

Method for Radiation Sterilization of Agriculture Waste for Producing Biofertilizer Carrier

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Introduction

❑ The Biofertilizer

- ✓ Substances containing living microorganisms that promote growth to the host plants. Biofertilizer increases the supply or availability of primary nutrient by their interaction in the rhizosphere.
- ✓ Usually prepared as carrier-based inoculants.

❑ Biofertilizer Market

- ✓ Global biofertilizers market was estimated at USD 590.9 million in 2015 and projected to reach USD 1.23 billion by 2021.
- ✓ Asia Pacific, the estimated Compound Annual Growth Rate (CAGR) will increase up to 13.5% in 2022.

❑ Impact on Malaysian Economic

- ✓ Demand expected to boost in light of regulatory support to incorporate new technologies for increasing crop yield.
- ✓ More potential employment could be created to provide jobs to the people giving an economic impact to the nation.
- ✓ Will benefit about an estimated 1 million farmers in Malaysia (Overview of The Agriculture Sector in Malaysia, DOA).

❑ Characteristics of Biofertilizer Carrier

- ✓ Inexpensive & easily available.
- ✓ High inorganic matter content & free from microbial contamination.
- ✓ Can optimise the growth of the biofertilizer microorganisms.

❑ The Potential of Mushrooms Spent Compost (MSC) as Biofertilizer Carrier

- ✓ Agriculture waste such as empty fruit bunch, paddy straw and mushroom spent compost (MSC) are available abundantly and not fully utilised.
- ✓ Could be converted into useful products.
- ✓ Could resolve environmental issue arising from disposal of those wastes such as burning.
- ✓ Good physical properties of water holding capacity, soil pH and soil porosity (Shitole et al., 2014).
- ✓ Great amount of macronutrients like nitrogen, phosphorous and potassium (NPK) and other trace elements (Kim et al., 2011).

❑ Sterilization of Carrier for Biofertilizer

- ✓ To keep high number of inoculum bacteria on carrier for long storage period.
- ✓ To offer nutrients and place to the inoculant bacteria against the occupation by the contaminated and/ or native bacteria.
- ✓ To prevent undesirable dispersion of pathogenic bacteria to agriculture waste.

❑ The Innovation- Method for Radiation Sterilization of Agriculture Waste for Producing Biofertilizer Carrier

This innovation harness the radiation technology for product and process improvement to overcome the conventional sterilization process shortfall. This innovation is based on works on MSC as a potential for biofertilizer carrier and our other previous works (Patent: MY-130294-A & P12013000655)

- ✓ Alternative to conventional heat sterilization for large volume sterilization process.
- ✓ Gamma irradiation - high penetration capability.
- ✓ Environmentally friendly process and product.

Before Innovation



MSC was left abandoned or discarded by burning

The Innovation



MSC after removal of plastic wrapper and fruiting cap



Radiation sterilization of ground MSC



Sterilized MSC used as carrier for plant biofertilizer



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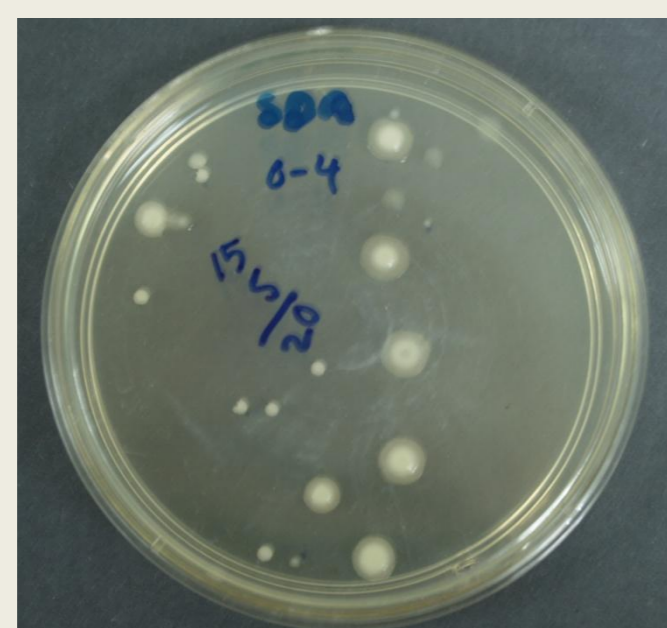
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Features of The Innovation

