



How to Cultivate Indigenous Microorganisms

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Past trends in conventional western agriculture, including monoculture without crop rotation, overuse of inorganic fertilizers, and wide-scale applications of broad-spectrum organophosphate pesticides, have hindered the role of naturally occurring microorganisms in promoting biological nitrogen fixation and decomposition of organic matter, microbiologically enhanced plant nutrient uptake, and other natural soil processes that depend on active soil microbe populations.

The current trend in U.S. agriculture, including Hawai'i agriculture, is toward less chemically intensive, more biologically based practices, in the hope that they may improve soil health and agricultural production and be less harmful to the environment than conventional agricultural production methods. In Asian countries, including Korea, deliberate collection and culturing of naturally occurring soil microorganisms has been a common agricultural practice for centuries, and application of these cultures to crop soils is believed to minimize the need for applications of inorganic soil amendments. However, little scientific documentation of the benefits of these practices exists. This publication outlines the principal steps in culturing naturally occurring microorganisms in a process similar to one used on farms in Korea. Those wishing to culture and utilize microorganisms in this way should be aware that the value of the techniques and applications described has not been verified in Hawai'i by controlled experiments. Therefore, the practices described in this publication should be considered as suggested, rather than recommended.

Although the people shown in the following photos are not wearing protective equipment, anyone following the procedures outlined should carefully consider their personal health situation and wear appropriate protective apparel; see suggestions for safe handling on page 7.

Collecting microorganisms from the environment

When is the best time to collect microorganisms?

Microorganisms (microbes) may be cultured at any time of the year; however, avoid wet, rainy seasons. Excessive moisture in the environment promotes growth of fungi that are less desirable for the intended uses.

How time-consuming is it to collect these microbes?

The collection process takes approximately 4–5 days in cooler weather (about 68°F, 20°C) and 3–4 days under warmer conditions (> 68°F, 20°C).

Where are the best places to collect microorganisms?

Beneficial microbes are highly concentrated under undisturbed forests or other vegetated areas. Combining microbes collected from multiple sites will likely result in a more robust culture.

What collection supplies will I need?

Collection materials are relatively inexpensive and readily obtainable.

- a small wooden box, 12 x 12 x 4 inches deep, preferably made of cedar (photo 1)
- steamed white rice
- white paper towels, enough to cover the wooden box
- two to four large rubber bands
- a sheet of clear plastic, large enough to completely cover the wooden box
- ¼-inch mesh wire screen large enough to completely cover the wooden box.

How are collection supplies assembled?

Fill the wooden box with 3 inches of steamed rice (photo 2). Cover the box with white paper towel, being careful not to let the towel touch the rice (photo 3). There should be an inch or so of air space between the rice the paper towel. Use rubber bands around the top of the box to secure the paper towel in place.

Cover the top of the box with wire screen (photo 4) to prevent animals from tampering with the rice. Top the wire with a sheet of clear plastic to protect the box from rain, and place it under trees or in another secluded area. The box should not be in direct sunlight.

Partially bury the box in the soil (photo 5). It should be buried at least 2 inches deep for best results.

Cover the box with fallen leaves from the harvest location (photo 6). Anchor the plastic sheet on all sides with small rocks to prevent it from being dislodged by wind.

Leave the box undisturbed for a minimum of 4–5 days. After that time, check to see whether the moist rice is covered with white mold. If mold growth is sparse, re-cover the box and wait an additional 2–3 days before re-checking. If the mold is a color other than white (other colors indicate growth of less effective fungi) or if rain has entered the box, the contents should be discarded and the process repeated.

Culturing the microorganisms

Once the desired microbes have been collected, the next step is to increase their numbers.

What materials are necessary for culturing?

The basic supplies for microbe culturing are

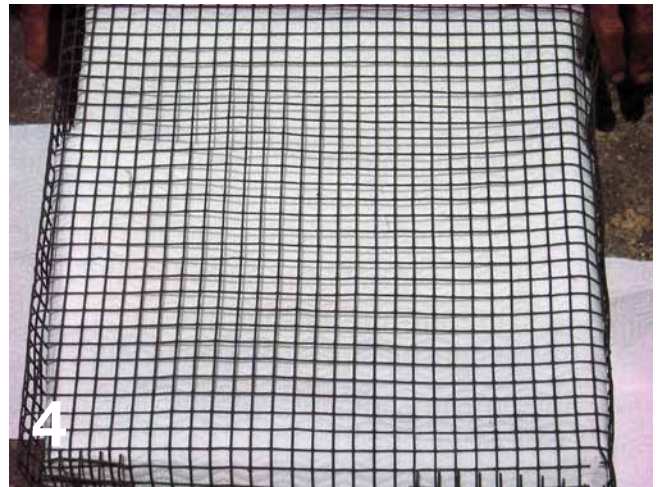
- a clean clay pot (hard-fired, glazed, or terra cotta)
- a wooden spoon
- white paper towels
- rubber bands
- a large clear bowl, big enough to hold contents of rice mixture
- a small food scale
- a straw mat
- a shovel
- a composting thermometer
- raw, granulated brown sugar
- wheat mill run* or, if available, mushroom growth medium waste.

