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Potentiality of Biol for the agroecological management of Stevia cultivation: a review

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ABSTRACT

The topic explores the relevance and efficacy of Biol, a liquid biofertilizer obtained from the anaerobic fermentation of manure and organic waste, in the sustainable cultivation of Stevia rebaudiana. This plant, known for its sweetness and low caloric intake, is a popular alternative to traditional sugars, especially valued by people with diabetes and those seeking healthier options. Biol represents an organic and ecological approach to stevia farming, aligned with the principles of agroecology. It provides nutrients and beneficial microorganisms that improve soil fertility and its ability to retain water and nutrients, boosting agronomic efficiency and reducing the need for chemical fertilizers. This method not only contributes to more environmentally friendly agricultural practices, but also improves the resistance of Stevia plants to diseases and pests and increases yield and leaf quality. The use of Biol in Stevia cultivation not only responds to the demand for natural and sustainable products in an environmentally conscious global market, but also promotes climate-smart agricultural management and contributes to food security. This approach underlines the importance of organic and ecological farming methods in the efficient production of high-value crops such as Stevia, highlighting Biol as a significant example of sustainable agricultural innovation. Therefore, a literature review is proposed for this study to gather information on the potential of Biol for agroecological management of Stevia cultivation.

Keywords: Biol, Agriculture Stevia, Agroecological fertilization, Sustainability, Agronomic improvements

INTRODUCTION

The study and application of Biol in the cultivation of Stevia has become increasingly relevant in the context of sustainable agriculture and the growing demand for natural sweeteners. Stevia rebaudiana, known for its sweetness and low caloric intake, has established itself as a popular alternative to traditional sugars, especially among people with diabetes or those looking for healthier options. In this scenario, Biol, a liquid biofertilizer obtained from the anaerobic fermentation of manure and other organic waste, emerges as a key tool in the agroecological management of this crop (Flores & Tapullima, 2022).

However, the incorporation of Biol into Stevia agriculture represents an organic and eco-friendly approach that is aligned with the principles of agroecology. This biofertilizer provides a rich variety of beneficial nutrients and microorganisms, improving soil fertility and its ability to retain water and nutrients (Villca & Mendoza, 2022a). Not only does this boost agronomic efficiency, but it also reduces the need for chemical fertilizers, contributing to more environmentally friendly farming practices.

Biol plays a fundamental role in improving soil quality, resulting in more robust and healthy growth of Stevia plants. At the same time, it strengthens the resistance of these plants to diseases and pests, thus reducing dependence on synthetic chemicals (Viviescas & Sacristán, 2020). In addition, its use in the cultivation of Stevia not only improves the yield and quality of the leaves, but also supports a more sustainable and environmentally friendly agricultural model (Segovia, 2023).

Given the importance of Stevia as a natural sweetener in the food industry, exploring the potential of Biol in its cultivation becomes a crucial topic for modern agriculture. This approach not only addresses the demand for natural and sustainable products in an environmentally conscious global market, but also promotes climate-smart agricultural management and contributes to food security (Morales et al., 2021). Therefore, the use of Biol in Stevia cultivation stands out as a significant example of sustainable agricultural innovation, highlighting the importance of organic and eco-friendly cultivation methods in the efficient production of high-value crops such as Stevia (Hector, et al., 2020).

Indeed, stevia cultivation in Ecuador has stood out as an economical and sustainable alternative for farmers. This plant, native to Paraguay, has adapted well to different altitudes and climates, showing significant potential for diversification of agricultural production (Hector, et al., 2020a). Its ability to grow in varied conditions and its high content of stevioside and rebaudioside, which make it considerably sweeter than sucrose, make it an attractive option for both local consumption and export.

No doubt the interest in stevia is not only due to its natural sweetness, but also to its beneficial health properties, such as its potential to be anti-cavities and its use in treatments for skin and diabetes. This, together with its application in livestock production and agriculture, expands its field of use beyond that of a simple sweetener. These characteristics have boosted its cultivation in non-traditional regions, under low controlled conditions (Pico et al., 2020).

Therefore, the trend towards organic stevia production in Ecuador highlights the importance of using sustainable agricultural practices. The use of organic fertilizers such as biol, a liquid fertilizer derived from organic waste, is presented as a viable solution to promote a more environmentally friendly agriculture (Escalante, 2023). This practice not only improves soil quality, but also reduces reliance on chemical inputs, aligning with the principles of agroecology and soil conservation.

Finally, this agroecological approach to stevia cultivation aligns with the growing market demands for organic and sustainable products. By integrating biol into stevia crop management, an opportunity is offered to improve the efficiency and sustainability of production, while maintaining the quality and beneficial properties of the plant (Pisarra et al., 2021). Not only does this approach benefit the environment, but it can also offer economic advantages to farmers, allowing them to access more lucrative and environmentally conscious markets.

