Anyone Growing Thermophiles?

By Al Chomica Dec 2019

Although many of my topics are about the food we grow, we do not eat any thermophiles. One grows thermophiles because of what they eat and then leave behind for us. This may not sound very appetizing, but plants just thrive in it and then we get to eat the food the plants produce. The part that I like is that those thermophiles get fed the spent plant material at the end of the season that they provided the same nutrients for in the beginning. This ecological arrangement recycles the nutrients in our yard and becomes an ongoing process year after year.

If you haven't already guessed, thermophiles are a group of microorganisms including bacteria and fungus that can withstand high temperatures. There are mesophiles that survive at cooler temps and there are also extremophiles that live in much hotter conditions. A couple years back I took a course on how to build a hot, or thermophilic compost heap and succeeded in maintaining four of them last year over the winter. They are also called, 30-day composts but I have found this not to be the case. They all burned away around 130 F, sometimes less and sometimes more depending on the material added. On one heap the addition of a few pounds of organic material pushed the temperature all the way up to 165 F. It is an interesting skill set to master. All of the heaps were fed differently, and they all had names.

Wikipedia describes them this way; A **thermophile** is an organism—a type of extremophile—that thrives at relatively high temperatures, between 41 and 122 °C (106 and 252 °F).

But where does the heat come from to support these critters? Well, nature has found a way in the typical composting process. There is an initial phase of rapid microbial growth on the most readily available sugars and amino acids. This phase is initiated by mesophilic organisms which generate heat by their metabolism and raise the temperature to a point where their own activities are suppressed. Then a few thermophilic fungi and several thermophilic bacteria continue the process, raising the temperature of the material to 150 F, or higher, sometimes within a few days. This peak heating phase has a profound effect on the microbial population because it destroys or inactivates all the mesophilic organisms, and the initial thermophilic fungi and leads to a prolonged high-temperature phase that favors other thermophilic species.

This phenomenon of culturing microorganisms to generate heat allows us to utilize these thermophilic heaps in several ways. One of my heaps was assembled in a hoop house where it burned all winter at 130 – 140 F and kept tender plants from freezing. It was used as a renewable heat source but also made soil. It was fed ground acorns, horse chestnuts and stale flour. Another massive one in a wire cage was used to burn up all my seed heads, weeds, woody stems and root balls of invasive Yellow Flag Iris and cattails. This one was fed fish carcasses and kitchen waste. It burned very hot yet when heavy rains fell last January the entire heap got snuffed out overnight and it never recovered until March when it got warm out again.

Another one was just fed used coffee grounds, malted barley and used cooking oil. It burned steady at 130 F for months as it created a rich, loamy soil. The 'Mother' heap was just started in the front yard where it decomposed all manner of substrates in experiments to see what it would consume. It was started off using sheep and horse poop and sunflower seeds in June 2018 and is still burning away in December of 2019! It gets fresh material added all the time and when it gets too big, I just take a few shovelfuls from it and either use it as compost or start off a new heap using it as the kickstart.

It consumes everything I throw into it including tin cans that take about a month to disappear. During the winter it looks like a mini volcano as it continuously spews steam out the top and becomes a highlight during garden tours. I have given buckets of this heap away to others who have also tried to make their own thermo heap but no one else has been able to coax life out of it so far because they don't understand what the heap needs.

One can best promote the growth of these thermophiles with an understanding of the concept how they generate the heat that sustains them. The temperature level generated by the heap determines the diversity of microbes that can consume the organic material within the pile, yet it is the normal body functions and respiration of the billions of microbes themselves that actually create the heat. The building of the massive population numbers takes a long time and requires surplus food for them to grow into, but this is where putrefaction can easily slip in and gain a foothold. They also require aerobic conditions which means the heaps should be turned every second day or so. This mixes up the food but also provides an opportunity to mix in more food, whatever it may be, along with air and water.

The heap should only have about a 60% moisture level or the thermophiles can get drowned-out almost instantaneously. If the temperature drops, pathogens can start to proliferate. If the pathogens dominate, the heap will then start to smell putrid as it off gases ammonia and the organic material will not be turned into a rich, black compost. It is a very fine line to keep things going the way they should. If I think about it, this skill set is about managing putrefaction. If I find a heap that is too wet, I can manage the moisture content with the addition of a wonderful charcoal product from Soil Matrix Biochar. I just sprinkle on a shovelful or two, mix it up and the smell immediately goes away.

