Multifunctional liquid biofertilizer as an innovative agronomic input for modern agriculture

Biobaja cecair multifungsi sebagai input agronomi inovatif untuk pertanian moden

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Abstract

Liquid biofertilizer is increasingly available in the market as one of the alternatives to chemical and organic fertilizers as well as solid substrate-based biofertilizers. One of the benefits from biofertilizer is the contribution from population of microorganisms available. These microorganisms may enhance the plant growth and create healthy rhizosphere. The advantage of a liquid biofertilizer is that no solid carrier is needed. These products are also developed for potential application in modern agriculture such as soilless farming systems, viz. fertigation and hydroponics. Traditionally, liquid biofertilizer is produced from fermentation of effective microorganisms which was recommended to be used within three months. Therefore, the development of low-cost and long shelf-life liquid biofertilizers was conducted at Malaysian Nuclear Agency (Nuclear Malaysia). Three biofertilizer inoculums (phosphate solubilising bacteria and plant growth promoting bacteria) were developed into four formulations of liquid biofertilizers. The liquid biofertilizers were kept at low temperatures (9 ± 2 °C) and room temperatures (28 ± 2°C) for shelf-life study. Nutrient broth liquid biofertilizer kept at low temperatures showed significantly high survival rates after storage for six months as compared to other formulations and treatments.

Keywords: Liquid biofertilizer, phosphate solubilising bacteria, plant growth promoting bacteria, shelf life; soilless system

INTRODUCTION

Biofertilizer is a substance containing living microorganisms, which, when applied to seeds, plant surfaces, or soil, colonises the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plants (Vessey, 2003). Biofertilizers usually need a carrier as medium for the microbial inoculants. A
suitable carrier material needs to be inexpensive, easily available, and high in organic matter content, and should have a high water-holding capacity and a favourable H⁺ concentration (Gaind and Gaur, 1990). Furthermore, a good quality carrier should be free from microbial contamination, and can optimise the growth of the biofertilizer microorganisms (Phua et al., 2009a). However, it is not easy to get a carrier that meets the desired qualities. Liquid biofertilizer is the solution to the problems where no solid carrier is needed. Thamizh Vendan and Thangaraju (2007) reported liquid and cyst formulation of *Azospirillum* exhibited better adherence and survival on seeds, seedling roots and in the rhizosphere than the carrier-based forms. This shows that liquid biofertilizer has greater potential than carrier-based biofertilizer. Previous works also showed that liquid biofertilizers increase the yield of chickpea (Kyaw and Khin, 2008); soybean (Tran et al., 2007; Panlada et al., 2007); tomato, chinese cabbage, lettuce and hot pepper (Jee, 2009); pepper and cucumber (Han and Lee, 2006). Liquid biofertilizers also have potential to be applied in modern agriculture such as soilless farming systems, namely fertigation and hydroponics. Jee (2009) reported that liquid biofertilizer EXTN-1 was able to control bacterial wilt of tomato caused by *Ralstonia solanacearum* in hydroponics and increased the yield. Traditionally, liquid biofertilizer is produced from fermentation of effective microorganisms, which was recommended to be used within three months (Hasarin and Viyada, 2008). Therefore, Malaysian Nuclear Agency (Nuclear Malaysia) embarked on the development of low-cost and long shelf-life liquid biofertilizers to be used in an innovative and high productivity cultivation system.

**MATERIALS AND METHODS**

Three isolates, namely AP1, AP2 and AP3 were isolated from compost samples by using the ten-fold serial dilutions technique. Isolate AP1 is phosphate solubilising bacteria that is antagonistic to bacterial wilt pathogen; isolate AP2 is a plant growth promoter and phosphate solubilising bacteria and isolate AP3 is a phosphate solubilising bacteria. These isolates were grown in sterile distilled water, Nutrient Broth (NB), Luria-Bertani Broth (LB) and Tryptic Soy Broth (TSB) respectively. These liquid biofertilizer were cultured for 48 hours on an orbital shaker. These products were then incubated at low temperatures (9 ± 2 °C) and room temperatures (28 ± 2 °C) for six months. Samples were drawn at regular intervals for microbial analysis. The shelf life of all isolates was studied by dilution plating. There were four replicates for each treatment.

**RESULTS AND DISCUSSION**

Figure 1 shows log number of viable cells of four types of liquid biofertilizers kept at room temperature (28 ± 2 °C) and low temperature (9 ± 2°C). After six months, liquid biofertilizers that were kept at low temperature (9 ± 2 °C) had significantly higher viable cells than those kept at room temperature (28 ± 2 °C). However, after six months storage there was no viable cell from liquid biofertilizer CLP1 (isolate AP1 grown in Luria-Bertani Broth and kept at low temperature). Nutrient broth liquid biofertilizer kept at low temperatures showed significantly high survival rates after storage for six months as compared to other formulations and treatments. Viable cells for CNP1, CNP2 and CNP3 were 2.90 x 10⁶, 2.37 x 10⁸ and 1.72 x 10⁷, respectively. Viable cells for carrier-based biofertilizers CAP1, CAP2 and CAP3 were at 7.29 x 10⁶, 1.08 x 10⁶ and 6.03 x 10⁵, respectively (Phua et al., 2009b). These results show that the liquid biofertilizers have more viable cells than carrier-based biofertilizers. In addition, no carrier is needed for liquid biofertilizers, which will save cost. Therefore, the liquid biofertilizer products could be promoted as low-cost and long shelf-life products.
Figure 1: Shelf life of liquid biofertilizer products incubated at different temperatures after six months storage

Keys:  
- **Storage at room temperature** (28 ± 2 °C)  
  - AP1, AP2 and AP3 = Sterile distilled water as medium  
  - NP1, NP2 and NP3 = Nutrient Broth as medium  
  - LP1, LP2 and LP3 = Luria-Bertani Broth as medium  
  - TP1, TP2 and TP3 = Tryptic Soy Broth as medium

- **Storage at low temperature** (9 ± 2 °C)  
  - CAP1, CAP2 and CAP3 = Sterile distilled water as medium  
  - CNP1, CNP2 and CNP3 = Nutrient Broth as medium  
  - CLP1, CLP2 and CLP3 = Luria-Bertani Broth as medium  
  - CTP1, CTP2 and CTP3 = Tryptic Soy Broth as medium

**CONCLUSION**

Development of low-cost and long shelf-life liquid biofertilizers was conducted at Malaysian Nuclear Agency (Nuclear Malaysia). Three biofertilizer inoculums were developed into four formulations of liquid biofertilizers. Nutrient Broth liquid biofertilizer kept at low temperatures showed significantly high survival rates after storage for six months as compared to other formulations and treatments. Since no carrier is needed for these liquid biofertilizers they have great potential to be promoted as low-cost and long shelf-life products suitable for soilless and other innovation cultivation system in the Malaysian agricultural industry.

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