Is the compost still hot to the touch? If so, then it's not finished composting and most likely will be highly bacterial and lacking diversity.
    5. Has the compost been sitting around in the hot sun at a store or is it dried out? You want the compost to have the same moisture content as if there was a plant growing in it. If it's too dried out then the microbes will be dead or dormant.
    6. Is the compost stored in a breathable bag?

    B. If you are buying earthworm castings or vermicompost you'll want to consider the above questions PLUS:

    1. What was the bedding for the worms?
    2. What were they fed?

Note the tiny balls in these African Earthworm Castings. That's the poop from the worms and one way to tell how well the material has been processed by the worms and screened by the manufacturer.

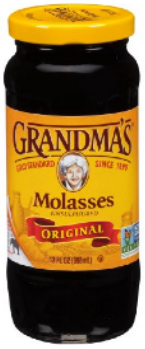
One good way to test the biology in a compost is to add a food source and see what happens. You should see a bit of white fuzz develop on the top of the compost or if added in higher amounts it may actually cause the compost to heat up. This is caused by the bacteria and other microorganisms reproducing rapidly to use up that food source, which produces heat. Common food sources are oat flour or "baby" oatmeal, though my favorite is organic alfalfa meal.

Here's an example of mold growth after 5-7 days after adding a food source. When you see this on the surface, it's typically not harmful and you can just mix it back into the compost by lightly tilling it back into pile.

Food Sources for the Microbes

There are many options for food sources when making aerated compost teas. With our brewers, we use a granulated product we call Microbe Catalyst that's a combination of a variety of ingredients to feed a diversity of microbes.

The advantage of a dry granulated product is that it's easier to measure and store than liquids.



My next favorite food source for ACT is unsulfured blackstrap molasses. It feeds all sets of microorganisms you want in compost teas.

Other good options are: organic alfalfa meal, fish hydrolysate, kelp meal, oat flour… pretty much any organic fertilizer or nutrient will feed microbes, though the more complicated and diverse recipes you see are not necessarily better than simple ones. If I'm not using our Microbe Catalyst, then I just use molasses and alfalfa meal, with maybe a touch of fish hydrolysate.

Tim Wilson of Microbe Organics recommends the following ratios when making ACT.

2.38% compost or vermicompost by volume per gallon of water = 0.4 cups
0.5 - 0.75% molasses by volume per gallon of water = 1.28 - 1.92 tablespoons
0.063% fish hydrolysate by volume per gallon of water = 0.5 teaspoons
0.25% (max) kelp meal by volume per gallon of water = 0.6 tablespoons

Brewing Environment

When brewing aerated compost teas, there are many other variables to consider besides just your brewer, compost, and food source. Water quality, temperature, brewing length, and elevation can all effect microbial growth.

Water Quality

To read an article on water quality and compost teas by my father, Leon Hussey, click here.

To summarize the article though, different sources of water can produce different levels of microorganisms. In general, I like to use rain water or we even pull water out of our local stream when making ACT. For those using municipal water, you'll want to remove any chlorine or chloramine from the water prior to brewing.

Chlorine can be removed by letting it off gas or bubbling the water for 24 hours or until the smell is gone. You can also add some form of organic matter, that can be as simple as a handful of garden soil. Charcoal water filters will also remove chlorine. If you want to take a more scientific approach to chlorine removal, you can use ascorbic acid. Two grams of ascorbic acid will neutralize 2 ppm (typical tap water levels) of chlorine in 100 gallons of water.

Chloramine is a much more stable and will not off gas. You can use any of the other methods though to complex the chloramine or remove it from the water.

Temperature

Lower temperatures can cause the microbial growth to slow down in ACT. Higher temperatures can have the opposite effect. I like to let the water adjust to the ambient temperature before adding my other ingredients. If I want to speed this up, I will run the brewer with just the water until the temperature stabilizes. My preference is to brew at ambient air temperature, as we are then selecting for the microorganisms that will be most successful at the temperature at which we are applying them.

In general, I like the air temperature to be above 55F and below 85F. That being said, you can brew at temperatures outside this range but then it's nice to have a microscope to monitor the results. Optimal range would be 65F to 75F.

Brewing length

As a general rule, 18-36 hours is a good range to stay within when making ACT.