The 18-month old heap in the front yard is named Thermo. I wanted to see how Thermo would react by disposing of some used cooking oil leftover from our deep-fried turkey at Easter and poured about two cups into the heap along with my usual bucket of ground acorns. The heap lost temperature within several hours but hung on at around 90 F for a couple days before rising back to 130 F. I added more oil and the temp only dropped to 100 F so I assumed the microbes that can consume oil were starting to multiply. Slowly I was able to add more and more oil until Thermo maintained a fairly steady temperature of 130 F by just being fed acorns, oil and water every second day while it was being mixed with a garden hoe. In December of 2018 I took a video of the process you can view here - http://bit.ly/1compost

On a recent garden tour, the question arose if the oil in the compost might be a bad thing. I wondered that myself but after applying oil to the heap and seeing it heat up, I knew something was likely consuming the oil to generate heat. I took a slide sample to view under a microscope and was so surprised at what I saw I had to call for my wife to see as well. The oil had broken down into pretty, microscopic blobs of iridescent colours. One orange blob had hundreds of bacteria lining the edge like gazelles at a watering hole. A big green blob had an amoeba bellied up to it as it consumed the oil. I had discovered that used cooking oil can be used to feed microbes!

During a month of -5 C temperatures in Feb 2019 the heap did not cool down and continued to stay at 130 F no matter how cold it was outside. The picture on the left shows thermo in the snow. I have carved a hole into the side to expose the inner profile. The heap is solid and hard and the top three or four inches is an active white band of either mycelium or microbes. Under that is a hot moist dark brown pile that generates steam on a constant basis and it drinks 2 L of water every day. It radiates so much heat the snow is melted away all around it and the birds seem to love sitting on top of it.

Measuring this temperature with a compost thermometer is an important step when making this compost because at lower temperatures pathogens and moulds can flourish. Pathogens are destroyed at the higher temp's as are any unwanted weed seeds. An ideal temp will be 125 to 140 F.

The thermometer also coincidentally provides an indication of the substrate available to feed the microscopic creatures. If temperatures are going up it means there is food available and the microbes are multiplying to consume it. When the temperature holds steady it provides an indication that the heap has reached a point where it will need more food or water in a day or so. Or it could be too wet. If the temperature continues to climb the pile may have to be broken apart with a garden hoe to cool it down. Reading Thermo's temperature with this thermometer is like reading the pulse of a living creature.

Here's a video of a steaming hot Thermo after being broken open - http://bit.ly/2compost

Over time, as I continue to co-exist with this living Thermophilic compost heap on a daily basis, I have learned to read it and determine what it will need a day or two in advance. Water and food needs have to be recognized and administered before the heap even knows it will need it. In some ways it has become a garden pet. I have come to recognize that it is similar to an anthill in that it is a colony of individuals all working together. It is also like a sentient being in that it breathes, eats, drinks, reproduces and generates heat in the process. I don't know if it sleeps.

At time of writing it is mid-December and Thermo has been on holidays since August. It is not a thermophilic heap at this stage although it has been fed all sorts of greens, weeds and lawn clippings. It is heavily populated by worms and not so much by microbes. I just received a supply of acorns and spent grain so Thermo is being woken up by feeding it a few things.

Meat and fish remains, the equivalent of about two chickens, about four Litres of sprouting acorns, two packages of porridge, about four Litres of last year's malted barley and about a Litre of used cooking oil were added to the heap and mixed together. No water was added because the heap was fairly damp from all the winter rains. The temp was at 40 F when mixed and went up 10 degrees in one day. On the third day Thermo was mixed and had some oil added and it went up to 80 F. On day 4, Thermo was at 90 F and slowly climbing.

The microbes take a while to replicate but it should have gotten hotter much more quickly so something was off and needed to be adjusted. I added a bunch of chicken litter, some oil and more acorns but noticed a slight ammonia smell. That indicates it is putrefying by being too wet so I devised a rain cover because it rains almost every night.