With FAO's projected 50% increase in food demand by 2050, it is essential to align agricultural productivity with sustainability. The growing acceptance of stevia as an alternative to sugar highlights the importance of sustainable growing practices, in the face of concerns about soil erosion and biodiversity loss (Ahmad et al., 2020). The need for sustainable alternatives is echoed in the IPCC's reports on the adverse effects of chemical fertilisers, driving interest in organic fertilisers such as BIOL, backed by IFOAM (Rojas et al., 2020).

Despite its benefits for the soil, adoption of BIOL has been limited, marking a call for more research to confirm its effectiveness in crops such as Stevia, whose impact is still partially explored (Samaniego, 2022). In this context, FAO and the World Bank recognize the potential of BIOL to contribute to food security and mitigate climate change, highlighting the importance of improving agricultural practices to benefit crops such as Stevia (Muñiz, 2023).

MATERIALS AND METHODS

To investigate the potential of biol in the agroecological management of Stevia cultivation, experiments were carried out using Stevia rebaudiana plants, selected for their genetic homogeneity and adaptability to the local environment (Samaniego, 2022). The biol, prepared from organic waste and manure from farm animals, was anaerobically fermented with the addition of local efficient microorganisms, maintaining controlled temperature and pH conditions for a period of 30 to 60 days. This preparation was applied to the Stevia growing soil, which was previously analyzed to determine its physicochemical characteristics, thus ensuring a standardized growth environment for all plants involved in the study (Martínez et al., 2023).

The effect of biol on stevia cultivation was evaluated through an experimental design that compared different concentrations of biol, applied at different stages of the plant's growth cycle. Variables such as growth rate, production yield of steviosides (natural sweeteners present in Stevia), and resistance to diseases and pests were measured (Monge et al., 2022). To this end, advanced analysis techniques were used, including atomic absorption spectrophotometry and high-efficiency liquid chromatography (HPLC), allowing a detailed evaluation of the quality of the biol and its impact on the quality and quantity of Stevia production (France, 2021). This methodological approach offered a solid basis for understanding how the use of biol can contribute to the sustainable and ecological management of Stevia cultivation, highlighting its potential as an innovative and sustainable agricultural practice.

RESULTS AND DISCUSSION

Biol's Potential

The relevance of studying and applying Biol in the cultivation of Stevia lies in the growing demand for agricultural products produced in a sustainable and environmentally friendly way. Stevia rebaudiana, known for its sweet leaves and low caloric impact, is an increasingly popular plant in the food industry (Olmedo, 2023). In this context, Biol emerges as a valuable tool that offers an organic alternative to synthetic fertilizers and pesticides, aligning with the principles of agroecological agriculture and contributing to the production of high-quality Stevia (Gálvez & Gálvez, 2023a).

In addition, the context and relevance of the topic "Potentiality of Biol for the agroecological management of Stevia cultivation" are significant in the framework of sustainable agriculture and the growing demand for natural sweeteners (Nshimirimana, 2020). Stevia, known for its high sweetening power and low calorie content, has become a popular choice compared to traditional sugars, especially for people with diabetes or those looking for healthier alternatives. In this scenario, the use of biol as a soil amendment presents an opportunity to improve sustainability in Stevia cultivation (Centurion et al., 2020). Biol, derived from plant biomass and high in carbon, has the ability to enrich soil fertility. This product contributes to greater water and nutrient retention in the soil, thus decreasing dependence on synthetic fertilizers (Sanahuja, 2022). This integration of biol in the cultivation of Stevia not only enhances agronomic efficiency, but also contributes to organic farming practices, aligned with the principles of sustainability and lower environmental impact. Therefore, exploring the potentiality of biol in Stevia cultivation is a relevant topic for both modern agriculture and the food industry, addressing the demand for natural and sustainable products in an increasingly environmentally conscious global market (Castaño, 2021).

Likewise, the use of Biol in Stevia can offer multiple benefits, including increasing soil fertility, improving nutrient uptake by plants, and promoting healthy growth (Méndez et al., 2022). This is especially important for growing stevia, which requires careful management to produce leaves with high levels of steviosides, the compounds responsible for its sweetness (Mora, 2021). In addition, Biol can help reduce dependence on chemical fertilizers, decreasing the negative environmental impacts associated with intensive agriculture and contributing to the sustainability of the crop (Bellmunt & Effio, 2023).

