THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension

az1739 June 2017

Compost Tea 101: What Every Organic Gardener Should Know

Valerisa Joe, Channah Rock and Jean McLain

Figure 1 (left) No Compost Tea added to the plant. After two 2 weeks of water. (right) Compost Tea added to the plant. After 2 weeks of water + compost tea.

Introduction

Growers of organic produce in the Southwestern United States face many challenges, including variation in water and temperature, and exposure to insects and disease. As a result, smallholder organic farmers are increasingly relying on soil additives such as compost tea that improve product quality, use less water, deter pests, and reduce reliance on chemical additives (Diver, 2002). But what exactly is compost tea? Do the benefits of using compost tea outweigh any concerns? For example, can it contain pathogens, and if so, do applicators have to worry about coming into contact with pathogens? This publication provides facts about making compost tea, and reviews both the benefits and potential disadvantages to help smallholder farmers to make educated decisions regarding the use of compost tea.

What is Compost Tea and How is it Made?

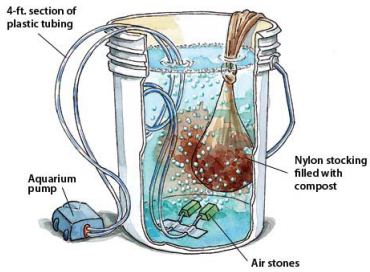
Compost is organic matter (animal product, plant product, or manure biosolids) that has been decomposed into a nutrient-rich humus-like material to be used as a fertilizer and soil amendment (Bezanson, 2014). Generally, compost tea is produced through steeping compost in water, just like a bag of tea in hot water, producing an organic-rich, high-nutrient liquid (Ingram and Millner, 2007). The smallholder farm may see commercially-available products with names such as "compost extract," "compost leachate," "organic tea," or "manure tea," but all of these refer to the watery end-product of circulating water through compost while maintaining conditions conducive to the microbial activity needed to break down the base organic material.

There are various methods used to manufacture composts depending on the scale of the process. Generally, small scale production is preferred by home gardeners or smallholder farms, and uses "static aerated pile" or "in-vessel reactor" methods, whereby compost is placed in an enclosed space and maintained in an aerobic state to encourage microbial biodegradation of organic matter (EPA, 1993). Microbial metabolism releases heat into the surrounding matrix, which aids in degrading pathogenic organisms that may be present in the raw organic matter. Target temperatures of ≥131°F (55°C), easily attainable in desert climates of the Southwest, can effectively kill most pathogens (Chen et al., 2011; EPA, 1993).

Though compost tea formulations are commonly available in garden stores, farmers' markets, and through the internet, organic growers can produce their own compost tea by saturating available manure/compost mixtures with water and collecting the leachate.

The most common methods used in smallholder compost tea production are listed in Table 1. Commercial and home formulations of compost tea are often supplemented with nutrient additives, including molasses, yeast, humic acid, soluble kelp, and fish hydrolysates (Durham, 2006). Regardless of which method is used, the end result is the same: a nutrient-rich liquid that allows organic growers to effectively recycle animal and/or plant biomass. The nutrient-rich condition shared by all compost teas, while providing benefits to soils and plants, is also the primary reason why compost tea can be a potential problem, as the addition of nutrient additives and water can cause pathogen proliferation.

Table 1. Common Aeration Compost Tea Methods

Method of Compost Tea	Processing Details	Diagrams
1. Bucket-Bubbler	This is the most common technique used to make compost tea among home growers. Aeration is supplied to the compost bucket using 1 or 2 hoses; the nozzle size does not matter as long as air is able to disuse through the bucket. Diffusion mats and aquarium-style stones and/or an impeller can be used to produce compost tea very rapidly (Ingham, 2015; Martin, 2014). This method "brews" mixes the composts and water together, for 3 days to fully extract all the nutrients from the compost.	 (Garden Gate eNotes, 2010)
2.Trough	This method is used for commercial production of compost tea. Compost, in a container with holes in the bottom, is suspended in the air over a trough. Water is poured over the compost, letting the tea drip from the top container into the bottom trough. Aeration can be added to circulate the compost tea, similar to the bucket method. Brew time is longer than bucket bubbler, can be up to 3 weeks because of the large volume of compost tea being made (Ingham, 2000).	

What are the Benefits of Using Compost Tea?

There are a number of documented benefits to applying compost teas to soil and/or plants, including increased soil water retention, improved soil fertility, and reduced reliance on the need for chemical pesticides and fertilizers (Dearborn, 2011). Regular compost also produces benefits to both plants and soils, but unlike compost tea, has not been acknowledged to reduce plant pathogens (On et al, 2015). Compost tea applied directly to plant foliage has been shown to suppress phytopathogens on a variety of edible crops, including tomatoes (Scheuerell and Mahaffee, 2002).