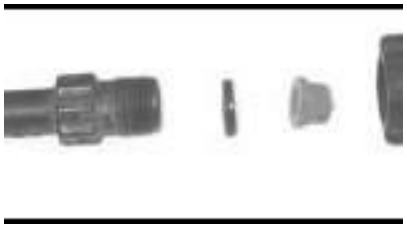
How To Apply Aerated Compost Teas

ACT can be applied both as a foliar application to the leaf surface of the plant or as a soil drench. When we go out to spray a property we will typically do a combination of both by soaking everything.

The simplest way to apply the tea is to use a watering can or just dump the tea right at the base of the plant. If you have a larger area to cover you can use a sump pump with a hose attached. While you shouldn't brew with an impeller pump (sump pump), Tim Wilson has shown with his microscope work, that one pass through the pump does minimal damage when used to apply ACT.

One important consideration when looking to spray ACT is remember that the tea is alive. That means we want a larger droplet size and lower pressure, sort of a "rainbow" effect when spraying the tea.

Also, the nozzle tip you choose is a consideration.



Recommended Tip

Not Recommended Tip

These handheld trigger sprayers don't work and will damage many of the microbes in ACT.

Concrete sprayers work well for applying tea. My favorite small sprayer is the Chapin 1949. They have multiple nozzle tips, and I just chose one that allows for larger droplet size and more volume. However, even the cheaper 1 gallon pump sprayers that you find at Home Depot typically work just fine.

For larger commercial applications, you may want to consider a setup like ours. We use an orchard gun with this setup and use the motor to both continue aerating the tea while driving and also apply the tea.

Application Rates and Frequency

The nice thing is you can't over apply ACT, the only issue would be overwatering. Generally accepted application rates are 20 gallons per acre for soil drench or foliar applications. For small scale applications, I like to just apply a pint or two at the base of a plant and then come back over the top with my regular watering.

Application frequency will vary based on your soil health, microclimate, watering habits, and goals.

For first time users in a garden, outdoor landscape, or farm, I like to do 5 applications throughout the growing season. I see gardeners and growers applying teas at rates ranging from once per week to 3x for the entire year. You'll need to determine what works best for your garden based on plant response, labor and cost.

Frequently Asked Questions

Q: I’m growing an annual plant and it looks like annual plants prefer a bacterial soil so should I make a bacterial dominant tea?

A: You want a "balanced" tea when making ACT. I see recipes all over the internet for a fungal tea or a bacterial tea or a vegetative tea or flower tea. The main benefit of ACT is nutrient cycling. It's a shotgun approach. That means you're putting out all the beneficial microbes you can and letting the plant determine what it wants in the rhizosphere basses on its exudates. The plant is in control. If the plant wants more bacteria in the root zone it will put out more bacterial exudates. People get confused when they see the plant succession table and see that annuals prefer a bacterial soil so they think they want a bacterial tea. I contend that having the fungal spores/hyphae in the tea will serve to improve the quality of the tea and overall soil health. And in general, if you have good fungal activity and biomass in your soil, you’ll still have all the bacteria/archaea as well.

Q: Is it possible to brew perpetually? Can I just keep adding new ingredients to keep the tea going?

A: This is one of the most damaging claims I've heard from other brewer makers. The short answer is "no" and I'll explain why. When ACT is brewed for 24-36 hours (approximate times based on multiple variables), you're creating an unsustainable amount of aerobic microbial activity and diversity. At some point your tea "peaks." There's no way to tell for sure without a microscope but hopefully if you bought a brewer the manufacturer can give you guidelines based on your ambient air temp, compost/food inputs, elevation, etc..). Regardless, after this "peak" point the microbes will have eaten most of the food sources you added at the beginning of the brew cycle (molasses, microbe catalyst, kelp meal, alfalfa meal, etc...). When this occurs you will start to see monocultures over time, meaning one morphology (shape) of bacteria will dominate the tea, which will then be consumed by one type of flagellate. Your tea will fluctuate back and forth between bacteria and flagellates. The flagellates will eat all the bacteria until there's not enough food left and then die off, only for the bacteria to bloom again and repeat the cycle. Think of it as a Darwinian experiment inside your brewer where "survival of the fittest" dominates. Remember that ACT is a "shotgun approach" to increase nutrient cycling. Well over time that diversity completely disappears and you lose much of the benefit of ACT. Of course, the first thought then is "why can't I just add more compost or food sources to the brew after a certain time period?" This sounds like a great idea but in reality it just doesn't work. I've tried brewing over the period of a week on multiple occasions where I took a brewer to trade shows and pulled samples every 10 minutes throughout the day. I found it very difficult to manage the tea and the quality of the brew would vary wildly from hour to hour. I'm not saying it can't be done but I found even with intense monitoring with the microscope it was very challenging and I would have been much better off just