On the other hand, the analysis of the potentiality of Biol in the agroecological management of Stevia is also significant in the framework of climate-smart agriculture and the search for food security, experiments were developed focused on the cultivation of Stevia rebaudiana, chosen for its genetic uniformity and ability to adapt to local environmental conditions (Forero & González, 2020). By adopting agricultural practices that respect the environment and promote biodiversity, farmers can contribute to climate change mitigation and the development of more resilient food systems (López et al., 2023).

In summary, the theme addresses the convergence of innovation in sustainable agricultural practices with the optimized production of valuable crops such as Stevia and (Mendoza & Solís, 2022). This approach not only has implications for the quality and yield of Stevia cultivation, but also contributes to a more sustainable and environmentally friendly farming model (Rengifo et al., 2022).

Below are some properties of the exhibits:

Board 1

Properties of Biol.

Property	Description
Origin	Anaerobic fermentation of manure and organic waste.
Guy	Liquid biofertilizer.
Nutrients	Rich in nitrogen, phosphorus, potassium and essential microelements.
Microorganisms	It contains beneficial microorganisms for the soil.
Soil Improvement	Increases fertility, water and nutrient retention capacity.
Chemical Reduction	Decreases the need for synthetic fertilizers and pesticides.
Environmental impact	Eco-friendly and sustainable, it reduces the carbon footprint.
Effect on plants	It improves resistance to diseases and pests, and boosts plant growth and health.

Fountain: (Castaño, 2021).

Definitions and Characteristics of Biol

According to Ramírez et al., (2023), Biol is a liquid biofertilizer that is produced through the anaerobic fermentation of manure and other organic waste. This nutrient-rich substance is known for its high efficiency in improving soil quality and providing essential nutrients for plants. Its composition rich in beneficial microorganisms contributes to the development of healthier soil, which in turn promotes the growth of crops such as Stevia. In addition, Biol is environmentally friendly, offering a sustainable alternative to traditional chemical fertilizers (Gonzalez et al., 2021).

Also Biol, referred to simply as "biol" in certain contexts, is a product of pyrolysis, a process of thermal decomposition of organic material such as agricultural waste, wood or manure, which occurs in the absence of oxygen (Guerrero et al., 2021). This process transforms the organic material into a carbonaceous material with distinctive characteristics, highlighting its high porosity, extensive surface area and rich carbon composition (N. Rodríguez et al., 2021). These qualities give Biol an exceptional ability to improve soil quality. Its effectiveness is manifested in the ability to retain water and nutrients, increase soil fertility, and decrease dependence on chemical fertilizers (Pérez et al., 2023). The use of Biol in agriculture and soil management is a sustainable practice, promoting a greener and more efficient approach to natural resource management (Diaz, 2020). In addition, biol can help sequester carbon in the soil, contributing to climate change mitigation (Gonzalez et al., 2020). It is also known for its potential to reduce nutrient leaching into soil and the emission of greenhouse gases such as nitrous oxide (Yined et al., 2022). These properties make biol a valuable tool in sustainable agriculture, improving not only soil health and crop yields, but also contributing to greater environmental sustainability (Curilla & Diego Flores, 2022).

Figure 1. *Characteristics of Biol.*

One of the most notable characteristics of Biol is its high content of nutrients, including nitrogen, phosphorus, potassium, and other microelements essential for plant growth (Alejo et al., 2022). In addition, it contains a variety of beneficial microorganisms, such as bacteria and fungi, which contribute to soil health and efficiency in nutrient uptake by plants (Zambrano, 2021).

Nutrient	**Description**	**Benefits for Plants**
Nitrogen (N)	Essential for vegetative growth.	Promotes leaf and stem growth.
Phosphorus (P)	Key to energy transfer and root formation.	It stimulates the growth of roots and flowers.
Potassium (K)	Important for osmoregulation and stress resistance.	Improves plant resistance to drought and disease.

Calcium (Ca)	Necessary for cell structure and growth.	Strengthens plant cell walls.
Magnesium (mg)	A central component of chlorophyll, vital for photosynthesis.	Essential for photosynthesis and overall plant health.
Sulphur (S)	Important for the formation of proteins and enzymes.	It helps in the formation of proteins and improves endurance.
Micronutrients	It includes elements such as iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo).	Essential in small amounts for various vital functions.

Another important characteristic of Biol is its ability to improve soil structure and quality. By applying Biol, the organic matter in the soil is increased, which improves its ability to retain water and nutrients. This results in more fertile and healthy soil, which provides an optimal growing environment for the plants (God, 2022).

The following graph shows:

Figure 2. *Basic parameters of obtaining Biol*

Board 2

Table: Regulations and Quality Standards for Biol.

Rules/Regulations	Description	Application in Biol
Minimum Nutritional Content	Set minimum levels of N, P, K, and other nutrients.	It guarantees the effectiveness of Biol as a fertilizer.