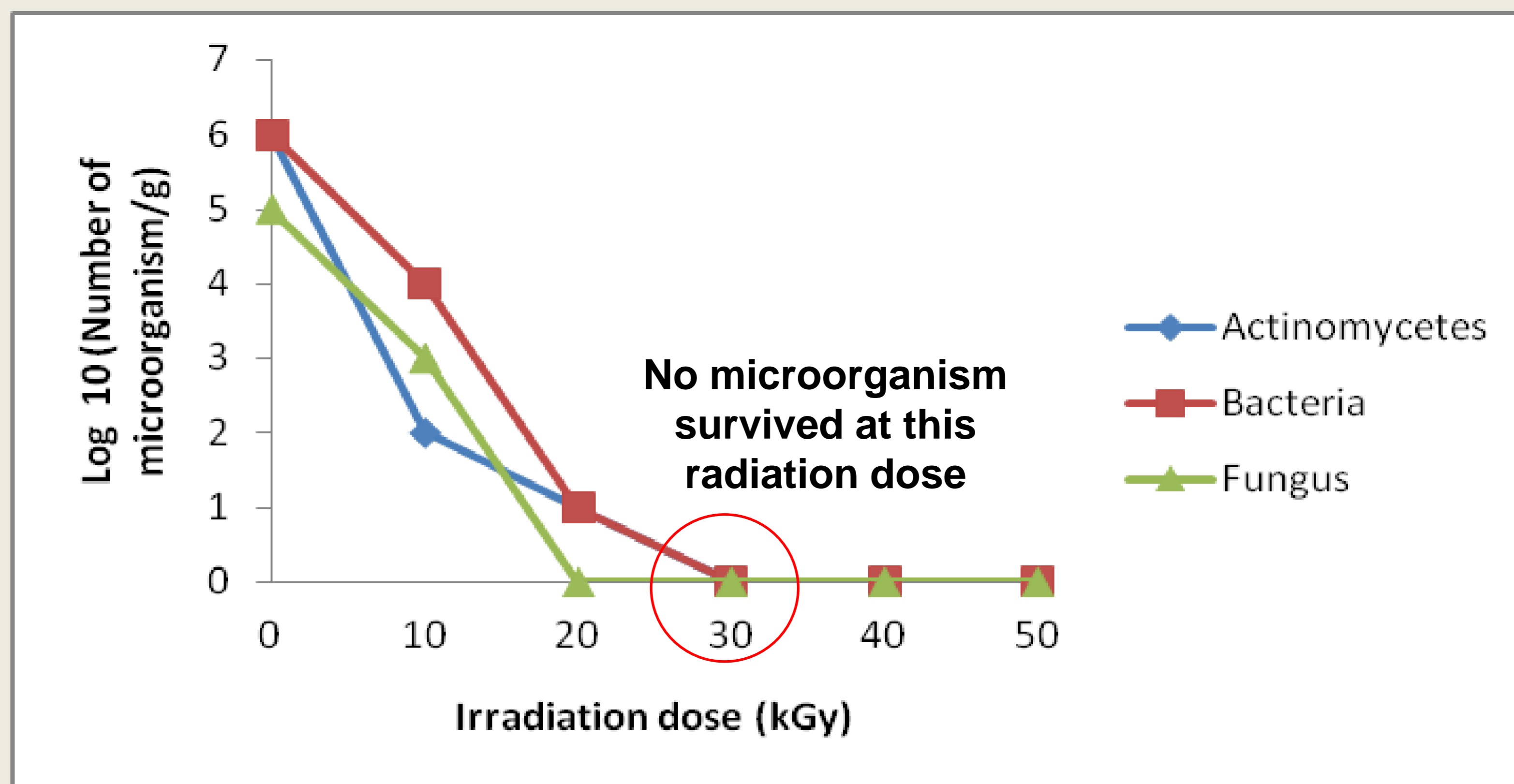
- ✓ Harnessing radiation technology for recycling, green technology and adoption of zero waste philosophy.
- ✓ Large scale sterilization - radiation sterilization is capable of processing large volume base on the irradiator throughput.
- ✓ Sterilization by irradiation will not alter the physical and chemical properties of material, thus preserving the macronutrients for inoculum multiplication.
- ✓ Pasteurization dose at below 10 kGy is an economic dose of radiation treatment process (Nahrul Khair, 1998).
- ✓ Radiation treatment process can ensure the pasteurization/ sterilization uniformity of the carrier due the penetration capability of gamma rays.
- ✓ Material - Better management of agriculture waste. Therefore, utilizing this agriculture waste as biofertilizer carrier could resolve environmental issues arising from disposal of those wastes, such as through burning.
- ✓ Irradiation service is well regulated by governing authority. Therefore, the product is ensured safe to human and environment.



Microorganism colony for non-irradiated



Microorganism colony after gamma irradiation at dose 20 kGy



Survival of microorganisms after sterilization by gamma irradiation

Radiation Sterilization of MSC

- ✓ Low moisture content, approximately 30-40%, is unlikely to produce free radicals.
- ✓ MSC contains degraded cellulosic materials produced in powder form for easily handling.
- ✓ Low density; ensures uniform pasteurization/ sterilization.
- ✓ Low bioburden/ less possibility of recontamination.

Technology Comparison Between Gamma Radiation and Heat Treatment

	Gamma radiation	Heat treatment
Technology	Radiation generated from radioactive source such as cobalt-60 and caesium-137	High pressure and hot water used to raised core temperature
Process parameter	Time	Time, pressure
Penetration	Deep	Surface
Uniformity	High	Low
Effectiveness	High	Low
Cost	Cheaper:RM 400/t	Cost and time consuming: The autoclave consumes high level of electricity and limited in volume
Properties	No effect to physical and chemical properties	Some changes in physical and chemical properties that may produce toxic substance to some bacterial strain
Handling	Easy to handle	Need for re-packaging into double layer HDPE plastic bags.

Opportunities

- ✓ Less reliance on imported chemical fertilizers (many from fossil fuel based sources) – cost savings.
- ✓ Protection of biological assets from plant diseases – healthier plants result in higher yield, longer lifespan and higher productivity.
- ✓ Established high value green and biotechnology products and services have good potential in other palm oil producing countries (Indonesia, Papua New Guinea, Western Africa) – Malaysia as hub for 'bio and green' technologies.
- ✓ Large fertilizer production and customized blends allows for niche product development – good potential for development of organic food industry.
- ✓ Demand for treated organic fertilizers in Japan, Korea, Europe and the USA.

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