

# Food, Agriculture and Microbes

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**Abstract** - As with the production of microbes are used widely in the agricultural and food industries. It is recognized that microorganisms as fungi, bacteria and yeasts can provide solutions to world problems in public health, Agriculture, food, environment and poverty. They are vital components of the world's biodiversity, contributing immense value ecologically and economically. They are fundamentally important in ecosystems, breaking down complex animal and plant remains in soil and thus releasing essential nutrients for plant growth; they form beneficial mutualistic relationships with various plants, for example, nitrogen-fixing rhizobia with leguminous plants and mycorrhiza with forest trees; being used as biocontrol agents for pests and pathogens as well as in the detoxification of wastes and waste breakdown. Recently, greater consciousness of the effect of fossil fuels on the environment has increased the call in some quarters for the use of more environmentally friendly and renewable sources of energy, has led to a search for alternate fermentation substrates, exemplified in cellulose, and a return to microbial fermentation production of ethanol and other bulk chemicals. They are used in manufacturing numerous industrial products such as food, drugs, hormones, and enzymes etc. It is thus crucial that the microbial diversity of the world is not lost and that it is identified, characterized and exploited in a sustainable way for the benefit of humankind. The world must benefit from its microbial diversity, which is crucial to solving increasing problems in food provision, public health and poverty alleviation. The application of these bio-agents is expected to produce cleaner products for consumption and exportation. Farmers use a bacterium that produces a natural fertilizer. This type of bacterium is normally associated with bean plants, growing in nodules on the roots in a symbiotic - mutually beneficial - relationship. The bacterium converts nitrogen gas in the air to a form that plants can use- like fertilizer. By adding bacteria to the soil, farmers can increase the productivity of the plants. Microorganisms are widely used in various beneficial applications, including food, pest control, bioremediation, biodegradation, biofuel processes, and plant symbiosis and growth stimulation. This review provides an overview of the available microorganisms and their benefit to food and agriculture.

**Keywords** – Food, Agriculture, Microbes, Biodiversity.

## MICROORGANISMS

Microorganisms are so essential to us that it became our cell's energy producer: the mitochondria. (Similar bacteria became chloroplasts in plants.) While some microorganisms can make you sick, others can make you well. They produce antibiotics that treat infections. Microorganisms are important to both old and new biotechnologies. Microorganisms are tiny that come in an amazing variety of shapes and sizes. They include bacteria, viruses, fungi, yeasts, protista, and archaea. They were the first life forms, appearing 3.8 billion years ago in the boiling ocean. They produced the atmosphere's first oxygen, which paved the way for more complex

organisms and ecosystems. Today, microbes exist in every nook and cranny, under every condition imaginable. They are the ultimate adapters. Although individual microbes are tiny, they are massive as a group. They account for almost two thirds of the Earth's biomass (living material). They recycle the Earth's oxygen, carbon, nitrogen, and sulfur through the air, water, soil, and rock. Their collective "breathing" creates our atmosphere and controls our climate.

Agricultural production depends heavily on this biodiversity, and plants and animals cannot grow optimally without them or perform essential physiological needs. Microorganisms are widely used in various beneficial applications, including food, pest control, bioremediation, biodegradation, biofuel processes, and plant symbiosis and growth stimulation. Microorganisms are active 24 hours every day in diverse biological reactions. Their main role is breaking down residues and motivating elemental natural geo-biochemical cycles in nature. Biological control of plant diseases and biofertilization as well have the potential to reduce chemical inputs in agriculture, maintain greater biological balance in the ecosystem, and lead to more sustainable long-curiosity to a commercially viable agronomic practice. Utilization of certain beneficial microorganisms (BMO) to control plant disease and enhance soil fertility and increase crop production is an integral component in sustainable clean farming. Indeed, untold research dollars have been internationally spent searching for ways to conserve microbial biodiversity. In the future microbial genomes will be studied not only in their own rights but also as models for the understanding of basic mechanisms in cellular function in general[12].

## BIODIVERSITY

Biodiversity is the sphere of life on earth that encompasses ecosystems, natural habitats, fauna and flora, microbial species, and genetic resource. Microbial biodiversity provides food, fuel, construction materials, waste decomposition, renewal of soil fertility, disease combating and keeping genetic resources. They are the basis of life prosperity, the means of human lives, and by its conservation, we keep humanity, providing its treasures for the existing and future generations[13].

### *Useful Micro-organisms:*

Decomposers Fungi and most bacteria are saprotrophic and have an important role in an ecosystem as decomposers, breaking down dead or waste organic matter and releasing inorganic molecules. These nutrients are taken up by green plants which are in turn consumed by animals, and the products of these plants and animals are eventually again broken down by decomposers.