Heavy Metal Limits	Defines the maximum allowable limits for heavy metals.	It ensures the safety and non-contamination of the soil.
pH Regulations	It stipulates acceptable pH ranges for organic fertilizers.	Prevents damage to soil and plants.
Pathogen Testing	It requires testing for harmful pathogens.	Prevents the spread of disease.
Labeling & Documentation	It requires details of the composition, origin, and mode of use.	It informs the consumer and ensures proper use.
Storage Standards	Establish optimal storage conditions.	It preserves the quality and effectiveness of Biol.
Application Guidelines	It provides recommendations on how and when to apply Biol.	Maximizes efficiency and minimizes environmental risks.

Fountain: (López & Carrión, 2021).

Types and Process of Technical Procurement of Biol

Manure Biol

Also known as manure biofertilizer, it is an organic product obtained through the process of aerobic decomposition of animal manure, this process involves the microbial decomposition of manure in the presence of oxygen, resulting in the release of nutrients such as nitrogen, phosphorus, potassium, and other micronutrients essential for plant growth (Cortez, 2018).

Manure biol is a natural and sustainable nutrient source used in organic farming and gardening to improve soil quality and promote healthy plant growth. (Alvarez, 2022). He tells us what manure biol is used for:

1. **Improves soil structure**: Helps increase the soil's water-holding and aeration capacity, which promotes plant root growth.
2. **Provides nutrients:** Provides a variety of nutrients essential for plant growth, including nitrogen, phosphorus, potassium, and other micronutrients.
3. **Stimulates microbial activity:** Promotes the proliferation of beneficial microorganisms in the soil, which contributes to the decomposition of organic matter and the availability of nutrients for plants.
4. **Promotes plant health:** Helps strengthen the immune system of plants and makes them more resistant to diseases and pests.
5. **Encourages the production of high-quality crops:** Regular use of manure biol can lead to more vigorous crops, with better taste and nutritional value.

It is important to note that manure biol must be applied properly and in adequate quantities to avoid overfeeding plants and potential environmental contamination problems (Flores, 2018). In addition, its use is often more effective when combined with sustainable agricultural practices, such as crop rotation and integrated pest management (Cortez, 2018).

Plant Waste Biol

It is a biofertilizer obtained from the controlled decomposition of plant organic matter, such as crop residues, tree pruning, fallen leaves and other plant materials, this decomposition process is carried out through the action of aerobic microorganisms, such as bacteria and fungi, under conditions of adequate humidity and temperature (Monge et al., 2022).

Like manure biol, plant waste biol is a natural source of nutrients used to enrich soil and promote healthy plant growth in organic farming and gardening (Monge et al., 2022).

According to (Manrique & Sanchez, 2020), some of the benefits of biol from vegetable waste are similar to those of biol from manure:

1. **Nutrient input**: The decomposition of plant residues releases nutrients such as nitrogen, phosphorus, potassium and other essential elements for plant growth.

2. **Improves soil structure**: Biol from plant residues helps to improve soil structure, increasing its water retention capacity, aeration and biological activity.

3. **Stimulates microbial activity:** Promotes the proliferation of beneficial microorganisms in the soil, contributing to the decomposition of organic matter and the availability of nutrients to plants.

4. **Increases soil fertility:** Regular use of biol from plant residues can increase soil fertility in the long term, improving its ability to sustain healthy and productive crops.

5. **Reduces reliance on chemical fertilizers: By** providing a natural source of nutrients, biol from plant residues can help reduce the need for chemical fertilizers, contributing to the environmental and economic sustainability of agriculture.

As with any biofertilizer, it is important to apply biol from plant residues properly and in adequate amounts to avoid soil imbalances and potential contamination issues. In addition, its effectiveness can be improved when combined with other soil management practices, such as crop rotation and the use of vegetation cover (Manrique & Sanchez, 2020).

Wastewater Biol

Wastewater biol, also known as activated sludge or biosolids, is obtained as a result of the wastewater treatment process in water treatment plants. During this process, wastewater goes through several stages of treatment, one of which involves the removal of suspended solids (Borja, 2020).

Once the solids are removed, a mixture of water and organic matter is produced that is known as sewage sludge. This sludge then undergoes an additional treatment process, which may include anaerobic or aerobic digestion, to further decompose the organic matter and stabilize the biological components present in the sludge (Castillo, 2019).

Once the sludge has been treated and stabilized, it can be used as wastewater biol in agriculture and gardening. Biosolids contain nutrients such as nitrogen, phosphorus, potassium, and other elements essential for plant growth, making them a potential source of organic fertilizer (Velazco, 217).

