



Liquid vs Carrier-Based Biofertilizers: Efficiency and Field Performance

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INTRODUCTION

Biofertilizers are living microorganisms that enhance plant growth by increasing the availability of nutrients in the soil. They play an important role in sustainable agriculture by reducing the dependence on chemical fertilizers and improving soil health. Microorganisms such as *Rhizobium*, *Azotobacter*, *Azospirillum*, phosphate-solubilizing bacteria (PSB), and mycorrhiza are commonly used as biofertilizers.

Biofertilizers are generally available in two main forms: liquid biofertilizers and carrier-based biofertilizers. Carrier-based formulations were developed earlier and contain microbial cultures mixed with solid materials such as peat, lignite, charcoal, or vermiculite. Liquid biofertilizers are a more recent innovation in which beneficial microorganisms are suspended in a liquid medium that provides nutrients and protection for longer survival.

Both types aim to improve crop productivity and soil fertility, but they differ in terms of shelf life, microbial population, field performance, storage, and application methods. With increasing interest in sustainable farming and organic agriculture, biofertilizers have gained significant attention among farmers and researchers. This article discusses the concept, characteristics, efficiency, advantages, limitations, and field performance of liquid and carrier-based biofertilizers, as well as their role in improving agricultural productivity and environmental sustainability.

2. Concept of Biofertilizers

Biofertilizers are microbial inoculants containing living cells of beneficial microorganisms that promote plant growth by increasing the supply or availability of primary nutrients to crops. These microorganisms colonize the rhizosphere (root zone) or plant tissues and enhance nutrient uptake through biological processes such as nitrogen fixation, phosphorus solubilization, and production of growth-promoting substances.

Biofertilizers improve soil fertility and plant health in several ways. Nitrogen-fixing bacteria convert atmospheric nitrogen into a form that plants can absorb. Phosphate-solubilizing microorganisms release phosphorus from insoluble compounds in the soil. Mycorrhizal fungi enhance water and nutrient absorption by forming symbiotic associations with plant roots. The application of biofertilizers also improves soil structure, microbial diversity, and long-term

soil productivity. Compared with chemical fertilizers, biofertilizers are environmentally friendly and help reduce soil pollution. They are widely used in crops such as cereals, pulses, oilseeds, fruits, vegetables, and plantation crops.

Based on the type of formulation, biofertilizers are broadly classified into carrier-based biofertilizers and liquid biofertilizers, each having distinct properties and performance characteristics.



3. Carrier-Based Biofertilizers

Carrier-based biofertilizers are traditional formulations where beneficial microorganisms are mixed with a solid carrier material. Common carrier materials include peat, lignite, charcoal, vermiculite, or compost. These materials provide a surface and nutrients for microbial survival and are usually sterilized before inoculation with microbial cultures.

Carrier-based biofertilizers are generally applied through seed treatment, seedling dipping, or soil application. They have been widely used for several decades

due to their simple production methods and low cost.

However, carrier-based formulations have certain limitations. The shelf life is usually limited to about 6 months, and the microbial population may decline rapidly under unfavorable storage conditions such as high temperature or humidity. Maintaining the quality of carrier materials is also important, as contamination can reduce the effectiveness of the product. Despite these limitations, carrier-based biofertilizers remain popular in many developing countries because they are relatively inexpensive and easy to produce locally.

4. Liquid Biofertilizers

Liquid biofertilizers are advanced formulations in which beneficial microorganisms are suspended in a nutrient-rich liquid medium. The liquid medium contains additives that help protect microbial cells and maintain their viability for longer periods.

One of the major advantages of liquid biofertilizers is their longer shelf life, which can extend up to 12–24 months under proper storage conditions. They also contain a higher concentration of microorganisms compared with carrier-based products.

Liquid biofertilizers are easy to apply through seed treatment, soil application, drip irrigation, or foliar spray. The microorganisms in liquid form adapt quickly to soil conditions and establish better colonization in the plant root zone.

Another advantage is that liquid formulations are less prone to contamination and can tolerate higher temperatures during storage and transport. Because of these benefits, liquid biofertilizers are increasingly preferred by farmers and agricultural extension agencies.

Liquid Biofertilizer Benefits

	Liquid Azospirillum	Liquid Azotobacter	Liquid Organic Biofertilizer
Yield and Quality	Increased grain weight in rice	Not specified	Increased size and brix in tomatoes
Chemical Inputs	Reduced nitrous-oxide emissions	Reduced nitrous-oxide emissions	Reduced nitrous-oxide emissions
Cost-Effectiveness	Can replace urea and DAP	Can replace urea and DAP	Can replace urea and DAP
Soil Vitality	Lifts soil organic C	Lifts soil organic C	Lifts soil organic C
System Integration	Compatible with multiple systems	Compatible with multiple systems	Compatible with multiple systems

Source: <https://www.bulkgrochem.com/>

5. Efficiency of Liquid vs Carrier-Based Biofertilizers

The efficiency of biofertilizers depends on several factors such as microbial population, survival rate, soil conditions, crop type, and application method. In general, liquid biofertilizers are considered more efficient than carrier-based formulations.

Liquid biofertilizers usually contain a higher microbial count, often around 10^9 cells per milliliter, whereas carrier-based products may have lower populations due to loss of viability during storage. The protective compounds present in liquid formulations help microorganisms survive under stressful environmental conditions.

