Effective microorganism

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Effective microorganisms (EM) are various blends of common predominantly anaerobic microorganisms in a carbohydrate-rich liquid carrier substrate (molasses nutrient solution) of *Em Research Organization, Inc.*,[1] and its commercial licensees and manufacturers.[2] In commercial agricultural amendments or for environmental applications, EM is purported to support sustainable practices in farming, improve composting operations, and to reduce environmental pollution.[3]

The efficacy of EM on agricultural crops has been studied throughout the world. While some studies stated that *Effective microorganisms* (*EM-A, EM-Bokashi*) show no effect on yield and soil microbiology in field experiments as bio-fertilizer in organic farming. Observed effects relate to the effect of the nutrition rich carrier substrate of the EM preparation.[4][5] However, there are more studies proving the positive effect of EM.[6] For example, an eleven years long application of EM compost showed effects on yield and nutrition of the crops. Compared to the traditional compost and control, yields and nutrition of wheat treated with EM compost was significantly higher.[7]

Beside the application in agriculture, EM has been using in wastewater treatment.

Many of the so-called "pit additives" used for improving the performance of sanitation systems, namely pit latrines, septic tanks and wastewater treatment plants, are also based on EM. Despite the claims made by manufacturers, available studies which have used scientific methods to investigate these additives have come to the conclusion that long-term beneficial effects are not proven.[8][4]

However, many studies also showed the effectiveness of EM application in the reduction such as biochemical or biological oxygen demand (BOD) and chemical oxygen demand (COD) of wastewater.[9][10][11][12]

Contents

Possible constituents

One trademarked product was originally (c. 1985) marketed as EM-1 Microbial Inoculant.[13] Such EM blends include:[14]

- Lactic acid bacteria: Lactobacillus casei
- Photosynthetic bacteria: Rhodopseudomonas palustris
- Yeast: Saccharomyces cerevisiae
- Others: beneficial microorganisms that exist naturally in the environment may thrive in the mixture.

In his presentational essay "EM: A Holistic Technology For Humankind", Higa states:"I developed a mixture of microbes, using the very common species found in all environments as extensively used in the food industry–namely Lactic Acid Bacteria, Photosynthetic Bacteria an[d] Yeasts (..) EM (..) was developed by accident (..)"[15]

Background

The concept of "friendly microorganisms" was developed by Professor Teruo Higa, from the University of the Ryukyus in Okinawa, Japan. He stated in the 1980s that a combination of approximately 80 different microorganisms was capable of positively influencing decomposing organic matter such that it reverts into a "life promoting" process. Higa invoked a "dominance principle" to explain the asserted effects of his "Effective Microorganisms". He claimed that three groups of microorganisms exist: "positive microorganisms" (regeneration), "negative microorganisms" (decomposition, degeneration), "opportunist microorganisms" (regeneration or degeneration). Higa stated that in every medium (soil, water, air, the human intestine), the ratio of

"positive" and "negative" microorganisms was critical, since the opportunist microorganisms followed the trend to regeneration or degeneration. Therefore, he claimed that it was possible to positively influence the given media by supplementing with "positive" microorganisms.

Validation attempts

The concept has been challenged and no scientific studies support its main claims. This was acknowledged by Higa in a 1994 paper co-authored by Higa and soil microbiologist James F Parr. They conclude "*the main limitation...is the problem of reproducibility and lack of consistent results.*".[3]

Various experimenters have examined the use of EM in making organic fertilizers and investigated the effects of the fermented organic fertilizer on soil fertility and crop growth, not distinguishing the effects of the microorganisms in the EM treatments from the effect of the EM nutrient solution in the carrier substrate. The resulting effects on crop growth depend nonspecifically upon multiple factors, including effects of the introduced EM nutrient solution with microorganisms, effects of the naturally microorganism-rich bio-organic fraction in the soil, and indirect effects of microbially-synthesized metabolites (e.g., phytohormones and growth regulators).[16][17][18][19][20][21]

