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Review

Production of effective microorganism using *halal*-based sources: A review

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Contemporary Malaysia faces rapid population growth that will increase competition for land and water resources for industrial use and urban growth. Solutions are needed to increase agricultural productivity to combat hunger and poverty. Since the agriculture sector has long been the backbone of the economy, the nation has found effective microorganism (EM) technology that has potential use in developing a sustainable agriculture sector. Malaysia is recognized as a modern Islamic country; citizens have concerns regarding *halal* issues associated with EM ingredients, which are not clearly mentioned by the manufacturer. Hence, a *halal*-based source is suggested in the utilization of EM technology. This study presents the development and applications of EMs that are not restricted to the agriculture system.

Key words: Component, effective microorganisms (EM), agriculture, halal-based source.

INTRODUCTION

In recent years, with focus on feeding a rapidly growing human population, Malaysia has jeopardized the environment and its natural resources, which are already under great stress. Consequently, off-farm input (example, fertilizers and pesticides) plays an important role in food production. However, Peter Triantafillou, a lecturer at the Royal Veterinary and Agricultural University in Denmark, reported that the intensive pesticide used in Malaysian agriculture has caused serious public health problems, and it has been heavily criticized for more than two decades. However, the government remains committed to the use of these pesticides as part of its economic development (Pesticide News, unpublised observation). A recent study by Shah and Devkota (2009) also revealed that pesticide residues had contaminated soil in the grounds of a nearby school and were having adverse health effects on local school children. Other factors such as excessive soil erosion, the associated transport of sediment, and improper treatment of human and animal waste also has caused serious environmental and social problems throughout the world. Hence, the public has become increasingly concerned about possible health hazards due to serious future uncertainty about water quality. All these problems need solutions to maintain and possibly enhance both the quality of the world's environment and the provision of food for humankind and all forms of life on earth. Considering such a point of view, the answer may lie in the widespread use of effective microorganisms (EM). The concept of effective microorganisms was developed by Japanese horticulturist, Teuro Higa of the University of Ryukyus in Japan. He reported in the 1970s that a combination of approximately 80 different microorganisms is capable of positively influencing decomposing organic matter such that it reverts to a life-promoting process. His studies have shown that EM may have a number of applications,

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including agriculture, livestock, gardening, landscaping, composting, bioremediation, cleaning septic tanks, algae control and household uses (Higa and Parr, 1994).

Successful use of EM depends on suitable formulation techniques. EM can show better performance if it is mixed with suitable ingredients that act as nutrients, adhesives or wetting agents (Sekeran et al., 2005). Consequently, researchers have shown considerable interest in the possible use of inoculants of beneficial microorganisms and organic fertilizer (example animal manure) in the development of agriculture. Hanekon et al. (1999) highlighted the potential of using EM to treat pig manure prior to feeding it to fish. Thus, predominantly, Muslim consumers who are constrained in handling pig manure are dealing with the halalness of the product.

Today, Muslim consumers are paying increased attention to their halalness. This is very good in terms of Islamic practices and faith. Hence, it has long been a stated goal of the Malaysian government to establish Malaysia as a global halal hub for the promotion, distribution and production of halal products and provide services to Muslim countries throughout the world (Maheran et al., 2009). According to Mian and Chaudry (1994), if genetic modifications improve product flavor, color, texture, composition, etc., but do not alter the way such products are metabolized by the human body, and are otherwise safe to consume, there might not be any acceptance problems by Muslims. In this context, the use of genetically modified organisms such as EM has raised concerns about their halalness. To date, no research has been carried out on halal issues regarding the production of EM.

EFFECTIVE MICROORGANISM TECHNOLOGY

Professor Higa, University of Ryukyus, Okinawa, Japan, developed the first batch of effective microorganisms, which was eventually called EM, in 1980 (Higa and Parr, 1994). It is available in a liquid concentrate form and produced through a natural process of fermentation; it is not chemically synthesized or genetically engineered. EM is a combination of various beneficial, naturally occurring microorganisms mostly used for or found in food. It is produced in vats from cultivation of more than 80 varieties of microorganisms. The microorganisms are drawn from 10 genera belonging to 5 different families: *Lactobacillus plantarum, Lactobacillus casei* and *Streptoccus lactis* (lactic acid bacteria), *Rhodopseudomonas palustrus* and *Rhodobacter spaeroides* (photosynthetic bacteria), *Saccharomyces* cerevisiae and *Candida utilis* (yeasts), *Streptomyces albus* and *Streptomyces griseus* (actinomycetes), and *Aspergillus oryzae, Penicillium* sp. and *Mucor hiemalis* (fermenting fungi) (Diver et al., 2001).

Originally, EM was available in a dormant state and required activation before application. Activation involved the addition of water and jaggery (molasses) to dormant EM. The mixture is then fermented at ambient temperature for 8 to 10 days. During the period of activation, a white layer of *Actinomycetes* forms on the top of the solution with a pleasant smell. The pH is also a determining factor and should be below 4.0 (Sekeran et al., 2005).

Based on previous research, most of the raw materials of EM liquid concentrate are not clearly stated and identified since they have been manufactured by different companies. In particular, there is no certainty regarding the sources of EM and their *halalness*. Considering such a point of view, these unclear circumstances might give rise to *halal* questions among predominantly Muslim consumers. Thus, developing EM from *halal*-based sources (example, fruits) is suggested rather than importing EM stock from Japan.

APPLICATION OF EFFECTIVE MICROORGANISM TECHNOLOGY

EM technology involves growing, applying, managing and re-establishing high populations of beneficial microorganisms in an environment or system. The use of effective microorganism technology has broadened in the last two decades from agriculture to water treatment, odor control, animal husbandry, human health, and other numerous industrial treatments (Higa et al., 1996).

