# PROCEEDINGS OF VII. INTERNATIONAL AGRICULTURAL, BIOLOGICAL, LIFE SCIENCE CONFERENCE AGBIOL 2025

## 07-10 SEPTEMBER 2025

## ISTANBUL, TÜRKIYE

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## ISTANBUL, TÜRKİYE

**Organized by**
**Trakya University**
**Istanbul Beykent University**
**International Researchers Association**

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# WELCOME NOTES

You are welcome to our VII. AGBIOL Conference that is organized by Trakya University, Beykent University and International Researchers Association. The aim of our conference is to present scientific subjects of a broad interest to the scientific community, by providing an opportunity to present their work as oral or poster presentations that can be of great value for global science arena. Our goal was to bring three communities, namely science, research and private investment together in a friendly environment of Edirne, Turkey in order to share their interests and ideas and to get benefit from the interaction with each other.

In September 2018, we organized the first AGBIOL Conference with more than 700 scientists and researchers from all over the world with over 800 scientific papers. Due to COVID-19 situation, II. AGBIOL 2020 has organized fully on-line event which was one of the biggest online conferences in recent years in the world with 499 papers and 1133 authors with 333 oral and 166 e-poster presentations from 55 countries. Due to COVID-19 situation, AGBIOL 2021 was organized online again. AGBIOL 2022 conference was organized with a worldwide participation from 44 countries over 522 papers contributed by over 1300 authors. AGBIOL 2023 was organized with a record and worldwide participation from 33 countries 833 papers contributed by over 2000 authors with 522 oral and 311 poster presentations. AGBIOL 2024 consisted of 835 papers contributed by about 2000 authors with worldwide recodr participation again from 55 countries with 522 oral and 311 poster presentations.

There is a worldwide record participation from 60 countries 988 papers contributed over 2300 authors with 400 oral and 588 poster presentations in AGBIOL 2025.

The AGBIOL 2025 is normal participation as well as with online participation in Beykent University in Istanbul, Turkey on 07-10 September, 2025. The program included oral talks by invited prominent scientists and oral and e poster presentations by participants in selected topics from the submitted abstracts focusing on Agriculture, Biology and Life Sciences topics.

With care for our nature and environment, we aim the green congress, meaning that as little as possible papers will be used. Abstract book is published in electronic book and is distributed to the participants by e mail for online participants. All the e-posters are prepared in electronic form and then submit to via the conference e mail and exhibited in electronical poster boards as well as in online e poster hall in our web page during the conference.

The participants with paid conference fee accessed all the normal and virtual presentation talks in each session, as well as to visit the virtual poster hall via preliminary provided. The abstracts were published in the Conference Abstract and Proceedings Book. Participants might send us their full papers, which based on their preferences are published either in our Conference Abstract and Proceedings Book or in selected International Indexed Scientific Journals.

**Conference Topics:**

Agriculture, Forestry, Life Sciences, Agricultural Engineering, Aquaculture and Biosystems, Animal Science, Biomedical science, Biochemistry and Molecular Biology, Biology, Bioengineering, Biomaterials, Biomechanics, Biophysics, Bioscience, Biotechnology, Botany, Chemistry, Chemical Engineering, Earth Sciences, Environmental Science, Food Science, Genetics and Human Genetics, Medical Science, Machinery, Pharmaceutical Sciences, Physics, Soil Science.

We would like to thank all of you for joining this conference and we would like to give also special thanks to TUBITAK and collaborators for giving us a big support to organize this event.

Prof Dr Yalcin KAYA
Head of the Organizing Committee

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# SUSTAINABILITY ASSESSMENT OF OPEN AND CLOSED SYSTEMS IN MICROALGAE CULTIVATION: A REVIEW

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## ABSTRACT

Microalgae are attracting interest in many sectors, particularly agriculture, energy, environment, food, medicine, and cosmetics, due to their high biomass production capacity and ability to grow in various environments. The environmental, economic, and social sustainability of products derived from microalgae is one of the most discussed topics today. The cultivation system for microalgae is the most important factor influencing their long-term viability. Microalgae are typically grown in two systems: open ponds and closed systems, also known as photobioreactors. Open systems, like open raceway ponds, natural lakes, and lagoons, have direct contact with the atmosphere and are generally simpler. In contrast, photobioreactors are closed systems that produce microalgae under controlled conditions. In this study, these two fundamental systems commonly used in microalgae cultivation were compared in terms of sustainability. Open-system microalgae production offers greater economic benefits; it is less environmentally sustainable. The primary causes of this are the high risk of contamination and evaporation resulting from these systems' contact with the environment. Although product yield is low in these systems, more resilient species can typically be cultivated. Because closed systems produce microalgae under more controlled conditions and have a higher biomass yield, they have been found to be more beneficial for environmental sustainability. However, because of setup capital and operating costs, microalgae production in these systems is more costly. To summarize, both open and closed systems for microalgae cultivation have benefits and drawbacks in terms of environmental and economic sustainability. As a result, rather than selecting a single system, working with hybrid systems and focusing on operational conditions to local needs and resources should be viewed as the key to microalgae sustainability.

