засобу від мікробного забруднення у процесі зберігання та використання, необхідним є введення консервантів, підбір яких буде наступним етапом нашої роботи.

BIOTECHNOLOGICAL ASPECTS OF USING PROBIOTIC FERTILIZERS IN AGRICULTURE

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Introduction. Nowadays, there is a global scenario of lack of resources to feed an ever-growing worldwide human population. Agriculture is the main primary sector involved in food production and should overcome the problem, producing sufficient nutriment for the global population. However, the reality is not as expected. Intensive agriculture is based on the application of increased levels of chemical fertilizers. Both pesticides and chemical fertilizers, when used indiscriminately, can affect human and livestock health and accumulate in soils and water, polluting ecosystems. Intensive agriculture has more associated problems, reduction of the diversification of croplands, shortage of soil nutrients, loss of genetic diversity, contribution to global warming, etc.

Aim. According to the above mentioned problems related to the application of chemical fertilizers and pesticides and, moreover, allowing the obtention of better quality products, the application of microorganisms, especially bacteria, with plant growth promoting features, the so-called plant probiotics, may be a possible solution to increase crop production. In this review, we summarize some of the best-known mechanisms of plant probiotic bacteria to improve plant growth and develop a more sustainable agriculture.

Research results. The term Plant Probiotic Bacteria was first mentioned to name a group of microorganisms benefiting plants, which fulfils three essential criteria that combined result in better plant protection. Plant Probiotic Bacteria can be classified according to their interactions with the host plant, being divided into 2 groups: free-living rhizobacteria and endophytes. Rhizobacteria live outside plant cells and enhance plant growth as a result of the metabolites that they release in the rhizosphere. Endophytes live inside plant tissues and cells and directly exchange metabolites with their host plant, positively affecting their growth. Most endophytic bacteria live in the intercellular spaces of the host plant; however, there are some bacteria able to form truly mutualistic interactions with their hosts and penetrate plant cell inside. Moreover, some of them are able to integrate their physiology and even go through a process of bacterial differentiation within the plant cells, resulting in the formation of specialized structures. The best known mutualistic symbiotic bacteria are the rhizobia, which establish symbiotic associations with leguminous plants, fixing atmospheric nitrogen for the plant in a specialized root structure, commonly called root nodules.

A plethora of studies showed the worldwide use of Plant Probiotic Bacteria as biofertilizers, contributing to the increase of crop yields and to the improvement of soil fertility; thus, these bacteria have the potential to contribute to more sustainable agriculture and forestry.

Although is quite abundant in the Earth, nitrogen is the most limiting nutrient for plants, whose require it for the formation of aminoacids and subsequently, proteins. Some prokaryotes have the exclusive of managing the process of combination or conversion of atmospheric nitrogen into organic forms, which can be finally assimilated by plants. Amongst free-living rhizobacteria, members of the genera *Azospirillum, Azotobacter, Beijerinckia, Bacillus, Paenibacillus, Burkholderia, Gluconoacetobacter* and *Herbaspirillum* were reported as nitrogen-fixing microorganisms. Moreover, some species of this genus are tested as biofertilizers for several cereals, such as wheat, barley, oat, rice or maize; oil plants, such as, linseeds and sunflowers. Phosphorous is the second essential nutrient for plants, after nitrogen and the major part of the reservoirs are not available for them. Nevertheless, when applied as fertilizer to crop fields, phosphorous passes rapidly to become insoluble and thus, unavailable to plants. Therefore, the use of phosphorous- solubilizing bacteria, such as the genera *Micrococcus, Pseudomonas, Bacillus, Paenibacillus, Deftia, Azotobacter, Klebsiella, Pantoea* and *Flavobacterium,* might represent a green substitute for these environment-damaging chemical fertilizers. After nitrogen and phosphorous, potassium is the third nutrient essential for plant growth. Some rhizobacteria are able to make available the insoluble potassium forms. Amongst Firmicutes, there are many examples like genera *Bacillus* and *Paenibacillus* are one of the most reported as potassium-solubilizing bacteria. *Bacillus edaphicus* has been reported to increase potassium uptake in wheat. Wheat and maize plants inoculated with the *Bacillus mucilaginosus* under laboratory controlled conditions showed increased plant biomass and chlorophyll content in leaves.

Conclusions. Nowadays, worldwide agriculture faces several challenges: enough sustainable food and feed production to satisfy the increasing demand of a raising human population with an expanding demand of livestock products, using limited resources, caring about environmental problems induced by traditional practises of intensive farming and fulfilling the food quality requirements of the markets in developed countries. In this review, we summarized a plethora of studies, which show the potential of plant probiotic bacteria to produce benefits for plants in several ways. These benefits include phytostimulation, nutrient mobilization and biocontrol of plant pathogens.