EM in environmental management

A major problem facing municipalities throughout the world is the treatment, disposal and/or recycling of solid wastes. Solutions using EM developed in Okinawa in the 1970s have been used for environmental management (Higa, 1998). In countries such as Australia and many nations of Europe and Asia, even Japan, EM-based household and industrial waste management products are used quite successfully. The implementation of kitchen composting systems has helped to manage kitchen waste and generated rich fertilizer, thus eliminating the need for chemical fertilizers (Freitag et al., 2002). There is also investigation into the potential of EM to lower the lipid content of lipid-rich food debris wastewater (Siripornadulsil et al., 2008).

Since clean water resources are crucial to human health and the natural environment, and play a key role in economic growth and development, EM technology may help mitigate water crisis by purifying water for recycling. EM acts to purify wastewater by devouring all of its toxins and the stench of solid waste is eliminated almost immediately. Therefore, Kurihara et al. (1990) reported that EM mud balls adopted locally are emerging as one of the environmental solutions to reduce water pollutants and thus improve water quality in the rivers and drains. In addition, EM also has the ability to absorb toxic gases (example, hydrogen sulphide and ammonia) and convert them into organic acids, thereby eliminating their foul odor (Eduardo, 2007 unpublished). Thus, the environment of barns and animal hygiene are both improved. Moreover, after the recent natural disaster in Asia, the tsunami, EM technology was successfully used to mitigate the smells. EM technology proved effective in odor control and sanitation management.

Composting also has been studied, mostly in treating municipal sewage sludge and solid wastes. Sprinkling an EM solution on material accelerates the breakdown of organic matter and thus requires less time than the natural process of composting. Use of EM solutions in biofertilizer preparation also helps to increase the number of beneficial microorganisms in the soil; this in turn improves the soil's microbial health and promotes a healthy environment for plants (Boraste et al., 2009). In another way, Freitag et al. (2002) also highlighted the introduction of EM into anaerobic treatment facilities to reduce the unpleasant by-products of the decomposition and the production of residual sludge. Qasim et al. (1997) and Akbar et al. (1996) also proved that EM has the potential to deoxidize heavy metals and convert them into organo-metallic compounds, which are not harmful to human or animal health.

EM in agriculture

Numerous EM application experiments have also been conducted on various soils, grain, oil crops, fruit trees and vegetables; when studied as an additive in poultry and livestock feeds in Jiangsu, Zhejiang, Jiangxi and Henan provinces, researchers found that when applied with manure, EM can reduce the need for chemical fertilizers and pesticides, which improves a farmer's profitability and protects the environment (Zhao, 1995 unpublished observation).

Research has shown that the inoculation of EM cultures to the soil/plant ecosystem can improve soil quality, soil health and the growth, yield and quality of crops. EM is used in agriculture via a number of methods. It is inoculated into the rhizosphere (around the root) with the intention to regenerate soil, increase yields or improve nutrient content of the crop. Sangakkara et al. (2002) has reported that EM application increases the release of nutrients from organic matter, enhances photosynthesis and protein activity, and provides better penetration of roots by improving physical properties of soils. Research on papaya in Brazil (Chagas et al., 1999), herbage grasses in Holland (Bruggenwert et al., 2001) and Austria (Hader et al., 1999), vegetables in New Zealand and Sri Lanka (Daly et al., 1999) and apples in Japan (Fujita et.al, 2000) illustrate this phenomenon clearly.

EM has microbes with an acid-producing nature; they have the ability to maintain fitness and enhance the digestion, nutrient absorption and assimilation abilities of animals when it is added to feeds and drinking water. Therefore, Li Wei-Jionge et al. (1994) found that EM contains many naturally occurring beneficial microorganisms, which are both oxybiotic and anaerobic microbes. After entering the body of animals as foodstuffs, these microbes may multiply rapidly and they not only check the growth of pathogenic microbes but also form the normal microbial group within the host body to produce its main vitamins, provide nutrients and prevent attacks from pathogens. With better-feed utilization and improved animal well-being, there is a marked improvement in the growth of animals. In Pakistan, EM also appeared to be a safe growth promoter for chickens and carried no associated risks when applied to promote growth and potentiate the immune response in chickens (Ahmed, 1996 unpublished observation).

In 1990, research on nature farming using EM was started in Malaysia. Sharifuddin et al. (1993) indicated that the use of organic amendments, particularly chicken dung, with EM can significantly increase the yield of production of sweet corn and leaf mustard. Crop residues and animal wastes can also be effectively composted to produce biofertilizers for development of agriculture (Bruchem et al., 1999; Shintani et al., 2000).

CONCLUSION

Perceiving bacteria as dangerous is now bringing greater awareness of the microbial world as a fundamental element of life. Since the present natural environment is so deteriorated, more EM technologies are being used in developing the agriculture and environment sectors. EM finds fairly wide application in many areas of human society because of its eco-friendly nature, and it requires less inputs: cost and capital. EM technology is based on the power of nature, strengthens the intrinsic power of agricultural soil, minimizes the loss of energy in recycling of farm products, suppresses the incidence of insect pests and plant diseases, and produces more foods that enhance human health. Thus, EM technology can solve agricultural problems and contribute to food production and environmental protection in Malaysia.

Halal products are fast gaining worldwide recognition. This is not merely because the number of Muslims is growing, but more significantly, because *halal* is being recognized as a new benchmark for safety and quality assurance. Producers of EM need to understand *halal*-based sources as well as associated production processes to meet consumers' expectations. There is no compromise when it comes to the question of *halal* for Muslims, as it is one of the tenets of Islam. Thus, the idea to develop EM from *halal*-based sources is quite interesting to introduce the concept of *halal* in EM technology and to sustain agriculture and the environment.

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