



Phi'on products are designed to address the fundamental link between healthy soils, plants, water, animals and humans.



Microbial formulations: Techniques and ingredients

Introduction

The purpose of this note is to describe the techniques and ingredients for a wide range of basic microbial formulations for a wide range of purposes.

People with an interest in preparing microbial formulations would have an interest in the restoration of biology in soil or the application of biology in balancing conditions for plants, water, air, animals and humans. This information may apply to people with an interest in biological farming (including organic, bio-dynamic and permaculture), organic waste management, animal husbandry, land care or land restoration (eg. soil contamination), forestry, odour control and bio-conversion (digestion of organic wastes).

A basic approach comprises a **foundation formulation** that can be used as a base microbial formulation or added to other specialised formulations. There are also **specialised or purpose-made formulations**.

The **microbial mother culture** used in these formulations is **Effective Microorganisms™ (EM1)**. However, there are other microbial cultures (eg. VAM) in the market that could be used especially in specialised formulations.

The microbes used in these formulations are **beneficial microbes and primarily anaerobic**.

The information provided below assumes that the user of the information has a good understanding of:

- Biology and the general types of microbes and their function
- Microbial balancing theory and practices
- Fermentation techniques

This specialised knowledge and any other additional information is available at www.phion.com.au, email rob@phion.com.au or ring 02-48428182 to obtain the necessary papers.

The information included in this paper is basic, albeit set within some special knowledge base for the practitioner. In the initial stages there would some value for people with little experience in making microbial formulations to visit www.phion.com.au and see what is on offer through **microbial balancing products, enhancer ingredients** for microbial formulations, **product application notes**,

and **papers** on soil, plant, water, air, animal and human health. Specialised papers are added to the BLOG area on the **Phi'on** website every week, and includes an area for biological farming and gardening.

Ongoing and specialised consultancy services can be provided for a set fee for a given time. Contact rob@phion.com.au or ring 02-48428182 for details. This includes **practical workshops or demonstrations** for individuals and groups.

The specialist knowledge to make animal and human probiotics is not discussed in this paper or on the **Phi'on** website. This area of formulation requires specialist knowledge, experience, ingredients and techniques and contains considerable intellectual property (IP).

Basic equipment requirements

There are some basic requirements before embarking on the preparation of microbial formulations. This includes:

- Fermentation containers (20-60 Litres) that are usually available as beer brewing equipment
- Microbial mother culture (starter culture). Acquire the **Effective Microorganisms™ (EM1)** from www.phion.com.au (02-48428182). Other suppliers are available within Australia and a search on the Internet will provide a list of EM1 distributors.
- Mixing buckets or containers (10-60L) for mixing ingredients for specialist formulations
- Supply of molasses or raw sugar (available in 20L pails)
- A source for additional ingredients for specialised formulations (see below)
- A warm area that is out of direct sunlight for storing the fermentation containers.
- A wooden paddle for stirring the formulations
- A digital pH meter for checking the progress of the fermentation.

Foundation formulation

The ingredients are:

- EM1
- Molasses or raw sugar
- Water (good quality spring, groundwater, or rainwater and not chlorinated water)

Preparation technique:

- In a 20-30L fermentation container (buy from any brewing outlet and add a tap for pouring) add $\frac{3}{4}$ of the volume with water
- Dilute 5-10% of volume or 2-3 kg of the molasses or raw sugar into warm water and add to the water in the fermentation container; and stir well for 3-5 minutes (anti-clockwise)
- Add 5-10% or 2-3L of EM1 to the water and molasses mix and stir well for 5 minutes.
- Put on the lid and leave container in a warm location with no direct sunlight.
- Fermentation will occur over time (2-6 weeks) at a rate dependent on temperature (38°C is ideal) however this cannot be always achieved and therefore the fermentation will take longer (say 4-6 weeks)

- Expect a yeast crust to form within 1-2 weeks and this is normal
- The product will be ready when the pH reaches 3.8-3.2.

The result after 2- 6 weeks will be a fermented microbial formulation that is ready to use and has multiple application in this expanded (fermented) form.

Applications

The foundation microbial formulation is a concentrate and can be applied, depending on application, as a concentrate or in a diluted form, as follows:

- **Soil and plant conditioner**, 1:9 ratio of 1 Litre (L) of microbial foundation concentrate to 9 Litres of water. Spray onto the soil or plants. The best times for application are at seed planting (seed inoculants), mid crop (energy boost) and after harvest to replenish soil energy.
- **Compost inoculants**, spray at a ratio of 1:9 and spray 1.5L of the 1:9 mix to 1 cubic metre of compost. Repeat every 28 days.
- **Water conditioner**, spray at a ratio of 1:9 at the edge of the water body (eg. pond or dam) and into the drinking water of animals.
- **Air conditioner**, spray at a ratio of 1:9 into the air. This is effective against odours or smells in animal enclosures, animal urine spots, and most industrial or agricultural surfaces.

Specialist Formulations

This is the opportunity to use your intuition or imagination based on an understanding of biological processes. There is no limit to the formulations that can be produced from this innovative process.

The key ingredient is to set an objective for the application of the product and design a recipe. Then it is up to your imagination.

These formulations can take on two forms:

- Adding additional ingredients to the **foundation formulation**.
- Formulating a range of organic ingredients to extract nutrients and minerals in water and then adding a % of the **foundation formulation** (usually < than 10% of **foundation formulation**) to this new formulation. Also, see notes below on how to make and use **Starter Cultures** in formulations.

Adding additional ingredients to the foundation formulation

Additional ingredients can be added to a foundation formulation during the fermentation process. However, care is required here to ensure that the % added will not adversely change the fermentation outcome (ie. achieving an end pH of between 3.8- 3.2).