### *Agricultural and Environmental Benefits of Microbes*

The important role of nitrogen fixation by rhizobia and other bacteria for plant growth has been known for decades. What is less appreciated, and less well understood, is the pervasive influence that other microbes have on plant health and growth; they enhance stress tolerance, provide disease resistance, aid nutrient availability and uptake, and promote biodiversity. The most intense interactions between microbes and plants take place at the rhizosphere, which is the interface between plant roots and the soil. ...Soil microbes have a tremendous influence on plant health and productivity[1]. One straightforward and visible benefit for the plant is a better supply of and access to nutrients. ...Arbuscularmycorrhizal fungi, which form an intricate internal symbiosis with the roots of most flowering plants, are associated with the provision of phosphorous to the plant[16] Bacteria of the *Azospirillum* genus promote increased root mass and more efficient nitrogen uptake from the soil in response to the plant hormone indole-3-acetic acid. Using these bacteria and fungi could provide significant environmental benefits as they would allow a reduction in the application of nitrogen and phosphorous fertilizers.

### **SEWAGE TREATMENT**

**Sewage treatment** employs bacteria which break down harmful substances in sewage into less harmful ones. Aerobic bacteria decompose organic matter in sewage in the presence of oxygen. Once the oxygen is used up the aerobic bacteria can no longer function, and anaerobic bacteria continue the decomposition of organic matter into methane gas and carbon dioxide, along with water and other minerals. The digested sludge is rich in nitrates and phosphates and can be spread on the land as fertilizer [14; 15]. Some sewage treatment plants have used the methane as a cheap form of fuel (biogas). Anaerobic micro-organisms are also being used to convert carbohydrate-rich crops, such as cane sugar and maize, into ethanol which is used as a substitute for petrol in cars. This biofuel (or gasohol) is used widely in Brazil, which has meagre oil resources.

The carbon cycle Fats, carbohydrates and proteins all contain carbon atoms, so dead and waste organic matter contains a lot of carbon. In breaking this down, saprophytic bacteria and fungi take up some carbon to build their own bodies, and release some as carbon dioxide during respiration. However, the carbon cycle need not involve decomposers because autotrophs can access carbon from the abundant carbon dioxide in the air.

### **BIO-PESTICIDES**

In recent years it has become evident, as a result of public opinion and environmental legislations, that new and safe alternatives to traditional synthetic pesticides are both desirable and mandated. Most sustainable and environmentally acceptable pest control means might be achieved using biocontrol agents [2](Fig.1). Biological

control offers an environmentally friendly alternative to the use of pesticides for controlling plant diseases[2,3,4,5,6,7,8,9,10,11,12] (Fig.1) . In addition to enhancing the nutrient supply to plants, microbes also confer a degree of protection against plant diseases. In particular, various bacteria and fungi – especially of the genera *Pseudomonas*, *Bacillus* and *Trichoderma* – produce a range of metabolites against other phytopathogenic fungi[ 17; 18] ...With development, such microbes could become a realistic alternative to the heavy fungicide regimens used in agriculture at present. A reduction in the use of these chemicals would lead to obvious environmental benefits. In addition to these direct effects on plant growth, rhizobacteria exert another health-promoting effect on the plants with which they interact. This phenomena is known as induced systemic resistance and arises when interactions with non-pathogenic bacteria confer better disease resistance on plants.[17]

*Government program and national obligations toward regional and international conventions include:*

1. Increase exports and attract investments in the field of nature conservation and natural protectorates.
2. Provide innovative and untraditional solutions for governmental disbursements, budget and economical techniques for self finance.
3. Raising efficiency of administrative board and services through development of institutional structure, development of human resources, and efficiency of natural protectorates, in addition to indicators of awareness, planning and follow up.
4. Reduce unemployment; maintain social dimension and society values through presenting protectorates as a model of sustainable development, combating poverty, protection of intellectual property and heritage of local inhabitants.
5. Open door policy to realize Egyptian benefits through cooperation with donor states and organizations, implementation of international conventions and benefiting from their organizations.
6. Using modern technology and potentials to improve communication network, develop information systems of natural protectorates and biological diversity, in addition to modern techniques of monitoring.
7. Deepening public participation in national work through partnership with local communities, civil society, enhance women's role, benefits for unable groups, in addition to raising environmental awareness and information.