throwing out the tea and starting over. Of course, these brews were just for demonstration purposes and not for actual plant or soil applications.

Q: My tea didn't foam this time but last time it had a bunch of foam. Does that mean it's no good?

A: Foaming is not a good indicator of microbial activity or growth*. This myth has been around for years and is simply not accurate.

Q: Are vortex brewers are better than other designs?

A: I hear this argument a lot but it doesn't hold water from a scientific perspective or in my own experience with direct microscopy. Yes, they look cool and it is possible to make a good tea using a vortex design. What ultimately affects the quality of your tea is the ability of your brewer to maintain appropriate levels of dissolved oxygen throughout the entire brew cycle. An air lift, whether a vortex is formed or not, is the most efficient way of raising dissolved oxygen, however many other designs are possible. The important thing is that the microbes are extracted from the compost/soil particulate and that there are no "dead zones" in the brewer where dissolved oxygen levels can drop or material can settle.

Q: How do I judge a compost tea or compost tea brewer or product?

A: This is a tough question and frankly the answer isn't what you'll want to hear. The only way to evaluate ACT is with direct microscopy. I've seen some companies that will show you some great before and after pictures, but these are typically done without any controls to determine efficacy. If they can't show you any real data or microscope work, then I wouldn't waste my time with what they have to say. There is a lot of snake oil salesmen in the ACT and organic gardening industry who can make any product sound amazing. The factors I look for are the following: Do they have microscope work and lab tests to support their brewer? What sort of DO levels and air pump are they using? Are there any "dead zones" or are you getting good agitation? Is the brewer itself easy to clean?

Q: I see a lot of recipes on the internet with mycorrhizal fungi in them. Is this a good thing to add to my tea?

A: Mycorrhizal fungi is a root symbiont. That means it needs to come into direct contact with plant roots in order to become active and grow. Adding it to an aerated compost tea certainly isn't going to hurt anything, but it may just become an expensive food source for other organisms in the tea. Also, ACT is typically applied as a soil drench, which is not the best method for applying mycorrhizal fungi. Save your money and keep it out of your teas. You can read more about mycorrhizal fungi on our blog by *clicking here.*

Q: How do I make a nematode tea?

A: You don't. Nematodes don't like a liquid medium and you may get some in your ACT but they aren't going to increase in numbers or be very happy in your tea. Best way of increasing bacterial feeding nematodes in teas that I'm aware of is to add oat flour or "baby" oatmeal to your soil or inoculate compost. This will create a mycelium mat and increase your nematode population.

Q: I want to do my own testing? Do you have any microscope recommendations?

A: Tim Wilson has done an excellent write up regarding microscopes which you can read here. He also sells a DVD on his website that is very helpful in identifying these sets of microorganisms under the microscope. It is available for download for $28 by clicking here.

Q: Do I need to worry about e. coli or salmonella or other pathogens in my ACT?

A: By keeping the tea aerobic for the entire brew cycle we reduce the possibility of any pathogens growing in the tea. And if you use compost material that is free of pathogens and has been composted properly then there's really no concern.

Q: Can I put the tea through my irrigation, hydro system, or use them with Blumats?

A: The big concern in these situations is biofilm buildup in the tubing or reservoir. Some people have reported success when flushing the systems after applying, but my choice is usually to avoid this altogether and apply the tea separately using one of the methods described in the "application" section.

Resources

KIS Organics - www.kisorganics.com
Microbe Organics - www.microbeorganics.com
Gardening With Microbes - www.gardeningwithmicrobes.com
Logical Gardener Forum - www.logicalgardener.org
Soil Food Web, Inc. - www.soilfoodweb.com

*credit to Tim Wilson of Microbe Organics for his extensive microscope work and ACT research.