Innovations in Sustainable Agriculture and Aquatic Sciences

Editors
Banu YÜCEL
Mustafa Tolga TOLON

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Editors
Banu YÜCEL
ORCID iD: 0000-0003-4911-7720
Mustafa Tolga TOLON
ORCID iD: 0000-0002-2233-0663

Publishing Coordinator
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Tel: 0312 431 16 33
siparis@akademisyen.com

www.akademisyen.com

PREFACE

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We thank all of the authors with whom we collaborated to publish their books across disciplines.

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AUTHORS

Assoc. Prof. Dr. Çağrı KANDEMİR
Ege University, Faculty of Agriculture, Department of Animal Science

Assoc. Prof. Dr. Ruhan Ilknur GAZIOGLU SENSOY
Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Horticulture

Prof. Dr. Suat SENSOY
Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Horticulture

Prof. Dr. Turgay TAŞKIN
Ege University, Faculty of Agriculture, Department of Animal Science

Asst. Prof. Fevziye Şüheda HEPŞEN TÜRKAY
Kirşehir Ahi Evran University, Faculty of Agriculture, Department of Soil Science and Plant Nutritioni Department of Soil Science

Asst. Prof. Mustafa ÜSTÜNDAĞ
Van Yüzüncü Yıl University, Muradiye Vocational School, Department Of Chemistry And Chemical Management Technologies

Res. Assist. Ekin VAROL
Ege University, Faculty of Agriculture, Department of Animal Science

Prof. Dr. Banu YÜCEL
Ege University, Faculty of Agriculture, Department of Animal Science

Chapter 1

AN ALTERNATIVE HONEYBEE PRODUCT FOR THE TREATMENT OF MASTITIS: PROPOLIS

Ekin VAROL[1]
Çağrı KANDEMİR[2]
Turgay TAŞKIN[3]
Banu YÜCEL[4]

INTRODUCTION

Mastitis is a common disease affecting dairy cows, causing significant harm to their health and profitability (1). Mastitis in dairy animals could be determined as the inflammation of the mammary glands/udder caused by infectious pathogens, affecting animal welfare and economic losses (2). Mastitis in dairy animals leads to economic losses due to reduced milk production, increased treatment costs, and culling of infected cows (3). Mastitis in dairy animals is an inflammation of the udder tissue caused by bacteria, leading to pathological changes in glandular tissue and abnormalities in milk (4). Mastitis is usually caused by the interaction between microbial infections and the host in the udder and its response. In other words, its effect is on milk yield, quality, animal health, and welfare (5). Although mastitis is usually seen locally, it may rarely become chronic in animals with weakened immune systems. The incidence of the disease in the herd may vary depending on environmental factors such as the age and lactation period of the animal. Mastitis can be seen in three different forms: clinical, subclinical and acute (6). Apart from these types of mastitis, there are also structural disorders of the breast caused by infection due to mastitis. Since the quality of milk secreted from such udders is different from normal, the picture is shaped towards clinical

[1] Res. Assist., Ege University, Faculty of Agriculture, Department of Animal Science, ekin.varol@ege.edu.tr, ORCID iD: 0000-0003-4382-5427

[2] Assoc. Prof. Dr., Ege University, Faculty of Agriculture, Department of Animal Science, cagri.kandemir@ege.edu.tr, ORCID iD: 0000-0001-7378-6962

[3] Prof. Dr., Ege University, Faculty of Agriculture, Department of Animal Science, turgay.taskin@ege.edu.tr, ORCID iD: 0000-0001-8528-9760

[4] Prof. Dr., Ege University, Faculty of Agriculture, Department of Animal Science, banu.yucel@ege.edu.tr, ORCID iD: 0000-0003-4911-7720

has a preventive effect on bacterial, fulgal and viral diseases. Considering the high number of side effects of synthetic drugs, propolis is a good alternative as it has no reported side effects in scientific studies. In addition, propolis offers a natural and economical preventive and complementary treatment opportunity compared to synthetic drugs.