The microbiologist of today is, therefore, largely concerned with the evolution of methods for the development and maintenance of microbial growth upon which an understanding of their unique and diversified biological and biochemical characteristics can be investigated. To this end, microbiologists have developed innumerable enrichment culture techniques for the isolation and cloning of microorganisms with specific nutritional requirements. These organisms and their unique characteristics have been essential to progress in basic biological research and modern applied microbiology. One

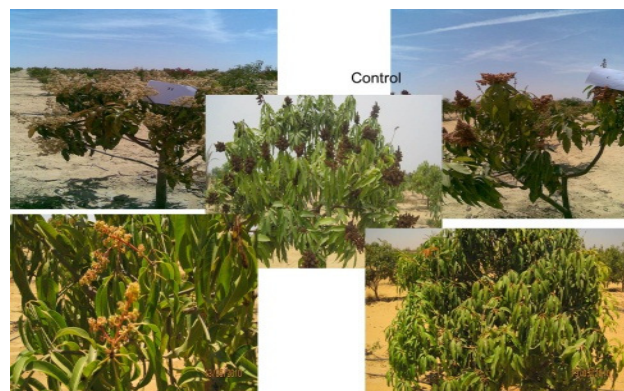
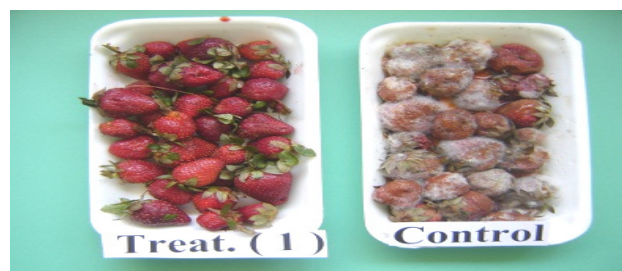
of the most important events in the history of microbiology was the invention of molecular cloning, allowing defined pieces of microbial genomes to be isolated and identified at the nucleotide level. Another landmark in the history of molecular diagnostics was the invention of PCR. It is in fact today difficult to imagine how workers in the field could be sustained before the invention of this marvelous technology. PCR has certainly revolutionized nucleic-acid-based analysis by providing a simple method to generate highly specific targets. Moreover, since it allows detection of single molecules it offers an unsurpassed sensitivity. Yesterday's microbiological research was largely a manual business. In the early days of molecular biology it was a major undertaking to sequence a dozen base pairs and the annual output of sequences before the mid-1970s was extremely limited and mostly the result of RNA sequencing by cumbersome methods. The new methodologies certainly changed the field and many laboratories started to produce sequences at speeds of thousands of nucleotides per year. At the time being there are numerous promising powerful exciting horizons for man's continued exploitation of microorganisms, e.g., genetic engineering, genomics, proteomics, bioinformatics.

The manipulation of cells, particularly micro-organisms, to produce useful substances is referred to as biotechnology. Micro-organisms are exploited extensively in the fields of medicine, agriculture, food production, waste disposal and many other industries. We make use of some saprophytic bacteria which do not produce waste products harmful to humans. The bacterium *Lactobacillus* feeds on milk, turning it into yoghurt. Other bacteria and fungi help in cheese-making and are responsible for distinctive flavours. Most industrial enzymes (protein catalysts) come from micro-organisms. Special strains of fungi and bacteria are developed by genetic engineering. They are grown in large fermenters where they secrete enzymes into their nutrient solution. The enzyme is isolated and concentrated for use. Examples of such enzymes include amylases for producing chocolates, fruit juices and syrups; cellulases for softening vegetables; proteases for tenderising meat and for removing biological stains when put in biological washing powders[18].

Yeast is a single-celled fungus that lives naturally on the surface of fruit. It is economically important in brewing and bread-making. Yeast respire anaerobically (i.e. without the use of oxygen) and breaks down glucose with the production of carbon dioxide, ethanol (alcohol) and energy. In wine-making the yeast feeds on fruit sugars in the grapes, and in beer-making it feeds on the maltose sugar in germinating barley. The term fermentation, is usually applied to this process of anaerobic respiration in which alcohol is produced. Controlled oxidation of alcohol can be carried out to produce vinegar (ethanoic acid). Bread-making uses the carbon dioxide produced by anaerobic respiration, not the ethanol. Starch in the dough breaks down to sugar, which feeds the yeast. The carbon dioxide bubbles make the dough rise before it is baked into bread.

## CONCLUSION

Strategies and national action plans succeeded to a large extent in achieving the expected targets, however many challenges are still facing nature conservation such as insufficient finance, development of the institutional structure, supporting infrastructure for the rest of the established protectorates, apply decentralization principle in management, risks facing protectorates' employees, implementation of laws, issuing new legislations, implementing international agreements, reduce violations on protectorates and depletion of natural resources; in addition to dealing with new emerging issues that have not been included in the national strategies such as invasive species, traditional knowledge, information technology and its modern tools; bio safety, climate change's impacts on biological diversity.



Efficacy of foliar sprays of different bioagents on the incidence of malformation and anthracnose of Awais mango cultivar .