The benefits of compost tea application are enhanced in arid environments where irrigation water may be limited. Organic farms are reported to use less water than conventional farms (Stolze, 2000), and studies in Australia suggest a correlation between decreased irrigation water use and the application of compost tea (Hansen et al, 2001). Evidence indicates that increased water holding capacity in organic fields reduces the overall need for water application (Bot and Benit, 2005), but enhanced awareness of water management by organic farmers, in tandem with a greater willingness to directly observe soil moisture (Madigan et al, 2009), all conceivably contribute to decreased water usage with the application of compost tea. In addition, compost adds labile nutrients to soil, which in turn induces microbial proliferation. Optimal water supplies enhance microbial activity in the rhizosphere (Brady and Weil, 2010), where the labile nutrients are metabolized and released for plant growth. Thus, the use of compost tea can reduce water needed for plant growth, while concomitantly providing multiple benefits to the soil and plant.

Are there Concerns Related to the Use of Compost Tea?

As stated above, compost teas are widely available, easy to use, and provide multiple benefits to organic gardeners; however, some caution should be exercised in using this product. Generally, commercial production of compost teas lacks regulation (Ingham, 2002). Though the composting process is adequate for destroying most pathogens, deviation from this process (such as addition of water and supplements during the brewing process, which could result in decreased temperatures in the compost), could result in the survival of pathogens commonly found in animal feces, including *Salmonella*, *Listeria*, and *Escherichia coli* (Table 2), all of which are able to proliferate in soil with viability of up to 20 years (van Elsas et al, 2010; Dhiaf et al, 2010). Thus, while animal feces are an excellent pre-cursor of compost tea due to high nutrient content, they also may carry foodborne pathogens that can potentially cause illness to consumers of raw produce.

Though the potential for foodborne pathogen presence in compost tea is real, it must be stressed that links between foodborne illness and compost tea have not been established in peer-reviewed medical literature. Microbial populations in compost tea vary due to geological region, sources of starting material, and incubation time, and the lack of regulation makes it difficult to monitor pathogen presence in compost tea. Smallholder farmers are advised to follow the guidelines in the next section to assure maximum likelihood of safe production and minimum pathogen exposure.

Consumers of commercially available compost teas should have an awareness that, in addition to pathogens, formulations may bear a microbial signature of soils local to where the compost tea was manufactured. Generally, this is not an issue, as proper treatment will kill all microbes (beneficial and otherwise), but mixing microbes from different soil regions could potentially introduce non-indigenous soil-borne plant pathogens and other non-beneficial microbes (Leaf Filter Gutter Protection, 2016). Microbes are known to influence soil pH, nutrient cycling, and water content; thus adding non-native soil microbes could have negative effects on soil composition (Brady and Weil, 2010).

Common Pathogenic Bacteria Species found in Compost Teas

In the United States, foodborne illness affects about 48 million people annually according to the Centers for Disease Control (CDC). There are many pathogenic bacteria that cause foodborne illness, including *Escherichia coli*, *Salmonella* and *Listeria*, each of which have been found in compost tea (Ingham, 2000).

Guidelines for Safe Use and Handling of Compost Tea

As stated above, foodborne illness has not been connected to the use of compost teas used on produce that is consumed raw, but the potential for pathogen exposure exists. To decrease the risk of foodborne illness, growers can implement these four easy-to-follow recommendations:

1. **Use compost tea only on non-edible plants or on non-edible portions of plants:** By far the best preventative measure for avoiding pathogen exposure is to use compost teas only on non-edible plants. By limiting the use of compost to non-edible plants, there is less chance of pathogen transfer into the human food chain. United States Department of Agriculture (USDA) guidelines state that compost teas

Table 2. Foodborne Pathogens Found in Animal Feces

Pathogenic Bacteria	Common Properties	Timeline of illness	Symptoms of Infection
Escherichia coli (*E. coli*)	• Most *E. coli* species do not cause illness • There are specific strains of *E. coli* that can cause illness. The most notorious is *E.coli* O157:H7, which is one of the most common causes of foodborne outbreaks in leafy greens and meats (Wang et al., 2016; Solomon et al, 2003)	Symptoms occur 6-48 h after ingestion Can last 1-7 days	Nausea Vomiting Diarrhea Fever
Salmonella	• One of the leading causes of foodborne illness in the U.S. and worldwide • Commonly found in the intestines of animals, including, chickens, turtles, and lizards (Crum, 2005)	Symptoms occur 6-72 h after ingestion Can last 4-7 days	Nausea Bloody vomiting Cramps Bloody diarrhea Fever Headache
Listeria	• Commonly found in soil and water • Not as common as *Salmonella* and *E. coli* outbreaks, but the mortality rate is very high, resulting in death in up to 30% of cases • *Listeria* has the ability to grow in colder conditions (Madigan et al, 2009; Farber et al, 1996)	Symptoms occur 3-70 days after ingestion	Fever Muscle Aches Nausea Diarrhea

should not be used on edible crops unless it is important for the production of crops.