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Chapter 2

ENHANCED CHARACTERISTICS AND EVALUATION PARAMETERS OF VERMICOMPOST

Fevziye Şüheda HEPŞEN TÜRKAY[1]

INTRODUCTION

Understanding the standards for organic materials in soil conditioners, fertilizers, and growth mediums is essential. These widely accepted standards ensure the effectiveness of the materials. Organic materials for these uses must be composted following specific guidelines. The most widely used composting method is thermophilic composting, also called traditional composting. There are standards for thermophilic composting processes. Globally, the beneficial impacts of thermophilically composted organic materials are well-documented and recognized (1, 2). Considering the benefits of organic matter for soils, the very important disadvantages of thermophilic composting from an agricultural perspective are ignored. However, information on vermicomposting, a new, alternative and advantageous composting method, is not detailed and widespread (3, 4). Vermicomposts do not have the disadvantages of thermophilic composts, in addition to their advantages. Although scientific studies on vermicomposting have increased in recent years, more scientific studies on quality parameters and mechanisms are needed (5, 6).

The primary ecological roles of earthworms vary based on their environmental needs and dietary habits. Epigeic earthworms, which are used in vermicomposting, inhabit the soil's surface layer, just above the mineral horizon. They thrive beneath the debris layer, consuming organic matter found on the surface (7-9). Earthworms naturally thrive in organic waste piles like barnyard manure, where multiple species often coexist, leading to the nickname "dung worms" (10). In this group, *Eisenia foetida* has been preferred by many, given its high reproductive efficiency, adaptability, and resistance to different environmental conditions (11). *E foetida* is distributed globally with exceptions made for extreme deserts and

[1] Asst. Prof., Kirşehir Ahi Evran University, Faculty of Agriculture, Department of Soil Science and Plant Nutritioni Department of Soil Science, suheda.turkay@ahievran.edu.tr, ORCID iD: 0000-0002-9413-264X

waste into fertilizers could be an essential part of the answer to the global recycling issue for organic waste in support of healthy soils. Future work would consider fine-tuning the different processes and parameters of vermicomposting to consolidate its benefits and application in sustainable agriculture adapted to local conditions.

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Chapter 3

APPLICATIONS OF BLUE BIOTECHNOLOGY IN HUMAN HEALTH

Mustafa ÜSTÜNDAĞ[1]

INTRODUCTION

The world population is increasing. It is estimated that the world population will be approximately 9.6 billion in 2050 (1). Today, factors such as rapidly developing industrialization, urbanization, pressure on natural resources, climate change, disrupted ecological balance and changing lifestyles also bring health problems, difficulty in accessing safe food and dependence on energy. Today, many countries in the world are faced with important and unsolved issues such as epidemics, climate change, access to safe food, alternative and renewable energy sources.

In order to meet future demand and find solutions to global problems, one of the most sensitive issues is to reduce pressure on natural resources. According to the Millennium Ecosystem Assessment Project; It is estimated that 60% of the world's 24 major ecosystems that support human societies, including rivers and lakes, ocean fisheries, forests, air quality and crop systems, are "degraded or used unsustainably" (2). Considering the degraded ecosystems and destroyed habitats, safe food production becomes increasingly difficult (1). While the spreading epidemics and pandemics experienced in recent years directly threaten human health (3,4), climate change poses an important global problem in terms of sustainable development (5,6).

With the advances in biotechnology, it is possible to minimize the effects of important issues that await solutions on a global scale or to resolve these issues. Today, biotechnological methods can increase the supply of food and feed production, improve sustainability, increase water quality, provide renewable energy, improve the health of animals and people, and help protect biodiversity by detecting invasive species.

[1] Asst. Prof., Van Yüzüncü Yıl University, Muradiye Vocational School, Department Of Chemistry And Chemical Management Technologies, m.ustundg@gmail.com, ORCID iD: 0000-0002-2990-4981

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Chapter 4

THE ROLE OF BIOSTIMULANTS IN ENHANCING YIELD, QUALITY, AND STRESS TOLERANCE IN SUSTAINABLE VEGETABLE PRODUCTION

Suat SENSOY[1]

INTRODUCTION

Vegetables, herbaceous horticultural crops integral to human nutrition, are consumed directly or after minimal processing, either raw or cooked, fresh or preserved. These crops encompass a wide array of plant parts, including roots, tubers, stems, leaves, flowers, fruits, seeds, and more. As an essential part of the human diet, vegetables are generally low in fat and carbohydrates while being rich in vitamins, minerals, and dietary fiber. Major vegetable-producing nations include China, India, the United States, Türkiye, Iran, Egypt, and Italy (FAOSTAT, 2022).