Fig.1. Treated and Untreated of Crop plants with microorganisms. A) treated plants; B) Untreated Plants

## REFERENCES

- [1] Bloemberg GV, Lugtenberg BJ (2001) Molecular basis of plant growth promotion and biocontrol by rhizobacteria. *Curr Opin Plant Biol* 4: 343–350 .
- [2] HaggagWafaa (2010). Mango diseases in Egypt. *Agriculture and Biolog. Journal of North America, USA* ; 1(3): 285-28
- [3] HaggagWafaa (2010). Role of entophytic microorganisms in biocontrol of plant diseases. *Life Science Journal, USA*;7(2):57-62.
- [3] HaggagWafaaM ,Malaka A. E. Saleh (2012b). Application and Formulations of *Streptomyces Aureofaciens* and *Pseudomonas putida* for Management of Grape Anthracnose and Grey Mould Diseases. *European Journal of Scientific Research* Vol. 91 No 2 November, 2012, pp.174 - 183
- [4] HaggagWafaaM and Elham G. Abdallah (2012c). Purification and Characterization of Chitinase Produced by Endophytic *Streptomyces hygroscopicus* Against Some Phytopathogens. *Journal of Microbiology Research* 2012, 2(5): 145-151
- [5] HaggagWafaaM, Malaka A. E. Saleh and Mostafa Abo El Soud (2012a). Semi - Industrial Processes of *Verticillium Lecanii* Producing Chitinase for Controlling of Grape Powdery Mildew. *European Journal of Scientific Research* Vol. 91 No 1 November, 2012, pp.41-57.
- [6] HaggagWafaaM, and Mostafa Abo El Soud (2012d). Production and Optimization of *Pseudomonas fluorescens* Biomass and Metabolites for Biocontrol of Strawberry Grey Mould. *American Journal of Plant Sciences*, 2012, 3, 836-845 .
- [7] HaggagWafaa M and Singer S. (2012f). Development and Production of Formulations of PGPR Cells for Control of Leather Fruit Rot Disease of Strawberry. *American Journal of Scientific Research* 67 (2012), pp. 16-22
- [8] HaggagWafaa M, R. Sabey and Abd El-Wahab M. E. (2011a). Characterization and Mechanism of Action of Biocontrol Agents Active in Suppression of *Foliar Plant Pathogens*. *World Academy of Science, Engineering and Technology*; France 77: 2367-2389
- [9] HaggagWafaa M.; Lashin, M. S. and El Azzazy, A. M. (2012e). Large Scale Production and Pilot Trails of *Tilletiopsis Pallescens* for Biocontrol of Mango Powdery Mildew. *European Journal of Scientific Research*. Vol.67 No.2 (2012), pp. 194-214
- [10] HaggagWafaa, Enas, M. Mostafa , El Azzazy, A.M. (2011b). Optimization and production of antifungal hydrolysis enzymes by *Streptomyces aureofaciens* against *Colletotric humgloeos porioides* of mango. *Agriculture Science*; USA 2(2): 146-157
- [11] Haggag, Wafaa, M., Mohamed, H.A.A. (2007). Biotechnological Aspects of Microorganisms used in Plant Biological Control (Article). *American-Eurasian Journal of Sustainable Agriculture*, 1(1):7-12.
- [12] Hoballah, E.; Attallah, A.G. and Abd-El-Aal, S. Kh. (2012). Genetic diversity of some new local strains of cyanobacteria isolated from Wadi El -Natrun, Egypt. *International Journal of Academic Research*, 4 (2) 314-326.
- [13] Raaijmakers JM, Vlami M, de Souza JT (2002) Antibiotic production by bacterial biocontrol agents. *Antonie Van Leeuwenhoek* 81: 537–547
- [14] Saber M.; Hoballah E.; Fatma H. Abd-El-Zaher and Eman I. Al-Mowafy (2011b). Decontamination of Enteric Pathogens in Sewaged Soils by Certain Organic Amendments. *Journal of Biotechnology Research*, 11: 1-15.
- [15] Saber, M.; Hoballah, E.; Azza, Sh. Turkey and Doaa, I. Ali (2011a). Microbial Decontamination of Enteric Pathogens in Sewaged Soils. *Australian Journal of Basic and Applied Science*, 5(11): 1312-1320.
- [16] Smith SE, Read DJ (1997) *Mycorrhizal Symbiosis* 2nd ed. San Diego, CA, USA: Academic.
- [17] van Loon LC, Bakker PA, Pieterse CM (1998) Systemic resistance induced by rhizosphere bacteria. *Annu Rev Phytopathol* 36: 453–483.
- [18] Walsh UF, Morrissey JP, O’Gara F (2001) *Pseudomonas* for biocontrol of phytopathogens: from functional genomics to commercial exploitation. *Curr Opin Biotechnol* 12: 289–295 .

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