The Technical Process

Anaerobic bacteria

Anaerobic bacteria are organisms that can grow and metabolize in the absence of molecular oxygen (CO2). Its metabolism adapts to environments where oxygen is absent or present in very low concentrations. Here's an overview of the technical process of anaerobic bacteria: Substrate selection: Anaerobic bacteria can use a wide variety of organic substrates as a source of carbon and energy. These substrates can be complex organic matter, such as carbohydrates, fats, proteins, or simpler compounds such as organic acids(Monge et al., 2022).

1. **Culture inoculation: To** start the anaerobic fermentation process, a culture of anaerobic bacteria is inoculated into the fermentation medium. This culture can consist of a pure strain of bacteria or a mixture of different species, depending on the substrate and the purpose of the process.
2. **Culture conditions:** Suitable culture conditions are established for anaerobic bacteria. This involves controlling factors such as temperature, pH, substrate concentration, and agitation of the culture medium to optimize the growth and metabolic activity of the bacteria.
3. **Anaerobic fermentation:** Once the proper culture conditions are established, the anaerobic bacteria begin to metabolize the organic substrate through a fermentation process. During this process, microorganisms break down organic substrates into end products, such as organic acids, alcohols, gases (such as carbon dioxide and hydrogen), and other compounds.
4. **Production of end products:** The end products of anaerobic fermentation can vary depending on the type of bacteria present and the substrate used. These products can be useful for various industrial applications, such as the production of biogas (methane), organic chemicals, or biofertilizers.
5. **Product recovery:** Once anaerobic fermentation is complete, the final products can be recovered from the fermentation medium. This may involve separating liquid and solid components, purifying desired products, and removing unwanted byproducts.
6. **Reinoculation or storage:** Depending on the final application of the products obtained, the culture can be reinoculated to start a new fermentation cycle or the products can be stored for later use or commercialization (Gonzales, 2016).

The technical process of biol from vegetable waste

It involves the transformation of plant-based organic matter into a liquid or solid fertilizer rich in nutrients and beneficial microorganisms for plants. Below is a summary of the steps involved in the production of biol from plant waste:

Selection of plant waste: Suitable plant residues are selected for the production of biol. These can include agricultural crop debris, tree and shrub pruning, fallen leaves, grass clippings, among others. It is important to avoid materials that can contaminate the biol, such as waste treated with chemical pesticides.

1. **Shredding or fragmentation:** Plant residues are shredded or fragmented into smaller pieces to increase the contact surface and facilitate microbial decomposition. This can be done by using a shredder or simply cutting the materials into smaller pieces.
2. **Preparation of the fermentation container:** A suitable container is selected for the fermentation of the plant residues. It can be a plastic tank, a bucket or any container that allows you to hold the waste and fermentation liquid. The container should be large enough to hold the waste and allow for proper aeration.
3. **Loading the plant waste:** The shredded plant waste is placed in the fermentation container. They can be added in alternating layers with other carbon- and nitrogen-rich materials to promote balanced decomposition and greater microbial diversity.
4. **Adding water:** Water is added to the fermentation container to moisten plant residues and create an environment conducive to microbial activity. The amount of water added can vary depending on the initial moisture content of the waste and weather conditions.
5. **Inoculation with microorganisms:** The fermentation container is inoculated with a source of beneficial microorganisms. This can be done by adding a small amount of previously produced biol, mature compost, or fertile soil rich in microorganisms. These microorganisms will help initiate and accelerate the decomposition process of plant waste.
6. **Mixing and aeration:** Plant residues are mixed and good aeration is ensured to promote aerobic microbial activity. This can be achieved by periodically stirring the waste or installing aeration systems that provide oxygen to the inside of the container.
7. **Fermentation and maturation:** Plant residues ferment over a period of time that can range from several weeks to several months, depending on factors such as ambient temperature, humidity, oxygen availability, and the composition of the residues. During this process, microorganisms break down plant waste and release nutrients in the form of biol.
8. **Filtering and storage:** Once fermentation is complete, the resulting biol is filtered to remove coarse solids and obtain a clear, homogeneous liquid. The filtered biol is stored in clean, hermetically sealed containers for later use as a liquid fertilizer.
9. **Application of biol:** Plant waste biol is diluted in water as directed and applied directly to the soil around the plants. It can also be used as a foliar fertilizer, spraying it on the leaves of plants. Biol provides essential nutrients and beneficial microorganisms that promote healthy plant growth and

improve soil quality (Crespo, 2021).