*Wheat mill run (WMR), also called “wheat midds” or “middlings,” is the materials remaining after flour, or

semolina, is extracted from wheat or durum during milling. WMR generally includes ground screenings from cleaning; remnant particles of bran, germ, and flour; and other offal from the milling process. In Hawai‘i, the basic source of WMR is Hawaiian Flour Mill in Honolulu (808 527-3215), a subsidiary of Pendleton Flour Mills; they sell it by the truckload or containerload, and in palates of various sizes of packaged containers (60-pound bags, and larger) to the livestock industry (for feed), garden supply stores (for bokashi compost), and mushroom farms (for growing medium).

How are the materials assembled to cultivate microbes?

- 1) Weigh and record the weight of the large bowl.
- 2) Use the wooden spoon to move the molded rice from the wooden box into the bowl (photos 7, 8). Weigh the filled bowl and calculate the weight of the rice mass by subtracting the weight of the empty bowl from the filled bowl.
- 3) Gradually add an amount of granulated brown sugar equal to the weight of the rice mass (photo 9). Hand-knead the sugar and rice until the material has the consistency of gooey molasses (photo 10). Protective gloves are suggested.
- 4) Fill the clean clay pot two-thirds full with the rice/sugar mixture (photos 11, 12). Cover it with paper towel secured in place with rubber bands (photo 13).
- 5) Store the pot in a cool area away from direct sunlight for 7 days. This will allow the mixture to ferment.
- 6) Working in a shaded area (photo 14), add a small amount of water to the fermented rice mixture in a 1:500 ratio. Then, slowly blend in wheat mill run (or used mushroom medium) until mixture is of semi-moist but not wet consistency (roughly 65–70% moisture) (photos 15–17).
- 7) Place a mound of the mixture on a soil surface and cover it with the straw mat or leaves, protecting it from sunlight (photo 18). Allow the microbes to propagate for 7 days. Periodically examine the external surface of the pile for white mold growth, monitor internal temperature of the pile with a composting thermometer so as not to exceed 122°F (50°C), and turn the pile with a shovel (a minimum of three to four times during the week) to keep fermentation temperatures from getting too high.
- 8) When the fermentation process is finished, internal temperature will stabilize, indicating cultivation is









finished. Your culture of naturally occurring microorganisms is now ready for use (photos 19, 20).

Application

What do I do with the fermented mixture?

Dilute the final product (1 to 1 by volume) with soil and incorporate this mixture into the surface soil as a top-dressing for crop production, or add it to your compost pile. This biological soil amendment is expected to enhance soil microorganism activity. For more information, please contact the author (mduponte@hawaii.edu).

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References

- Kyu, Cho Han. Natural farming. 2003. Janong Natural Farming Institute, Chungbuk, Republic of Korea.
- Szmanski, N., and R.A. Patterson. 2003. Effective microorganisms (EM) and waste management systems in future directions for on-site systems: Best management practice. Proceedings of the On-site '03 Conference, University of New England, Lanfax Laboratories Armidale. ISBN 0-9579438-1-4 p. 347–354.
- Mazzola, M. 2004. Influence of plant genotype on development of interactions with non-symbiotic plant beneficial soil microorganisms. *Research Signpost: Research Developments in Agricultural and Food Chemistry*. 37:103–122.
- Kirk, J.L., L.A. Beaudette, M. Hart, P. Moutoglis, J.N. Klironomos, H. Lee, and J.T. Trevors. 2004. Methods of studying soil microbial diversity. *Journal of Microbiological Methods* 58:169–188.

Best safety practices for handling fungi

While culturing indigenous fungi may often be safe, it can be important to take precautions when handling these organisms, because humans can be adversely affected by contact with fungal spores and the mycotoxins that fungi can produce. This is especially important for children, the elderly, immunologically compromised individuals, and people who have allergies, asthma, sinusitis, and similar respiratory problems. Take the following precautions when gathering spores, mixing ingredients, and applying a fungi-based soil amendment.

Wash your hands thoroughly with soap and water before and after handling fungal materials. Do not touch your mouth, nose, or eyes when handling fungi; do not use your hands to smoke or eat.

Work with fungi in an open-air environment, never in small, enclosed rooms.

Wear disposable gloves when handling fungi, and throw them out when done. Do not use your bare hands to handle fungal materials if you have a cut or open wound.

Wear eye protection and a disposable N95 respirator mask when handling fungi.

Do not move tools and other supplies that have been in contact with fungi to other areas of the farm or home unless they have been washed with soap and water.