When compost teas are used on edible crops, it is suggested that they be applied to the soil above plant roots, rather than directly to the foliage. Following application, growers should adhere to the 90-120 day rule set by the USDA. The 90-120 day rule states that compost applied to crop soil should not be harvested within 120 days when edible crop is in contact with the soil, and not harvested within 90 days of all other edible crops. This rule applies to all compost, even if no animal by-product has been used in the production of the compost, because there is the potential of pathogen growth (USDA, 2000).

2. **During compost production ensure bacterial killing temperatures:** Living in the arid Southwest, temperatures in spring and summer will usually heat compost to above a temperature of 131°F needed to kill pathogenic microorganisms. However, temperatures in fall and winter can create conditions for pathogenic bacterial growth. When making compost for compost teas, use in home gardens or smallholder organic farms, monitoring of interior temperature of the compost, along with constant turning to aerate the composting mixture, should result in minimal survival of pathogens.
3. **Wash hands and clothing immediately after gardening:** Proper hand washing is the most effective measure for preventing the contraction and spreading of foodborne illness. Since *E. coli, Salmonella* and *Listeria* are all commonly found in soil and water, and are not limited to compost and compost teas, thoroughly washing your hands and clothes will reduce the likelihood of spread of disease (CDC, 2015).
4. **Be aware of the lack of regulation in commercial compost tea production:** When buying commercially-produced compost teas, organic producers should keep in mind that regulations for this product are limited, and sometimes non-existent. As a result, labels will provide only the most limited product information. However, reputable sellers and compost tea producers, if asked, should be able to provide information regarding the initial contents of the compost and bacterial monitoring data, especially E coli. An inability or refusal to provide such data should make the consumer more cautious, making guidelines 1 to 3 (above) all the more important.

The benefits of compost tea, including delivery of a high-nutrient, natural plant fertilizer in a way that provides multiple benefits to the plants and soil, are well documented. Adherence to the four easy guidelines stated above will help in assuring the production of safe and sustainable fresh produce using compost teas.

References

1. Diver, S. (2002). Notes on Compost Teas: A Supplement to the ATTRA Publication Compost Teas for Plant Disease Control. Appropriate Technology Transfer for Rural Areas publication, Fayetteville, AK.
2. Bezanson, G.S., Ells, T.C., and Prange, R.K. (2014). Effect of Composting on Microbial Contamination and Quality of Fresh Fruits and Vegetables - a Mini-Review. Acta Horticulturae.1018:631-638.
3. Ingram, D.T., and Millner, P.D. (2007). Factors Affecting Compost Tea as a Potential Source of Escherichia coli and Salmonella on Fresh Produce. Journal of Food Protection. 70(4):828-834.
4. Environmental Protection Agency (EPA). (1993). 40 CFR Parts 257, 403 and 503 (FRO-4203 3): Standards for the use and disposal of sewage, Final Rule, Fed. Register, 58, 9248. US Government Printing Office, Washington DC.
5. Chen, L., de Haro Marti, M., Moore, A., and Falen, C. (2011). The Composting Process. Dairy Compost Production and Use in Idaho. The University of Idaho-CIS: 1179:1-5.
6. Scheuerell, S., and Mahaffee, W. (2002). Compost Tea: Principles and Prospects For Plant Disease Control. Compost Science & Utilization. 10(4):313-338.
7. Durham, H. (2006) Additives boost pathogens in compost tea. Agricultural Research. 54:22.
8. Garden Gates eNotes. (2010). [Online] Available from: http://www.gardengatenotes.com/images/2010/10/101019-large.jpg. [Accessed 2 October 2015]
9. Diver, S. (2002). Appropriate Technology Transfer for Rural Areas. [Online] Available from: https://www.slideshare.net/ElisaMendelsohn/notes-on-compost-teas-9584536 [Accessed 3 February 2017]
10. Ingham, E. (2015) Brewing Compost Tea. Kitchen Gardener. 29. [Online]. Available from: http://www.finegardening.com/brewing-compost-tea [Accessed 2 July 2015].
11. Martin, C.C.G. (2014). Potential of Compost Tea for Suppressing Plant Diseases. CAB Reviews. 9(32):1-38.
12. Ingham, E.R. (2000) The Compost Tea Brewing Manual. Soil Foodweb Incorporated. Corvallis, Oregon, USA.
13. Dearborn, Y. (2011). Compost Tea-Literature review on production, application and plant disease management. San Francisco Department of Environment Toxic Reduction Program: IPM Task Order # 3-18
14. On, A., Wong, F., Ko, Q., Tweddell, R.J., Antoun, H., and Avis, T. (2015). Antifungal Effects of Compost Tea Microorganisms on Tomato Pathogens. Biological Control. 80:63-69.
15. Stolze, M, Piorr, A., Haring, A., Dabbert, S. (2000). The Environmental Impacts of Organic Farming in Europe. University of Hohenheim Department of Farm Economics 410A.
16. Hansen, B; HF Alrøe; ES Kristensen (2001) Approaches to assess the environmental impact of organic farming with particular regard to Denmark. Agriculture, Ecosystems and Environment. 83:11-26.
17. Bot, A. and Benit J. (2005) The importance of soil organic matter key to drought-resistant soil and sustained food and production. Food and agriculture organization of the United Nations. Rome, Italy.
18. Madigan, M., Martinko, J., Dunlap, J.M., and Clark, D.P. (2009) Brock Biology of Microorganisms 12th Ed. (Pearson Education, San Francisco, CA).