**Keywords:** Microalgae, cultivation system, photobioreactors, economic sustainability, environmental impacts, social sustainability

## INTRODUCTION

Today, increasing energy demand, depletion of resources, and global environmental issues are driving growing interest in renewable and sustainable resources. In this context, microalgae have become one of the most promising sources for sustainable production systems due to their high biomass yield, rapid growth, ability to utilize $CO_2$, and capacity to synthesize various valuable products (Brooke et al., 2025). The sustainability of the system in which microalgae are grown has a direct impact on the sustainability of the final product (Ugya et al., 2025). Microalgae are grown in both open and closed environments. The advantages and disadvantages of each system in terms of sustainability are different. In the study, open and closed systems were compared, and it was determined which system was better suited for microalgae cultivation under what conditions.

## MICROALGAE

Microalgae are microscopic organisms with photosynthetic capabilities. They can multiply rapidly in various environments (Singh & Saxena, 2015). Their high biomass yields, ability to use atmospheric carbon dioxide, and ability to synthesize a variety of valuable products have made them an important biomass source in the biotechnology, food, energy, and health industries. Microalgae can produce a variety of products, including biofuels from lipids, food supplements from proteins, pigments, and antioxidants. They also have important roles in environmental applications like wastewater treatment and carbon capture (Chisti, 2020).

## MICROALGAE CULTIVATION SYSTEMS

Microalgae production is typically divided into two types: open and closed systems. The type of system used depends on the product, economic resources, environmental conditions, and technical capabilities.

Open systems are simple systems in which microalgae are grown in an open environment. Shallow ponds are the most commonly used type of open system. These systems are typically installed outside, have an open top, and are capable of absorbing carbon dioxide from the air (Costa et al., 2019). The main advantage of these systems is that they are simple and inexpensive to set up and operate. The use of natural light and ventilation lowers the energy consumption of these systems. The primary disadvantage of open systems is that they are completely exposed to the outside world. This can make microalgae susceptible to contamination from bacteria, fungi, or unwanted algae species. Furthermore, environmental factors such as temperature, light, and wind cannot be controlled in these systems. This lowers production efficiency. Growth rates are low, and product quality varies in these systems (Zuccaro et al., 2020).

Closed systems, also known as photobioreactors, are systems for cultivating microalgae in a controlled environment. These systems are made up of tubes, pipes, and transparent panels like glass or plastic (Zuccaro et al., 2020). These systems get their light and air from the outside. The most significant advantage of closed systems is that production conditions are entirely controllable. Light, temperature, and pH levels can be kept constant. This translates to higher yields and higher-quality products. The risk of contamination is extremely low. Closed systems allow for greater microalgae production per unit area. The primary disadvantage of closed systems is their high installation and operating costs (Jerney & Spilling, 2020). Additionally, technical knowledge and experience are required for the system to function.

## SUSTAINABILITY OF MICROALGAE CULTIVATION SYSTEMS

Microalgae cultivation systems' sustainability is not a one-dimensional issue; it needs to be assessed alongside resource consumption, environmental effects, expenses, and societal advantages.

Energy and water consumption are important factors for microalgae cultivation systems when evaluating environmental sustainability. The carbon footprint of closed systems is increased by the high energy requirements for lighting, $CO_2$ injection, and continuous mixing. Even though open ponds use less energy, their lower yields may have a greater environmental impact per unit of product (Gurreri et al., 2023). Water consumption is a major issue for both systems. In this sense, one notable strategy that could reduce costs and environmental impacts is the use of wastewater for microalgae cultivation.

Nutrient inputs used in microalgae cultivation are another factor that impacts sustainability. Industrial fertilizers are commonly used to supply nutrients like nitrogen and phosphorus. This imposes additional environmental costs in terms of fossil fuel consumption and greenhouse gas emissions. However, in recent years, the use of waste streams as nutrient sources, particularly urban and industrial wastewater, has provided circular economy-compatible solutions (Branco-Vieira et al., 2020). This promotes wastewater treatment while also minimizing the environmental impact of nutrient inputs.

Economically, the method of utilizing microalgal biomass is critical. The use of microalgae biomass for biofuel production is economically limited due to high production costs. Applications aimed at high-value-added products, on the other hand, appear to be more profitable. Microalgae derivatives used in cosmetics, pharmaceuticals, and food additives provide a higher revenue potential as well as a shorter return on investment (Acién et al., 2017; Pérez-López et al., 2018).