The effectiveness of ″Effective Microorganisms (EM)″ was investigated scientifically in an organic farming field experiment between 2003-2006 at Zürich, Switzerland, differentiating the effects of the EM microorganisms from the effects of the EM nutrient solution in the carrier substrate of the EM treatments. "The experiment was arranged to separate the effect of the microorganisms in the EM treatments (EM-Bokashi and EM-A) from its substrate (sterilized treatments)." EM microorganisms showed no effect on yield and soil microbiology as bio-fertilizer in organic farming. Observed effects related to the effect of the nutrition rich carrier substrate of the EM preparations. "Hence ‘Effective Microorganisms’ will not be able to improve yields and soil quality in mid term (3 years) in organic arable farming."[4][5]

In a study (2010), Factura et al. collected human fecal matter in airtight buckets (Bokashi-dry toilet) over several weeks, adding a mix of biochar, lime and soil after each deposit of fecal matter. Two inoculants were tested—sauerkraut juice (pickled sour cabbage) and commercial EM. The combination of charcoal and inoculant was very effective in suppressing odors and stabilizing the material. EM had no advantage over sauerkraut juice.[22]

Due to the fact that only very few studies exist which have used scientific methods to investigate additives based on EM, any claims made by manufacturers regarding long-term beneficial effects need to be treated with care.

However, A review article (2013), which studies the nature of EM and the effect of EM on growth, yield, quality, and protection of vegetable plants, conclude “in 70% of published studies, it was concluded that EM had a positive effect on growth of vegetable, while, in the other 30%, they had no significant influence.[6]

In Agriculture, the effect of long term application of EM compost for soil fertility and crop yield improvement was investigated at China Agricultural University from 1993 to 2013. This filed experiment show that “The application of EM in combination with compost significantly increased wheat straw biomass, grain yield, straw and grain nutrition compared with traditional compost and control treatment.” Also, the experiment indicates the significant efficacy of EM on organic nutrition sources.[7]

In water treatment, Abdel-Shafy, H.I et al. (2014) examined the different hybrid treatment process for handling grey water for reuse. This study prove the reduction of TSS, COD, and BOD with addition of EM. Furthermore, it states that “Addition of effective micro-organisms (EM) to the raw greywater enhance the settling and aeration process effectively” and “increasing the EM dose to 1.5ml/L and settling time up to 4.5 h followed by aeration for 90 min could improve the final effluent up to the permissible level”. This final effluent meets the ‘Egyptian Guideline’ for unrestricted water reuse..[9]

In addition, the effect of EM on reduction of COD and BOD of wastewater is proved in the studies with Yamuna waste water (the river of the Ganges in northern India) and the rubber processing wastewater. [10][11] Namsivayama. S.K.R et al. (2011) also illustrates that “The result of the experiment shows that EM has the potential to improve the effectiveness of treatment of domestic wastes”. [12]

Applications

EM-Bokashi, invented and marketed by Higa, uses commercial EM to ferment organic kitchen waste. Treatments with EM-Bokashi show no effects on soil microbiology or as bio-fertilizer which are caused by the EM microorganisms. Observed effects relate to the effect of the nutrition rich compost carrier substrate of the EM-Bokashi preparation.[4][5] Natural Yogurt, or Sauerkraut juice (pickled sour cabbage) can be successfully substituted for commercial *EM-bokashi* bran.[23][24]

In a community course of the Christchurch city council, New Zealand, 4-13 year old students were invited to "learn the science behind reducing and utilising organic waste as a resource by turning it into natural fertilisers",[25] using EM in Bokashi composting for home kitchen waste at the EcoDepot/EcoDrop.[26]

In India, effective microorganisms have been used in an attempt to treat some sewage-polluted lakes in Bangalore in 2015.[27]

After the Bangkok floods of 2011 effective microorganisms were used in an attempt to treat polluted water.[28]

Scientific methods to investigate applications of waste water additives have come to the conclusion that long-term beneficial effects are not proven.[8]

Pit additives used for improving the performance of sanitation systems do not work, because "the quantity of bacteria introduced to the pit by dosing additives is insignificant compared to the number already present in the faecal sludge. Similarly, while some additives operate on the logic of adding more nutrients to the sludge to feed bacteria and encourage their growth, faecal sludge is already rich in nutrients."[8]

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