19. Brady, N., and Weil, R.R. (2010). Elements of the Nature and Properties of Soils: 3rd Ed. Pearson Education, Inc., Upper Saddle River, NJ.

20. Dirk van Elsas, J., Semenov, A.V., Costa, R., and Trevors, J.T. (2010) Survival of Escherichia coli in the environment: fundamental and public health aspects. The ISME Journal: Multidisciplinary Journal of Microbial Ecology. 5:2:173-183.

21. Dhiaf, A., Abdallah, F.B., Bakhrouf, A. (2010) Resuscitation of the 20-year starved Salmonella in Seawater and Soil. Annals of Microbiology. 60:1:157-160.

22. Leaf Filter Gutter Protection. (2016) [Online] Available from: http://www.leaffilter.com/blog/home-exteriors/outdoor-landscaping/which-soil-is-best for-your area/ [Accessed 2 November 2016].

23. Centers for Disease Control (CDC). (2016). Burden of Foodborne Illness: Findings. [Online] Available from: https://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html.

24. Solomon, E.B., Pang, H.J, Matthews, K.R. (2003) Persistence of Escherichia coli O157:H7 on Lettuce Plants following Spray Irrigation with Contaminated Water. Journal of Food Protection. 12: 2196-2405.

25. Wang, R., Luedtke, B.E., Bosilevac,J.M., Schmidt, J.W., Kalchayanand, N., Arthur, T.M. 2016) Escherichia coli O157:H7 Strains Isolated from High-Event Period Beef Contamination Have Strong Biofilm-Forming Ability and Low Sanitizer Susceptibility, Which Are Associated with High O157 Plasmid Copy Number. Journal of Food Protection. 9: 11: 1875-1883.

26. Crum, N.F. (2005). Non-typhi Salmonella empyema: Case Report and Review of the Literature. Scandinavian Journal Diseases. 37:852-857.

27. Farber, J. M., Ross, W. H., & Harwig, J. (1996). Health risk assessment of Listeria monocytogenes in Canada. International Journal of Food Microbiology, 30(1-2), 145 156.

28. United States Department of Agriculture- National Organic Program; Final Rule (2000). [Online] Available from: https://www.gpo.gov/fdsys/granule/CFR-2011-title7-vol3/CFR 2011-title7-vol3part205/content-detail.html [Accessed 2 November 2016].

29. Center for Disease Control (CDC) (2015) Show Me the Science - Why Wash Your Hands? [Online] Available from: https://www.cdc.gov/handwashing/why-handwashing.html [Accessed 3 February 2017]

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension

The University of Arizona
College of Agriculture and Life Sciences
Tucson, Arizona 85721

Valerisa Joe
Graduate Research Assistant, Department of Soil, Water & Environmental Science

Channah Rock
Associate Water Quality Specialist & Professor

Jean McLain
Associate Director Water Resources Research Center /Associate Research Scientist

Contact:
Valerisa Joe
vmjoe@email.arizona.edu

This information has been reviewed by University faculty.
extension.arizona.edu/pubs/az1739-2017.pdf

Other titles from Arizona Cooperative Extension can be found at:
extension.arizona.edu/pubs