The Technical Process of Sewage Biol

It involves the transformation of sewage sludge from water treatment plants into a stabilized, nutrient-rich organic product that can be used as fertilizer in agriculture and gardening. Here's a rundown of the steps involved in the production of wastewater biol:

1. **Sewage sludge collection:** Sewage sludge is collected from sewage treatment plants. This sludge can contain a mixture of organic and inorganic solids, as well as active microorganisms and unwanted materials.
2. **Sludge pretreatment:** Before starting the fermentation process, the sewage sludge can be pre-treated to remove coarse materials and facilitate biological decomposition. This can include processes such as sieving, dewatering, or centrifugation to separate the solids from the liquid.
3. **Sludge conditioning:** Conditioned sewage sludge is mixed with other organic materials and water to adjust its composition and provide optimal conditions for microbial activity. This may involve the addition of carbon-rich materials, such as agricultural crop scraps, food residues, or mature compost.
4. **Inoculation with microorganisms:** The batch of conditioned sewage sludge is inoculated with a source of beneficial microorganisms. This can be done by adding a small amount of previously produced biol, mature compost, or fertile soil rich in microorganisms. These microorganisms will help initiate and speed up the decomposition process of sewage sludge.
5. **Mixing and aeration:** Sewage sludge is mixed and good aeration is ensured to promote aerobic microbial activity. This can be achieved by mechanically agitating the batch or installing aeration systems that provide oxygen to the inside of the fermentation tank.
6. **Fermentation and decomposition:** Sewage sludge ferments for a period of time that can range from several weeks to several months, depending on factors such as ambient temperature, humidity, oxygen availability, and the composition of the sludge. During this process, microorganisms break down the organic solids present in the sludge and release nutrients in the form of biol.
7. **Maturation and stabilization:** Once fermentation is complete, the resulting biol undergoes a maturation and stabilization process to reduce the presence of pathogenic microorganisms and undesirable chemical compounds. This may involve storing the biol for an additional period of time and monitoring the quality of the final product.
8. **Filtration and storage:** Wastewater biol is filtered to remove coarse solids and obtain a clear, homogeneous liquid. The filtered biol is stored in clean, hermetically sealed containers for later use as a liquid fertilizer.
9. **Application of biol:** Wastewater biol is diluted in water as directed and

applied directly to the soil around the plants. It can also be used as a foliar fertilizer, spraying it on the leaves of plants. Biol provides essential nutrients and beneficial microorganisms that promote healthy plant growth and improve soil quality (Lopez, 2020).

Board 3

Types and Process of Technical Procurement of Biol.

Letter	Type of Biol	Number	Source of Organic Matter	Method of Obtaining	Yield (%)	Nutrient Concentration (mg/L)
To	Biol Manure	1	Cow manure	Anaerobic fermentation	60	Nitrogen: 300; Phosphorus: 70
B	Plant Waste Biol	2	Crop residues	Anaerobic digestion	50	Nitrogen: 200; Potassium: 100
C	Biol Wastewater	3	Urban Wastewater	Mixed treatment	70	Nitrogen: 150; Phosphorus: 50

Fountain: (Alvarez, 2022).

The following graph shows a basic process of obtaining biol in an artisanal way:

Figure 3. *Artisanal production of Biol*

Advantages and Disadvantages for obtaining Biol

Advantages:	**Disadvantages:**
• It can be made based on inputs found in the community. • It does not require a specific recipe, the ingredients may vary. • It is easy to prepare and can be adapted to different types of packaging. • It improves the vigour of the crop, and allows it to withstand with greater Pest and disease attacks and the adverse effects of climate change. • It promotes physiological activities and stimulates plant development. • It is an organic fertilizer that does not pollute the soil, water, air or the products obtained	• The time from preparation to use is long. • In large extensions, a backpack is required to apply. • When not protected from solar radiation, the sleeves (rustic biodigesters) tend to spoil, reducing their useful life.

Contributions of Biol to Stevia cultivation

Biol, as a natural biofertilizer, provides a series of benefits to the soil and Stevia plants, improving their growth and development (Sánchez, 2021). Being rich in nutrients and beneficial microorganisms, Biol improves soil fertility, increasing its organic matter content and improving its structure (Ramírez, 2015).

This results in soil that is healthier and able to retain water and nutrients more effectively, which is crucial for Stevia cultivation, which requires well-drained, nutrient-rich soils (Effio, 2023).

Biofertilizers have been shown to not only enhance the growth of Stevia, but also increase the concentration of steviol glycosides, key components for plant sweetness (Hoseini et al., 2021).

They are significant and multifaceted, contributing to both environmental sustainability and agronomic efficiency (López, 2019). Biol, a carbon-rich material obtained through biomass pyrolysis, improves soil quality by increasing its water and nutrient retention capacity, which is especially beneficial in regions with poor soils or adverse climatic conditions (Pérez, 2020).

In addition, biol can play an important role in plant disease mitigation and pest management, contributing to a healthier and more productive Stevia crop (Ramirez, 2021). Therefore, the integration of biol into the cultivation of Stevia not only improves crop yields, but also promotes more sustainable and environmentally friendly agricultural practices (Hector, & Garcia, et al., 2020).

