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Microbial Consortia

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SUMMARY

One gram of soil contains diverse group of micro-organisms which includes Bacteria, Actinomycetes, Fungi, Algae, Protozoa and Nematodes. Interactions between microorganisms are influenced by the plant which exudates compounds. Microbial consortium provides beneficial additive or Synergistic results. These plant growth promoting micro-organisms have a beneficial effect on plant growth directly and indirectly. Advantages of Microbial consortium includes reducing metabolic burden, better utilization of substrate, robustness to environment change and activation of silent genes. Lack of consortium stability, preservation of mixed cultures, nutrient requirement of different microbes. Incompatibilities of the microbes in the mixture with each other etc. are some of the challenges for using microbial consortia. Microbial consortia can be used as Biofertilizers, Bioremediation, degradation of organic wastes, Biocontrol agent etc. it has been classified according to modes of construction, interactions and function.

INTRODUCTION

One gram of soil contains diverse group of micro-organisms which includes bacteria 9×10^7 cells per gram, Actinomycetes 4×10^6 cells per gram, Fungi 2×10^5 cells per gram, Algae 3×10^4 cells per gram, Protozoa 5×10^3 animals per gram and Nematodes 3×10^1 animals per gram. From this wide range of micro-organisms several species have multiple interactions which are influenced by the plant which exudates compounds ex: sugars, Amino acids and organic acids etc, have different niches, competition for nutrients and for colonization of space etc. Using a mixture of two or more compatible plant growth promoting micro-organisms of different species or strains is called microbial consortium which provides beneficial additive or Synergistic results (Gustavo *et al*., 2021, Louca *et al*., 2018).These plant growth promoting micro-organisms have a beneficial effect on plant growth directly by Nitrogen fixation, Phosphate solubilisation, increase water uptake, synthesize phytoharmones ex: Auxins, Cytokinins, Gibberlins and Abscisic acid (Sandra *et al*., 2018, Gustavo *et al*.,2021, Owen *et al*., 2015, Gopalakrishnan *et al*., 2014) and indirectly help plant by reducing ethylene, disease suppression, and inducing plant resistance to pathogens by synthesizing antibiotics, Siderophores (Bjelic, 2014., Gustavo *et al*., 2021, Sandra *et al*., 2018, Abhilash *et al*.,2016). Microbial consortia perform better than single strain in terms of metabolizing complex compounds, carrying out multiple reactions, degrading polymers like Cellulose, remaining stable in fluctuating environment, use of complex and multiple carbon sources for constructing long Biosynthetic pathways . All these activities may not be present in single micro-organism (Bhatia *et al*., 2018, Brennar *et al*., 2008 and Gustavo *et al.,* 2021).

Advantages of Microbial Consortium

- Distributing the tasks between two or more strains help to optimize tasks more easily which helps in reducing metabolic burden on the strain (Mccarty and Ledesma-Amaro., 2019, Shahab *et al*., 2020, Hong *et al*., 2020 and Du *et al*., 2020)
- Through division of labour multiple tasks can be carried out simultaneously (Qian *et al*., 2020, Wang *et al*., 2020, Mccarty and Ledesma-Amaro, 2019 and Shahab *et al*., 2020).
- Diverse genomic size in microbial consortia helps to perform unique tasks (Mccarty and Ledesma-Amaro, 2019).
- Different strains having multiple functions are robust to the environment change (Mccarty and Ledesma-Amaro, 2019 and Jiang *et al*., 2019).
- Broad range of substrate spectrum (Mccarty and Ledesma-Amaro, 2019, Giri *et al*., 2020
- Activation of silent genes (Ibrar and Zhang, 2020 and Ancheeva *et al*., 2018).

Challenges for using Microbial Consortia

Lack of consortium stability during fermentation process, because one organism may dominate over other. Preservation of mixed cultures is also a challenge because different microbes have different survival rates. Nutrient requirement of different microbes has to be known (Bhatia *et al*., 2018). Incompatibility of the microbes in the mixture with each other (Harish and Jagadeesh, 2016). Fumigated soils alter the Bio-community structure of the soil and their interactions which help in nutrient acquisition and mobilization (Backer *et al*., 2018, Dangi *et al*., 2017).

Applications of microbial consortia

Microbial consortia can be used as Biofertilizers, Bioremediation, degradation of organic wastes, Biocontrol agent etc (Harish and Jagadeesh, 2016).

Microbial Consortium Classification (Bhatia *et al*., 2018).

Microbial consortium has been classified according to modes of construction, interactions and function. Bernstein and Carlson (2012) has classified microbial consortia in terms of construction in to Natural Microbial Consortium (NMC), Artificial Microbial Consortium (AMC), Semi-synthetic Microbial Consortium (SeMC) and Synthetic Microbial Consortium (SyMC).

1) Natural Microbial Consortium: group of microorganism living together symbiotically in nature is called Natural Microbial Consortium.

2) Artificial Microbial consortium: here group of different wild microbes growing symbiotically are grown together in a closed system.

3) Semi- synthetic Microbial Consortium: wild and engineered group of microorganism are cultured together.

4) Synthetic Microbial Consortium: it includes group of microorganisms that are metabolically engineered are grown.

Classification of Microbial Consortium according to modes of interaction in to Synergistic, Commensal and Mutualist, (Bernstein and Carlson, 2012).

1) Synergist: in this type of interaction parallel use of different substrates by dividing their labour

2) Commensal: in Commensal interaction one organism is benefitted without affecting the other organism.

3) Mutualist: in this type of interaction all microorganisms are benefitted.

Classification According to Functional Modes

1) Environment Maintenance Consortium (EMC) 2) Nutrient Exchange Consortium 3) Substrate facilitator consortium 4) Signal exchange consortium

1) Environment Maintenance Consortium: in this type of consortium a favourable environment is provided for partner growth (Wu *et al*.,2016)

2) Nutrient Exchange Consortium (NEC): In the consortium some group of microorganisms fail to produce life-supporting molecules. Hence these group of Microorganisms provide life-supporting molecules and support the growth of the Consortium (Shou *et al*., 2007).

3) Substrate Facilitator Consortium: in this Consortium some group of Micro-organisms provide hydrolases to produce free sugars for growth of other Micro-organisms which cannot hydrolyze all type of carbon source (Dwidar *et al*., 2013).

4) Signal Exchange Consortium: in this Consortium one group of Micro-organisms produce signaling molecules for communication which induces other group of micro-organism in the consortium to express Cryptic genes to produce Antibiotics and metabolites (Perez *et al*., 2011)

CONCLUSION

Microbial fertilizers depend on both plant and microorganism physiology and technical aspects like suitable microorganism, fermentation process, carrier material etc (Sandra *et al*., 2018). Microbial Consortia can be beneficial by understanding their interactions, community profiles. Using genomics like Metabolomics, Proteomics etc. are costly. Hence new techniques have to be introduced. Long term preservation of mixed

microbial cultures is very important (Bhatia *et al*., 2018). Microbial Consortia interactions has to be studied which can help plant growth, soil health and reduce use of chemical fertilizers. Microbial Consortia help impove plant growth by fixing atmospheric nitrogen, by secreting Vitamins, Exopolysaccharides and Enzymes (Naik *et al*., 2020). Microbial consortia can be applied through Seed treatment, Soil application, Root dip, Foliar application etc. and provide multiple methods of mechanisms to fight pathogens and also provide protection against Biotic and Abiotic stresses.

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