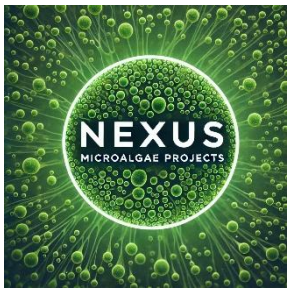

APPLICATIONS OF MICROALGAE IN AGRICULTURE

Biofertilizers

Microalgae are a valuable source of biofertilizers due to their high content of macro and micronutrients essential for plant growth[1][2]. Microalgal biomass can:

- Provide nitrogen, phosphorus, and potassium, as well as micronutrients such as zinc, iron, copper, and manganese[4].
- Act as a slow-release fertilizer, especially for phosphorus, due to its storage in the form of polyphosphates[4].
- Enrich the organic carbon content of the soil[4].

Biostimulants

Biostimulants derived from microalgae can significantly improve crop growth and productivity[1][5]. These effects include:

- Promotion of growth and improvement of crop quality.
- Increased absorption of mineral nutrients.
- Improved tolerance to abiotic stress.
- Faster ripening and higher crop yields.

Biopesticides

Microalgae offer a promising alternative to chemical pesticides[5]:

- They can provide protection against pests and diseases.
- They have broader positive impacts on health and the environment compared to chemical pesticides.
- They can benefit crops even in the absence of biotic stress.

Improved soil quality

The application of microalgal biomass can significantly improve soil health[4][7]:

- Increases soil fertility.
- Reduces erosion and nutrient loss.

- Improves soil quality over time.

Improved product quality

Microalgae-based inputs can improve crop quality in several ways[5]:

- Production of larger fruits.
- Increased content of soluble sugars.
- Extending the shelf life of products.

Practical applications

Microalgal biomass and its derivatives can be applied in various ways[14]:

- As a seed treatment.
- As a foliar spray.
- As a liquid fertilizer for soil irrigation.
- As dry biomass incorporated into the soil.

Importantly, the use of microalgae in agriculture not only benefits crops, but also contributes to environmental sustainability. The production of microalgal biomass can be integrated into wastewater treatment systems, thus promoting a circular economy model in agriculture[13].

In conclusion, microalgae and their biomass offer a wide range of applications in sustainable agriculture, from fertilizing and stimulating growth to protecting against pests and improving soil and crop quality. Its use represents a promising alternative to conventional chemical inputs, with potential benefits for both farmers and the environment.

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ADVANTAGES OF USING MICROALGAE AS A BIOSTIMULANT AND BIOFERTILIZER

Nutritional benefits

- **Complete nutrient intake**: Microalgae provide a wide range of macro and micronutrients essential for plant growth, including nitrogen, phosphorus, potassium, iron and other trace minerals[13].
- **Gradual release**: They act as slow-release fertilizers, especially for phosphorus, allowing for more balanced and sustained plant nutrition[1].

Improved soil health

- **Organic enrichment**: They increase the organic carbon content of the soil, improving its structure and fertility in the long term[12].
- **Erosion prevention**: They produce polysaccharides (mucilage) that can prevent erosion and improve soil structure[2].

Stimulation of plant growth

- **Production of phytohormones**: Microalgae generate bioactive substances such as auxins, gibberellins and cytokinins, which promote plant development[14].
- **Improved rooting**: They stimulate root development, which increases the absorption capacity of nutrients and water by plants[4].

Environmental benefits

- **Pollution reduction**: Being a natural alternative, they reduce dependence on chemical fertilizers, thus reducing the associated environmental pollution[34].
- **CO2 capture**: The use of microalgae as biofertilizers contributes to the capture of carbon dioxide, adding organic matter to the soil and improving it[1].

Increased plant resistance

- **Stress tolerance**: Biostimulants derived from microalgae increase plant tolerance to various types of abiotic stress[4].
- **Strengthening defenses**: By strengthening plants, they make them more resistant to pests and diseases, minimizing the need for additional chemicals[4].

Sustainability and economy

- **Sustainable production**: Microalgae production systems are more viable as they can be grown on waste effluents, promoting a circular economy model[1].
- **Cost-effectiveness**: In the long term, they can be cheaper than conventional chemical fertilizers, especially considering the associated environmental benefits[3].

In conclusion, the use of microalgae as biofertilizers represents a promising and sustainable alternative for modern agriculture. They offer multifaceted benefits ranging from nutritional

improvement of plants to environmental protection, thus contributing to a more balanced and ecosystem-friendly agricultural production.

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