Figure 2. *Contributions of Biol to Stevia Cultivation.*
Source:(Enriquez, 2021).

Table 4
Contributions of Biol to Stevia Cultivation.

	Contribution of Biol	Number	Measure of Impact	Data Numeric/Description	Improvement in Stevia (%)
To	Enrichment of the Soil	1	Increase of matter organic	5% increase in soil	Growth 20% on plants
B	Improving Soil Health	2	Reduction of agents Pathogens	25% decrease	Lower incidence of disease of the 15%
C	Increase of Absorption of Nutrients	3	Improvement in Absorptionof NPK	Increase of the 30% in absorption	10% increase in production of leaves

D	Environmental Sustainability	4	Reduction in the use of chemists	40% decrease	Improvement in Sustainability of the 25%

Source: (García, et al., 2020).

Agroecological Management of Stevia Cultivation

The agroecological management of Stevia cultivation focuses on sustainable and environmentally friendly practices to optimize the growth and production of this plant, known for its high content of natural sweeteners and low calories (Vitor, 2022). This approach involves the integration of techniques that promote soil health, biodiversity and ecological balance, minimizing the use of synthetic chemicals (Gonzalez et al., 2024). Practices such as crop rotation, the use of organic fertilizers, and biological control of pests and diseases are common in agroecological management (Pisarra et al., 2021). In addition, the selection of varieties adapted to local conditions and efficient water management are key aspects for the successful cultivation of Stevia. Not only does this methodology improve the sustainability of the crop, but it can also result in a higher quality of the final product. By adopting agroecological practices, Stevia producers can contribute to a more sustainable and environmentally friendly food system, while also meeting the growing demand of health-conscious consumers and the environmental impact of their food choices (Flores González, 2019).

Application of Biol in Stevia Cultivation

In the application of Biol in Stevia cultivation, a careful approach is followed to ensure that the plants receive adequate nutrition without overdoing it. Biol is applied directly to the soil, focusing on the root zone of Stevia plants (Apollon, 2023). The specific dosage of Biol depends on several factors such as soil quality, environmental conditions, and the growth stages of the plant. Generally, you start with a moderate amount and adjust based on the response seen in the crop (Flores & Tapullima, 2022).

Board 4

Application of Biol in Stevia Cultivation.

Cultivation Stage	Application of Biol	Expected Benefits
Soil Preparation	Apply Biol two weeks before sowing.	Improves soil fertility and structure.
Sowing	Apply diluted Biol during seedling transplanting.	It stimulates the growth of young roots and shoots.
Vegetative Growth	Apply Biol every 15-30 days.	Promotes healthy and vigorous growth.
Pre-flowering	Reduce the application of Biol to avoid overgrowth.	It balances growth and prepares for flowering.

Post-harvest	Apply Biol to improve soil recovery.	It maintains soil health for the next cycle.

Fountain: (Héctor, Torres, et al., 2020).

Biol, being a liquid biofertilizer, is diluted in water to facilitate its application and ensure an even distribution of nutrients (Sánchez et al., 2022). This dilution helps prevent excessive concentration of nutrients in a specific area of the soil, which could be harmful to plants. The frequency of application is also carefully adjusted, often increasing during Stevia's fast-growing phases, such as during leaf formation (León et al., 2019).

Figure 4. *Application of Biol in Stevia Cultivation.*

The response of Stevia plants to Biol is usually evident in terms of more vigorous growth, better overall health, and increased production of sweet leaves (Gálvez & Gálvez, 2023). Careful observation of the culture is essential to determine the efficacy of Biol and to make necessary adjustments to the dose or frequency of application. By adopting this practice, you not only improve the health and yield of the Stevia crop, but also contribute to a more sustainable and environmentally friendly approach to farming (Héctor et al., 2020).

In addition, biol helps to create a favorable environment for soil microorganisms, improving the bioavailability of nutrients essential for optimal Stevia growth. This practice not only boosts the productivity and quality of Stevia, but also contributes to the sustainability of the crop, reducing reliance on chemical fertilizers and improving carbon sequestration in the soil (Villela & Jiménez, 2022). Therefore, the application of biol in Stevia cultivation is a promising approach that aligns the goals of efficient agricultural production with environmental conservation and sustainability (Gálvez & Gálvez Dávila, 2023).

In addition, Biol can help strengthen the resistance of Stevia plants to disease and environmental stress, which is especially valuable in ensuring the sustainability and productivity of the crop (Apollon, 2023). This improved resistance is due in part to the beneficial microorganisms present in Biol, which can compete with pathogens and improve overall plant health (Ovando, 2023).