I broke it wide open and scattered a few Litres of charcoal onto the heap to soak up some of the moisture. I added some more spent grains, dry coffee grounds and oil to keep the warming trend going. Within a week or so it should get back up to 130 F when all those microbes wake up and start reproducing their numbers. When it starts cookin', I'll be able to add any organic substrates…

…Two weeks later and the temp was hanging around 100 – 110 F. Something still needed to be adjusted so I removed a wheelbarrow of the compost out of the heap. It was observed that the ammonia smell was still there so the remainder of the heap was completely busted apart and a good dose of charcoal was applied. A shovelful of spent grain from a distillery, a shovelful of cheap flour, a scoop of chicken litter and a splash of cooking oil were mixed in and the heap was covered up from the rains. It can sometimes be a tricky thing to spark life into millions of creatures by mixing oil, water and grains together.

This picture shows 'Thermofish' last year in the back garden. It is big at 4' x 4'. After getting snuffed out by too much rain I had to devise a rain cover for it. The temps slowly recovered by adding oil but also because there was such a large mass of fish in the heap.

The wire cage is 14 ft long and is clipped together with ties. The wooden slats are required to help the heap stand straight because there are likely a thousand lbs of somewhat fluid substrate contained and it often slumps over.

Thermofish burns hot at around 150 F for about five weeks. When it cools down to 100 F, I break it open and turn it inside out in a different location in the garden. It gets more fish, malted barley and sheep poop at this time and will go back up to 150 F for another five weeks or so before cooling and being moved and turned again.

By planting time, Thermofish had been moved five times and everywhere it sat it left behind a wonderful compost footprint for our plants to grow in. The material left behind is laced with an intense number of worms. So much so that the raccoons dig this heap up almost every night to eat them. The raccoons mix up the compost quite nicely but unfortunately, they also dug out eight of my prize melons that had nice fruits. One visitor estimated there were 10 worms per cubic inch in this compost! It is just crawling…

When there are this many worms up near the surface it means the compost is no longer thermophilic. It has mostly been broken down by the microbes into a nice granular, black substrate that will be bagged for a year to mellow before being used in the garden or in potting soils.

When a thermophilic heap is hot, the worms migrate downward to the ground level where it is cool enough for them to survive. If I neglect the heap and let it cool down, the worms migrate

upwards. I suspect something similar happens with the microbes or perhaps they just go dormant when conditions are not favourable.

The microbes that are responsible for generating heat, while breaking down our organic material, were a mysterious component to me. Who exactly are they and what are they doing? I didn't know them and had never seen them so I decided to set up a microscope course at our home to see for myself. I contacted Debra Contreras, from Nature's Wisdom Organics, who microscopically analyses the wee beasties in soil samples for people. She showed me how to prepare slides and went through the technical aspects of operating a microscope. I learned what a bacterium looked like and got to see squirmy nematodes and big, fat amoebas for the first time. I saw what was really growing within these heaps and most of them looked like aliens. I was culturing the growth of billions of these creatures who were managing the putrefaction of my organic inputs by turning them into a rich organic compost.

We took samples from all four thermo heaps as well as some worm castings. She identified many species of micro fauna and keyed them out with her field guide books (there was even one guide just on nematodes). Debra claimed the thermophilic compost was one of the richest and most heavily populated she had ever seen. She estimated a count of 45,000 beneficial nematodes per gram of soil! Wow, it was just loaded. And the diversity and activity were almost beyond belief. It was like looking down at a busy intersection with all manner of microscopic critters zooming and squirming around every which way. She mentioned that some of the ranches and farms she has analysed had zero microbes and that the crops at these places grew poorly or not at all. I felt like a very rich gardener after her visit.

Many people that come by often express a feeling of how hard I work on these heaps, but I really don't. I collect free material throughout the year in little steps and small loads. Now that friends and neighbours know I collect leaves and acorns they sometimes even deliver to my gate. When I 'turn' my heaps all I do is rock back and forth dragging a hoe that does all the work.

The biological processes these heaps reveal to me has my mind occupied with wonderment and I learn incredible things from them all the time. They take centre stage during garden tours with some visitors becoming somewhat suspicious when they sense the active life force within these heaps. And then to see how magnificently plants thrive in these soil mixes provides one with an intense satisfaction that reaches a climax when eating something like a prize watermelon or a 25 lb kohlrabi that were grown in nothing but waste from harnessed microbes…

In the picture below, Lindo Patterson is holding a surprise gift for her son whose favourite food just happens to be kohlrabi. This one was grown in rich **compost** created by the thermo heaps and only made it up to 20 lbs. Some were even bigger at 22 and 25 lbs...