Another factor influencing efficiency is better root colonization. Liquid biofertilizers spread more uniformly when applied to seeds or soil, enabling microorganisms to establish

quickly in the rhizosphere. This improves nutrient availability and plant growth.

However, carrier-based biofertilizers can still perform effectively when produced and stored properly. In many cases, their efficiency depends largely on the quality of the carrier material and proper handling during transportation and storage.

6. Field Performance

Field performance is an important indicator of the effectiveness of biofertilizers. Numerous studies have shown that both liquid and carrier-based biofertilizers can significantly improve crop growth and yield when used correctly.

Liquid biofertilizers often show better field performance due to higher microbial survival and rapid colonization of plant roots. They are particularly effective in modern irrigation systems such as drip irrigation, where they can be easily applied along with water.

Carrier-based biofertilizers also provide positive results in field conditions, especially when applied through seed treatment or soil mixing. They have been successfully used in crops such as legumes, cereals, and vegetables to enhance nitrogen fixation and phosphorus availability.

In general, the effectiveness of both formulations depends on proper application methods, soil conditions, and compatibility with crop species.

7. Advantages and Limitations

Both liquid and carrier-based biofertilizers have several advantages and limitations that influence their adoption and effectiveness in agricultural practices. Understanding these aspects helps farmers and researchers select the most suitable formulation for improving crop productivity and soil health.

Advantages of Liquid Biofertilizers

Liquid biofertilizers offer several benefits due to their advanced formulation and improved microbial stability. One of the major advantages is their longer shelf life, which generally ranges from 12 to 24 months, allowing them to remain effective for a longer period during storage and transportation. They also contain a higher microbial population, ensuring better colonization in the soil and on plant roots. Liquid formulations show better tolerance to temperature fluctuations, which improves the survival of microorganisms under different environmental conditions. In addition, they are easy to apply through various methods such as seed treatment, soil application, and drip irrigation. Another important advantage is the lower risk of contamination, as the liquid medium often contains protective additives that help maintain microbial purity.

Limitations of Liquid Biofertilizers

Despite their advantages, liquid biofertilizers also have certain limitations. Their production cost is relatively higher compared to carrier-based formulations due to the need for specialized equipment and materials. Furthermore, they require proper storage containers and careful handling to maintain microbial viability during storage and distribution.

Advantages of Carrier-Based Biofertilizers

Carrier-based biofertilizers have been widely used for many years and offer several

practical advantages. One of the main benefits is their lower production cost, making them affordable for farmers. They are also easy to manufacture locally using available carrier materials such as peat, lignite, charcoal, or vermiculite. In addition, these formulations are widely available in rural areas, which increases their accessibility to small and marginal farmers.

Limitations of Carrier-Based Biofertilizers

Carrier-based biofertilizers have some limitations that may affect their efficiency. They generally have a shorter shelf life, which reduces their storage stability. The survival of microorganisms during storage is often lower, especially under unfavorable environmental conditions. Moreover, these formulations have a greater risk of contamination, which may reduce their effectiveness in the field.

8. Future Prospects

The increasing demand for sustainable agriculture and environmentally friendly inputs has created significant opportunities for biofertilizer development. Advances in biotechnology and microbial research are helping scientists develop more efficient and stable formulations.

Liquid biofertilizers are expected to become more popular due to their longer shelf life and better field performance. Research is also being conducted to improve carrier materials and develop new formulations that enhance microbial survival.

Government programs promoting organic farming and integrated nutrient management are encouraging the use of biofertilizers among farmers. Training and awareness programs can further improve adoption rates and ensure proper use of these technologies.

CONCLUSION

Biofertilizers are essential components of sustainable agriculture because they enhance soil fertility, reduce dependence on chemical fertilizers, and support environmental conservation. Both liquid and carrier-based biofertilizers play important roles in improving crop productivity. Carrier-based biofertilizers have been widely used for many years due to their low cost and simple production methods. However, they have certain limitations such as shorter shelf life

and lower microbial survival. Liquid biofertilizers represent a more advanced technology with higher microbial populations, longer shelf life, and better field performance.

REFERENCES

- Kaur, R., & Kaur, S. (2023). Carrier-based biofertilizers. In *Metabolomics, proteomes and gene editing approaches in biofertilizer industry* (pp. 57-75). Singapore: Springer Nature Singapore.
- Khandare, R. N., Chandra, R., Pareek, N., & Raverkar, K. P. (2020). Carrier-based and liquid bioinoculants of Azotobacter and PSB saved chemical fertilizers in wheat (*Triticum aestivum* L.) and enhanced soil biological properties in Mollisols. *Journal of Plant Nutrition*, 43(1), 36-50.
- Patil, R., Muttappanavar, R. K., & Jujin, S. A. (2023). Effect of Liquid and Carrier based Biofertilizers on Crop Growth and Soil Properties. *Strategies for Sustainable Agriculture*, 237.
- Richa. (2023). Liquid Bio-Fertilizers: Prospects and Challenges. *Metabolomics, Proteomes and Gene Editing Approaches in Biofertilizer Industry*, 77-99.
- Sarkar, A., Paul, S. K., Banerjee, M., Malik, G. C., & Barat, S. (2023). Studies on Carrier and Liquid Based Bio-Fertilizer on Performance of Lentil (*Lens esculenta*) in Alluvial Soil of West Bengal. *Environment and Ecology*, 41(4C), 2879-2884.