The application of Biol also contributes to the environmental sustainability of Stevia cultivation. By replacing or reducing the need for chemical fertilizers, Biol decreases the environmental impact of agriculture and promotes more natural and organic farming practices (Ardisana et al., 2020). Not only is this beneficial for the environment, but it can also be attractive to consumers looking for sustainably grown agricultural products (Héctor, Torres, et al., 2020).

Impact and Benefits of Biol on Stevia

The use of Biol in Stevia cultivation has been shown to have a significant positive impact on the growth, yield and sustainability of plantations (Taiariol & Leiva, 2023). Plants treated with Biol tend to exhibit greater vigour, better resistance to diseases and pests, and superior leaf quality, which is essential for the production of sweeteners. In addition, Biol contributes to the sustainability of stevia cultivation by reducing dependence on chemical fertilizers and improving soil health in the long term (Gonzalez et al., 2023).

Figure 5. *Impact and Benefits of Biol in Stevia.*

The impact and benefits of using biol in Stevia cultivation are remarkable and contribute significantly to agricultural sustainability and crop efficiency. Biol improves soil structure and quality, increasing its ability to retain water and nutrients, which is especially beneficial for Stevia, a plant that requires rich, well-drained soils (Mego, 2021). This improvement in water and nutrient retention can lead to more robust plant growth and an increase in leaf production, which is the source of natural sweeteners (Muñiz, 2023). In addition, biol helps reduce the need for chemical fertilizers, minimizing the environmental impact of the crop and associated costs (VARGAS, 2021). Another significant benefit is biol's ability to sequester carbon in the soil, contributing to climate change mitigation. In summary, the application of biol in the cultivation of Stevia not only improves the yield and sustainability of the crop, but also brings environmental benefits, making this approach a valuable practice in modern agriculture (Bellmunt & Effio, 2023).

The impact and benefits of Biol on Stevia cultivation are considerable, offering a number of advantages from both an agronomic and environmental point of view (Morales & Tuarez, 2023). As an organic biofertilizer, Biol provides the soil with a rich mix of nutrients and beneficial microorganisms, which has a direct positive effect on the growth and health of Stevia plants (Muñiz, 2023).

One of the main benefits of Biol is its ability to improve soil fertility. By increasing the organic matter content in the soil, Biol improves soil structure, its ability to retain water and nutrients, and promotes healthy microbial activity. This results in an optimal growing environment that can lead to better root development and more vigorous growth of Stevia plants (JULISA, 2021).

Biol also contributes to plant nutrition. By providing a balanced range of essential nutrients, including nitrogen, phosphorus and potassium, Biol can help ensure that Stevia plants receive the nourishment needed for optimal growth. This balanced nutrition is crucial for the production of high-quality leaves, which is the main goal in growing Stevia, given its use as a natural sweetener (Villamar, 2022).

Another significant benefit of Biol is its role in integrated pest and disease management. The beneficial microorganisms present in Biol can help suppress certain soil pathogens and reduce the incidence of disease. This can decrease the need for chemical pesticides, which is not only beneficial for the environment, but also for the health of consumers and the quality of the final product (Bellmunt & Effio, 2023).

From the point of view of environmental sustainability, the use of Biol in the cultivation of Stevia reduces dependence on synthetic chemical fertilizers, which is favorable for the conservation of ecosystems and the reduction of the carbon footprint of agriculture. By promoting more organic and eco-friendly farming practices, Biol aligns with global trends towards more sustainable and environmentally friendly agriculture (Núñez et al., 2021).

Board 5

Impact and Benefits of Biol on Stevia Cultivation.

Letter	Benefit of Biol	Number	Measured Parameter	Numerical Data/Description	Impact on Stevia Cultivation (%)
To	Improving Soil Fertility	1	Nitrogen Level	Increase of 40 mg/kg in soil	25% improvement in plant growth
B	Soil Disease Control	2	Pathogen Reduction	30% decrease in incidence	20% reduction in root diseases
C	Increased Performance	3	Leaf production	Increase of 2 kg/plant	15% increase in sheet yield
D	Sheet Quality Improvement	4	Content of Stevioside	10% increase in content	10% improvement in sweetener quality

Fountain: (Díaz & Hernández, 2021).

CONCLUSIONS

Biol emerges as an effective resource in the agroecological cultivation of Stevia, improving yield and sustainability. It is suggested to deepen studies to refine its application and understand its effect under various environmental conditions. It is crucial to encourage its adoption through training and support for farmers, aiming towards greener and more efficient agriculture. The future of Biol in agriculture is encouraging, promising progress towards sustainable food production.

Conflict of interest: The authors declare that they have no conflict of interest

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