Experience indicates two directions:

- Only add minimal ingredients at the start of the fermentation of a foundation formulation
- There is greater scope to add more ingredients towards the end of the fermentation of the foundation formulation.

The key to success is to know the starting pH of the ingredients. For example, if you are adding phosphoric acid to induce phosphorous in the formulation, just remember that the starting pH of this acid might be between 1-2 and this acid then needs to be diluted to a pH of probably 3-4 before it goes into the microbial formulation. Otherwise the fermentation might crash with an additive pH between 1-2.

Preferably, add only organic materials (liquid or solid). Solid materials should be held in a fine stocking or similar bag material. It is best to start with small % of less than 2% by volume for each ingredient and then work from there to check outcomes. In the case of the initial additives to the foundation formulation, the total additives volume should be kept to less than 5% of the total volume of the formulation (ie. less than 1.5L in 30L)

The potential ingredients to the foundation formulation are:

- EM2 to soil, compost, plant and drinking water formulations
- EM3 to waste water treatments
- Liquid seaweed
- Liquid fish concentrates
- Liquid trace minerals
- Liquid mineral water derived from rock dust (powder)
- A range of acids (phosphoric, citric, malic, etc.) depending on the objective of the formulation
- Liquid fermented herb extracts
- Microbe **starter culture** derived and evolved through the addition of waste from the bottom of a completed fermentation (includes the nutrients from dead microbes)
- Compost tea
- Liquid ORMUS
- Colloidal minerals (eg. copper and silver)
- Other liquid ingredients derived from separate and specialist fermentations as outlined below.

Creating an enhancer formulation from organic ingredients

This approach requires experimentation, trialling, observation, innovation and loads of patience.

The objective here is to create a liquid formulation that has a special application for soil, plants, water and air.

The starting process can be undertaken in a bucket, clear plastic garbage bin or container that is not a fermentation container. However, the process will need to end with the **foundation formulation being added to this mixture for final fermentation in a fermentation container** at a point in time when the mixture is ready for fermentation.

Recipe types and potential ingredients

Generally, these specialised formulations fall into the following categories:

- Fungi formulations derived from a pristine, fungi rich soil under either natural grassland, woodland/ forest, and commercial mycorrhizal (eg. VAM, fungi) cultures

- Trace mineral formulation with trace minerals (eg. silicates) captured from a wide range of sources including sea minerals, rock dust, diatomaceous clay, zeolite, carbonates, fulvic and humic acid, etc.
- A *terra preta* like soil conditioner comprising charcoal, sea minerals, manures, clays, ORMUS, etc.
- Fermented herb extracts (FHE) that combine herbs with properties that fit the intent of the formulation (eg. plant resilience, soil nutrients, hormones, etc.)
- Soil litter formulation that combines the microbial rich litter of grassland, woodlands and forests with trace minerals, charcoal, manures, clays, ash, etc.

Technique in developing the formulation

1. The ingredients are mixed into a container with water and stirred
2. The mixture is left for a period until the water is saturated with colloids from the ingredients. The time required for this process is not defined however it can take 4-6 weeks.
3. The water from this mixture is filtered off (from a coarse filter to a fine filter) and the colloidal water is then placed in a fermentation container
4. Add about 5-10% of **foundation formulation** and top up with water
5. Discard the residue (plants, sludge, etc.) from the initial formulation, into compost. This material is great for worms.
6. Leave the brew for about 2-4 weeks to finalise the fermentation, and check the pH to validate the completion of the fermentation cycle or process.

The potential recipes are endless in this approach to fermentation and the materials available are extensive. At least there is fun in devising the recipes and experimenting with the new formulations.

Ultimately these formulations will grow in number for the practitioner and then be available as an ingredient to build new formulations to suit a particular objective in microbial balancing.

General information to improve fermentation outcomes

1. Stir the formulation for about 2-5 minutes for the first 3-4 days to ensure the sugars (eg. molasses) are not settling on the bottom of the container
2. Cover the container with a material to limit direct light penetration into the container.
3. Once the initial stirring has been completed leave the fermentation to undertake its own internal layering and crust development. Any disturbance (ie. unnecessary and frequent stirring and opening the lid to air) during these later stages of fermentation could limit the anaerobic process the outcomes
4. Understand your intent for the formulation and be mindful of this intent when designing, making and nurturing the formulation
5. The rate of fermentation is dependent on temperature. Therefore, maintain a room temperature for the fermentation at or as close to 38°C (body temperature) as possible. This could involve some bottom heat (heat pads), covering the container with insulation (buy silver-foil and padded rolls) or use wool garments, and radiated heat from the sun (to heat the floor or room). Ideally, the temperature should be above 20°C at least.
6. Regularly check the gas release valve on the top of the fermentation container to ensure it has a supply of water (ie. with the goose neck design valve)

7. The fermentation will remain viable in the container for a long period without the need to decanter to other container (eg. 20L drums). Either way, the fermentation when kept under ideal conditions (including the initial supply of food/sugars for the microbes) will be viable over a 12 months period
8. Remember, the fermentation is a living culture. Also, microbes have a life of about 20-60 minutes and can go through 60,000 generations in a year and exchange DNA with other microbes. Therefore, changes will occur in the fermentation over time and no one fermentation will be the same as another. Microbes, like humans need a food supply and comfortable living conditions (ie. they have occupational, health and safety- OH&S needs, as well as us)
9. ALWAYS use fresh and original EM1 in a formulation. EM1 should never be activated to replace the original EM1 as there will be a loss of EM integrity in subsequent activations due to the exchange of DNA between microbes in fermentation. However, activated microbial formulations can be used to make a starter culture that can be added to a formulation at a rate of about 1-2 % of volume
10. Observation and record-keeping are critical in the innovation process of making microbial balancing formulations.