Microalgae production, on the other hand, can provide both environmental and economic benefits, as well as social benefits. The establishment of local production facilities has the potential to create jobs in rural areas while also contributing to regional development (Josa & Garfí, 2023).

## CONCLUSIONS

Consideration of the environmental, economic, and social aspects of microalgae cultivation systems' sustainability reveals notable variations amongst them. Although open systems are inexpensive and simple to set up, they have poor environmental efficiency; closed systems, on the other hand, are more controllable and effective in terms of the environment, but their high energy consumption limits their economic viability. On a social level, both systems provide opportunities for local production and employment; however, hybrid solutions seem to be more sustainable.

The development of hybrid systems, integration of renewable energy, and more efficient use of waste streams can all improve the sustainability of microalgae technologies.

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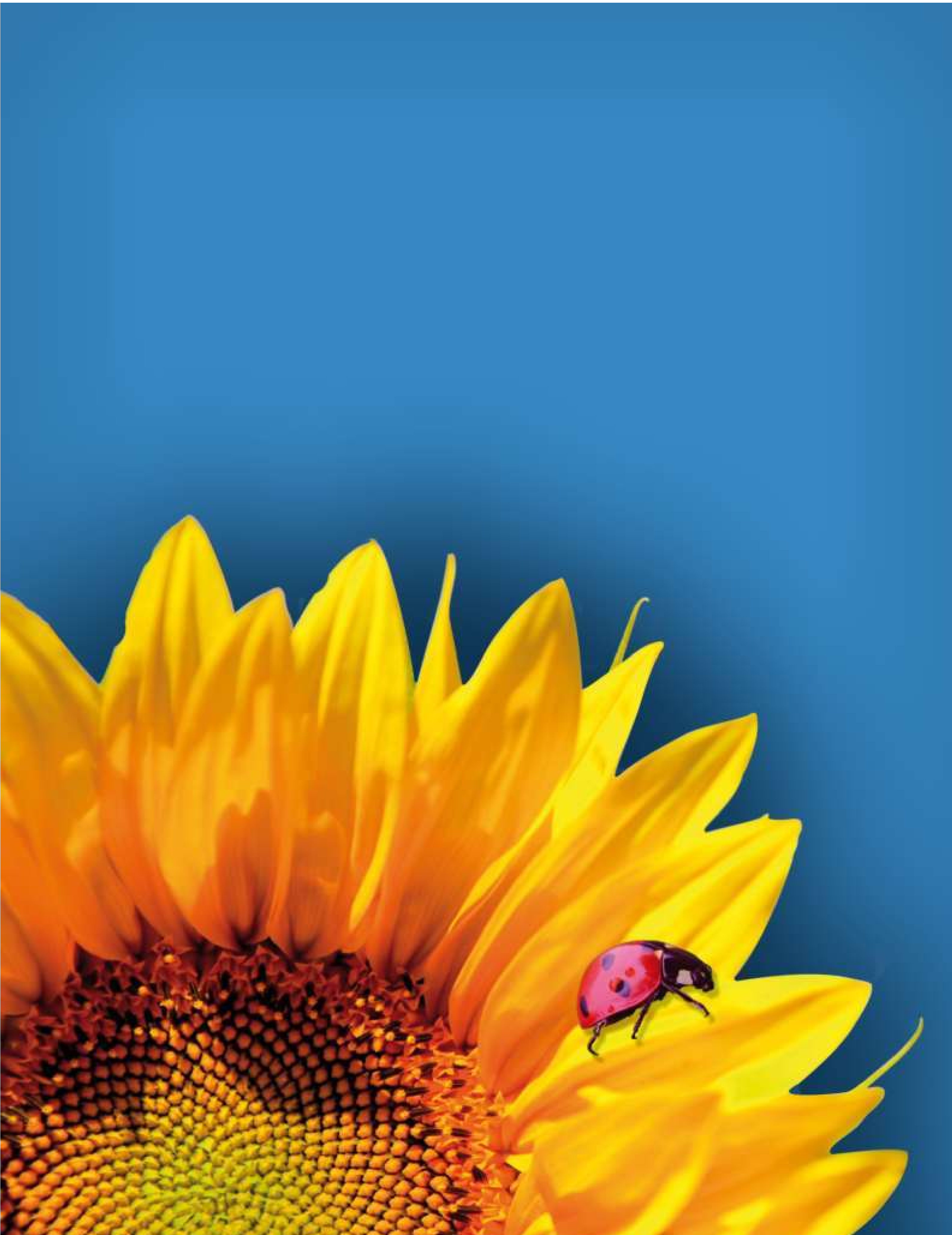

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