Sustainable vegetable production involves adopting environmentally and human-friendly practices that ensure long-term agricultural viability. Biostimulants have gained a critical role in this context, offering substantial benefits for enhancing vegetable yield, improving quality, and increasing resilience against both biotic and abiotic stressors. These biostimulants comprise a diverse group of substances or microorganisms known to positively influence plant growth, yield, and biochemical composition, while also bolstering the plant's capacity to tolerate stress (Shahrajabian et al., 2021a; Yılmaz & Gazioglu Sensoy, 2021).

Biostimulants, often referred to as bioactivators, include a wide array of compounds, containing humic substances, protein hydrolysates, amino acids, nitrogenous compounds, seaweed extracts, polymers, inorganic compounds, beneficial fungi, and bacteria, organic wastes, vermicompost, and various plant-derived exudates (Shahrajabian et al., 2021a; Yılmaz & Gazioglu Sensoy, 2021). These substances can be applied to leaves, soil, or seeds, and are known to enhance vegetable growth, improve nutrient uptake, increase yields, and elevate product

[1] Prof. Dr., Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Horticulture, suatsensoy@yyu.edu.tr, ORCID iD: 0000-0001-7129-6185

in enhancing soil's physical and chemical characteristics, which in turn boost nutrient availability and improve water retention.

Integrating biostimulants into modern vegetable production systems presents a promising strategy for achieving higher yields while maintaining or improving soil health. Their multifaceted benefits position biostimulants as essential tools for addressing the challenges posed by climate change and resource depletion, particularly in degraded ecosystems or semi-arid regions. Future research should focus on optimizing biostimulant application techniques and understanding their interactions with soil microbiomes to maximize their potential in enhancing crop productivity and environmental sustainability.

Moving forward, research on biostimulants should target several key areas to advance their application in sustainable agriculture. This includes the exploration of novel biostimulants with superior growth-promoting properties, investigating synergistic effects with other biostimulants such as AMF and PGPR, and assessing various application methods and timings. Assessing the sustainable influnces of biostimulants on soil health and microbial diversity will offer crucial insights. Future research should also examine how biostimulants improve plant resilience to environmental stress, their influence on nutrient use efficiency, and the biochemical mechanisms driving these interactions. Transitioning to field trials will be essential for assessing the practical benefits of biostimulants, while studies addressing their impact on crop quality and consumer acceptance will facilitate their integration into mainstream agricultural practices.

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Chapter 5

AGRICULTURE 4.0 AND VITICULTURE: THE CURRENT STATUS OF DIGITAL TECHNOLOGIES AND FUTURE PERSPECTIVES

Ruhan Ilknur GAZIOGLU SENSOY[1]

INTRODUCTION

Agriculture 4.0 refers to the integration of advanced technologies such as digitization, automation, and data analytics into the agricultural sector. Viticulture represents an important area in the transition from traditional agricultural practices to digitalization. Various innovations, including sensor technologies, the use of drones, AI-supported decision-making systems, and automation applications, are among these technologies. In addition to analyzing the current status, the potential benefits of these technologies in viticulture are also examined. These benefits include increased productivity, more efficient use of resources, improvements in quality control, and strengthening sustainability measures.

The concept of Industry 4.0, known as the Fourth Industrial Revolution, was introduced in Germany in 2011. It can be described as the replacement of muscle power by machines and human management by automation, because of technological advancements (Kilic and Alkan, 2018). The agricultural sector has been continuously influenced by these technological innovations. Following and implementing these innovations in the agricultural sector has become increasingly essential. According to the FAO's report titled "How to Feed the World in 2050," the global population is projected to increase by 34% and reach 9.1 billion by 2050. This growth is expected to make food security a more pressing issue, and FAO recommends that countries invest in agricultural R&D and prioritize policies in this area. As one of the top 10 agricultural economies in the world and the largest agricultural producer in Europe, it is crucial for Türkiye to focus on agricultural R&D and work to increase production in line with these recommendations (Pakdemirli et al., 2021).

[1] Assoc. Prof. Dr., Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Horticulture, rigazioglu@yyu.edu.tr, ORCID iD: 0000-0002-2379-0688

training, and infrastructure remain, and various measures should be taken to overcome them.

In summary, Agriculture 4.0 is characterized by the digitalization and automation of farming processes, focusing on improving efficiency through technological innovation. However, with the shift toward Agriculture 5.0—a model that emphasizes human-machine collaboration, personalized production, and sustainability—the disadvantages identified within Agriculture 4.0 can be minimized. Agriculture 5.0, which values societal and environmental concerns, can be seen as the next step beyond Agriculture 4.0, enabling solutions that are more aligned with human and environmental harmony in the future of farming.

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